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The optimization research of Southeast Asian container liner routes of SITC Company

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THE 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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(Date):2015-6-28

Abstract

With container shipping increasing into large-scale and container liner company's main cooperation with China in deepening, the world's major container shipping company on the main differences in service gradually narrowed, therefore, the construction of the feeder in southeast Asia region,fleet management and operation has become a strategic choice for a container liner company to foster the core competitiveness and enhance the competitive advantage. Under the present shipping environment, the difference of service between base ports is not big and the freight price is becoming more and more transparent, so the service of Southeast Asia regional liner is particularly important. The construction and optimization of Southeast Asia regional route can not only increase the development of the regional market, provide regional transportation but also can enrich the resources of the feeder route in order to container liner company to achieve the purpose of market competitiveness.

The thesis is composed of 5 chapters. The first chapter is discussingon the overseas and domestic research of experts and scholars in liner optimization modeland the main technical route of the thesis.The second chapter analyzes the situation of the Southeast Asia liner shipping market and the present liner routes of SITC.In chapter three, the optimization analysis of the vessel distribution on the liner routesis introduced. Chapter four taking SITC container liner company as an example, through the method of linear programming to do an optimization research of SITC in Southeast Asian routes operation and management. Chapter five, the thesis displays the summary and shortage.

Key words: Southeast Asia routes; Linear programming; Container transport

Catalogue

1Introduction

1.1Research background

With the rapid development of the world trade and modern logistics, the container transportation capacity grows dramatically. Obviously, the large-style trend of ships and the functional differentiation of port calls have become increasingly. At present, the situation of excess capacity is still grim. The International Monetary Fund (IMF) forecasts that world GDP growth of 2015 will reach 3.9%, the recovery is obvious. New york-based consulting firm (AlixPartners) estimated 2014 international seaborne trade grew by 4% to 6%. But this number is far less than the quantity needed to absorb the growth of new shipping capacity. It is estimated that besides the scrapping capacity, the net gain of 2014 capacity is about 1.2 million TEU. According to the standard data in 2013 (130 million TEU, 18.5 million TEU capacity), the net increasing capacities mean that the world container ships would carry extra 9 million TEU of goods every year. However, from the point of global economic growth, the increase of transportation demand in 2015 will not be able to fully absorb the new capacity.

Thus, the liner shipping industry is facing two challenges. One is on the demand side, the possibility of global trade growth is hard to replicate high growth rate in first decade in the 21st century; The other is the processing outsourcing in main developed countries has been completed. The result is that the global trade growth and the multiplier effect of the demand for container will be under pressure. Therefore, in 2015 the prospect of recovery from the downturn in 2014 will continue to transition and in a constant state of uncertainty and volatility. In 2015, the rhythm of the new shipbuilding still won't slow down. The pressure of excess capacity will still

be grim, freight rate will still be low, and the time for common prosperity is still difficult to forecast.

With Southeast Asia gradually out of the influence of the national economy crisis and the high-speed development of foreign trade, Southeast Asian countries are occupying the important position in the world trading system. However, theCargo transportation network between Southeast Asian countries is not perfect enough, especially in Southeast Asia container liner regional transportation network.There is several main problems exist in Southeast Asia container liner feeder, such as: routes are relatively few, capacity is limited, liner services level is relatively low, and etc. The present situation cannot meet the needs of increasing Southeast Asia container transportation; it seriously affects the further development of southeast Asia import and export trade.

1.2 Overseas and domestic research status

Shipping industry is a very ancient industry, for a long time, practitioners and researchers have participated in the research for ship scheduling optimization problems deeply, a large number of optimization model is established, considerable research has been applied to the practice, and achieved good economic benefits. The following main review at overseas and domestic in the research of route optimization, which mainly introduces the latest research and application of the liner route optimization.

In the past research, there are a lot of research on the problem of routing and scheduling, such as the famous "the postman problem" （TSP） and "transportation problem"（VSP）.But these studies are more for cars and trains, when it comes to maritime transport involving huge capital and operating cost, the research about shipping schedule and route optimization is relatively small, particularly in the

Southeast Asia liner shipping. The main reason of this situation is the influence of the uncertainty of the decision variables, such as the change of capacity, weather conditions, technology, government regulation, subsidies, the requirement of the minimum service frequency, etc. All these factors prevent people from the attempting and analyzing of the transportation system. A variety of reasons make liner route optimization and scheduling is much more difficult than other modes of transportation on establishing a model of the liner shipping.

1.2.1 In overseas research:

Korsvik JE, Fagerholt K, Laporte [7] found there exist some unreasonable transportation costs in certain products in many shipping companies, and developed a decision-making system in a timely manner to provide route choice problem, choose reasonable port and transport of the goods. Under the fixed routes and transport demand condition, Ronen, Christiansen[27] proposed the method to select best fleet ship type and fleet mixed solution.

Around route optimization design aspects of Rana and Vickson[11][12]，established with the goal of maximizing the liner companies benefit of nonlinear integer programming model, they tried to solve the problem of port selection and route optimization. The study not only discussed the design of the route, but also analyzed the optimal selection of berthing order in their study that based on the principle of no profit port no berthing, then designed a nonlinear integer programming model and used the Lagrange multiplier method to solve the model.

1.2.2 In domestic research:

To select the most suitable ports, Zhao Ning[5] has analyzed the procedures of setting liner routes in order to have a further study in the voyage costs. And a model is finally formulated to maximize the profits of the voyage. A deal of numerical

experiments has been done to prove the feasibility and effectiveness of the model. Yang Qiuping, XieXinlian, HuoWeiwei[20]did a research on ship routing model and fleet planning model, considered the highest profit as the goal to improve the optimization of Marine resource allocation. The study combines short-term scheduling with long-term planning in the model, through simplex algorithm, the final purpose is to solve the linear programming model and numerical experiments to prove the effectiveness of the model. MiLiangchuan, Huang Feiwu[23] and etc，using the analytic hierarchy process to establish a hierarchy structure model（including AHP model）analyzing the factors which affected the route design. Another method can be used in many situations, For example, Fang Liang[14] used SWOT method to compare 11 major asian ports as a transshipment port. This approach focusing on the typical factors influence a port such as economy, convenience, practicality and comparison of competitive advantages with disadvantages. Another method is worth mentioning is the Saving Method, in the research of RenFei[22], he focused on designing liner routes between China and Japan, choosing the four ports as the optimal basic port on main line from the 19 candidates port, according to comparison of routes, cargo amount and transportation cost. Then the remaining 14 ports were selected as the branch point to be analyzed. Zhang Yang[21] optimized program of "A" container liner company's fleet deployment in Southeast which based on the operation and practice of “A” Container LinerCompany's liner service in Southeast Asia and combines with the strategic theory ofenterprise's development.

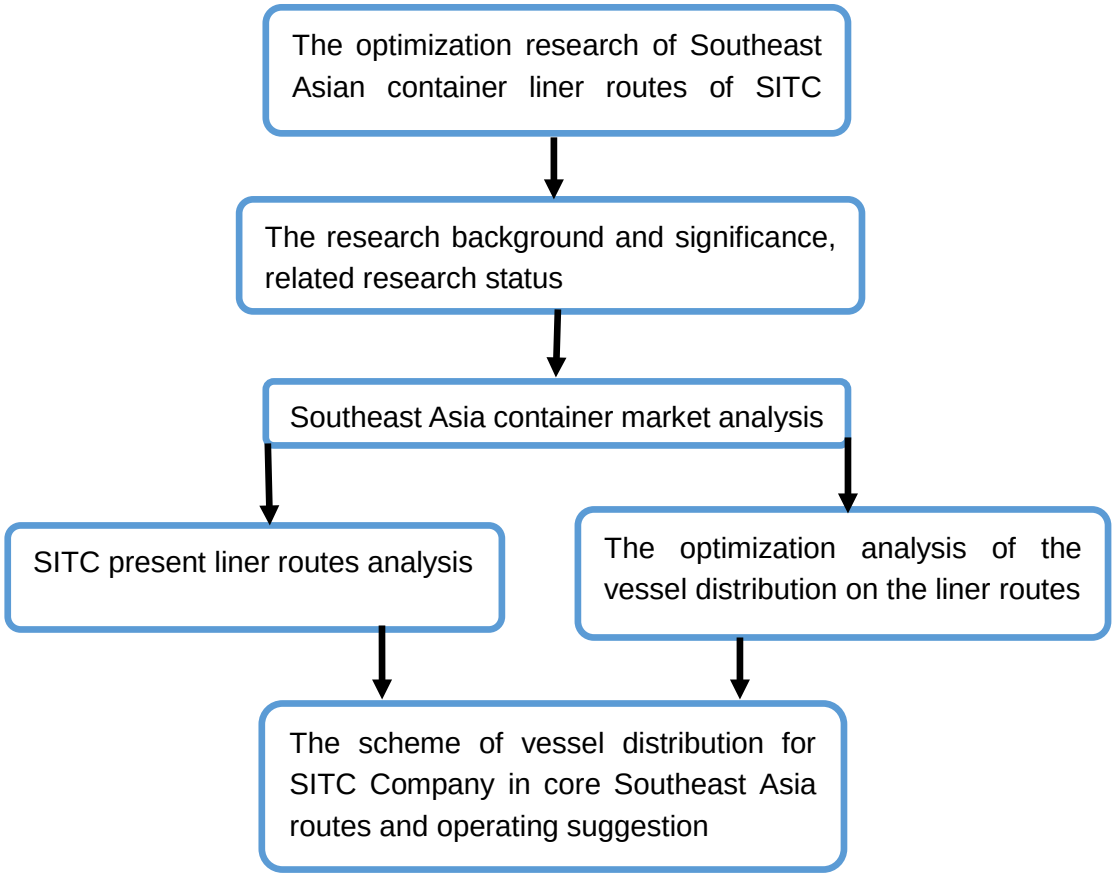
1.3The technical content and routeof the paper

This paper analyzed the route of southeast Asia, the affiliated ports, the condition of freight volume and capacity, and the southeast Asia region were used to predict the container volumes; Secondly，Through the analysis of the cost of transportation of container transport and the characteristics of the line parameters, based on the

overseas and domestic research about the planning of vessel allocation and find out the advantages and disadvantages of these models in actual application.Through the container transportation company actual ship inspection and investigation, optimize the course fitting model, according to the current actual situation, propose a feasible container transport routes fitting model.

According to SITC container liner company development of Southeast Asia regional liner route, operating conditions, volumes are analyzed; by using linear programming according to SITC container liner company's southeast Asia routes set are analyzed; Finally, this paper put forward the company in southeast Asia area with the ship in the optimization scheme ,operation strategy and management advice. As a container shipping company who wants to survive in the fierce competitive environment, it is essential to strengthen scientific management on the basis of the existing conditions, the rational allocation of transport network, scientific configuration shipping resources, different type and reasonable shipping quantity in reasonable route, in order to achieve minimum cost, the maximum profitable capacity.

Technology roadmap is shown below:



Tab1.3 The technical routes

2. Summary of Southeast Asia routes

2.1 Development situation in Southeast Asia

Shipping, is the induced demand of international trade, the condition of world trade directly determines the shipping market movements. Drastically affected by the global financial crisis, the international shipping market falling constantly. Due to the big international efforts which a huge amount of new building ships as before, the present trade fell sharply, so that no goods can be shipped, form a supply glut, owner was in sluggish market.However, it is against the backdrop of depression, south-east Asia's trade is not decreased in number, transportation are the direct embodiment of the improvement of the amount of containers. In order to promote the economic and trade development of east Asia, east Asia led negotiations after consulting for a long time, China ASEAN free trade area was established in the first day of 2010, the establishment of a free trade area means that more than 90% or more of the products in China with six ASEAN countries such as Indonesia are in the zero tariff trading environment. This almost zero lower tariffs for East Asia's economic and trade development will play a huge boost, thus, container liner transportation between China and ASEAN will have great potential for development, shipping company will adjust capacity to China and its trade is growing between trading partners. Southeast Asia is one of the important parts of Asia, with a population of five hundred million, and it has unlimited potential and the prosperity. Economic vitality "as the U.S. economic recession, Singapore, Vietnam and other Southeast Asian emerging markets began to emerge stronger. The explosive force, in the long run, the future of southeast Asia cargo will be further room for growth; In the short

term,

There will be some pressure. Southeast Asia is one of the important parts of Asia, with a population of five hundred million, and it has unlimited potential of prosperity and economic vitality. With the recession in America, Singapore, Vietnam and other Southeast Asian emerging markets began to show a powerful explosive force, the Chinese economic landscape layout again at the same time, the landscape planning is also changing in neighboring countries. As can be seen from the figure 3.1 the association of south-east Asian nations (ASEAN) and China's maritime container traffic is more and bigger, now China has become the biggest Marine transportation partners.

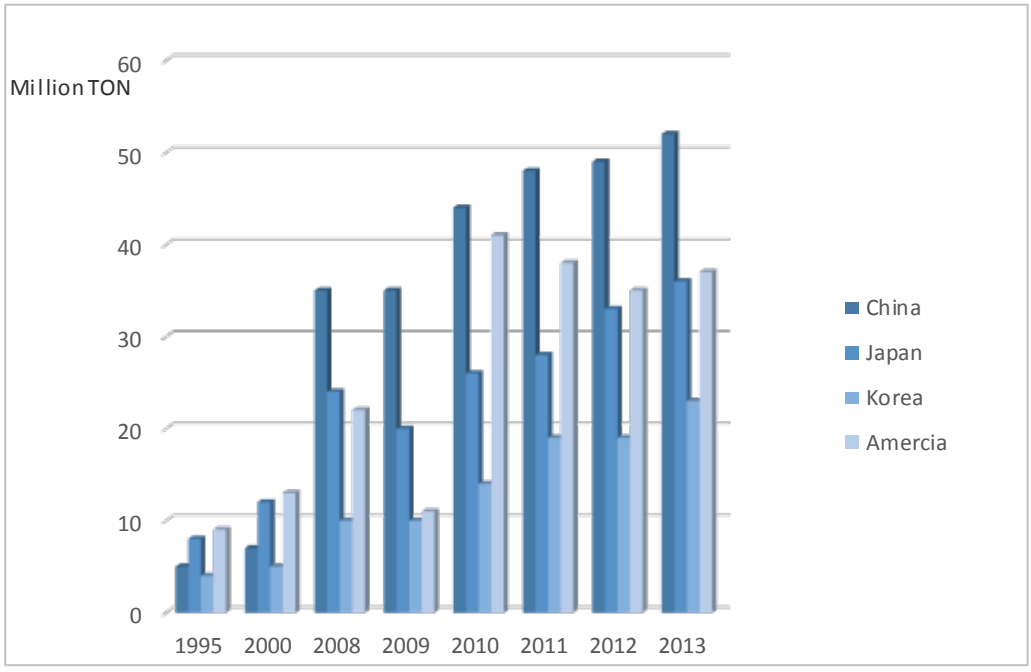


Fig2.1 Container shipping traffic between ASEAN and China, Japan, Korea, America respectively

2.1.1 Container throughput situation in Southeast Asia

According to relevant research institutes, 2000-2009 global container throughput in the 10 years the compound growth rate achieved 7.85%, China's fastest-growing container throughput, realize the compound growth rate of 22.22%.The United States, Japan and European growth is slower, the association of south-east Asian nations (ASEAN) growth of container throughput and global growth close to synchronization, this shows the association of south-east Asian nations (ASEAN) the development of container ports has been faster than Europe and the United States and other developed countries, began to present growth trend. Completion of the China-ASEAN free trade area with ASEAN container port development speed will increase further, the association of south-east Asian nations container port will have a lot of room to grow. Tab 2.1.1 and Tab2.1.2 shows the container throughput of the ASEAN countries and each country's main port container throughput. Can visually see from the graph, in addition to the affected by the economic crisis of 2008, container throughput fell in 2009, the rest of the year the port throughput growth ratio increased year by year.

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010
Singapore	16.94	18.41	21.33	23.19	24.79	27.94	29.92	25.87	31.12
Malaysia	8.63	9.91	10.80	11.36	12.85	14.33	15.46	16.37	17.53
Thailand	3.65	4.12	4.74	5.22	5.42	6.20	6.56	6.05	7.06
Indonesia	1.97	2.42	3.17	3.73	3.85	4.16	4.58	3.97	4.87
Vietnam	0.49	0.73	1.31	2.12	4.01	5.76	6.13	5.85	6.57

Philippines	3.01	3.14	3.36	3.24	3.86	4.05	3.77	3.58	4.01

Tab 2.1 .1container throughput of main countries in Southeast Asia (million TEU)

Port	2004	2005	2006	2007	2008	2009	2010
Singapore	21.33	23.19	24.8	27.93	29.92	25.87	31.12
LaemChabang	3.62	3.79	4.22	4.84	5.13	4.64	5.46
Jakarta	3.17	3.28	3.32	3.9	3.98	3.8	4.13
Ho chi minh	1.69	2.03	2.6	3.2	3.43	3.54	3.64
Haiphong	0.69	0.86	1.04	1.21	1.43	1.27	1.52
Manila	2.62	2.64	2.63	2.8	2.98	3.25	3.46
Bangkok	1.32	1.35	1.45	1.55	1.38	1.34	1.52

Tab 2.1.2 main container port throughput in Southeast Asia(million TEU)

2.2 The present situation of Southeast Asia routes in SITC

Fig2.2.1 Sitc container liner service network diagram

2.2.1SITC container liner current situation

SITC shipping group,scope of business is involved in container liner transportation, ship owners, ship management, ship agency, container leasing and other fields. Until December 31, 2014, the company are operating 67 container ships, which has its own 32 vessels; operating over 59 routes, network covering China, Japan, South Korea, Taiwan, Hong Kong, Vietnam, Thailand, Philippines, Cambodia, Indonesia, Singapore and Malaysia, 53 major ports in 12 countries and regions. The main business of SITC is in Asia area short range routes, most of the container ships in the fleet are 1 000 TEU container ship capacity, the main advantages of this type of vessels are operating efficiency and ship speed (compared with other companies

such as market positioning), flexible deployment of capacity and operating costs. From the vessel, SITC fleet is relatively young, average age is about 5.7 years. A younger fleet is beneficial to improve the operating efficiency and reduce the maintenance cost, to enhance low cost competitive advantage.

Reviews the ten years of development, the company development situation is good, but facing competition increasingly fierce domestic and international liner shipping market environment, combined with the current wave of the world economic crisis sweeping, new SITC processing requires keeping alive and maintaining development in case of the dark future.Companies should think seriously about how to analyze and master the opportunities and risks of shipping market, reduce operating costs, improve management, and improve enterprise's survival and competition ability. Thus it is necessary to have a practical and feasible development strategy with the development of a programmatic guidance for the company. In this paper, combining the successful experience of new SITC in recent years, base on the analysis of Company's market environment and the container traffic volume forecast, emphatically from the two aspects of camp and management container shipping, to discuss the future of the company in container business development. To come at the end of the development of decision-making, provide theoretical support for the policy makers

2.2.2 SITC container liners in Southeast Asia

Until the April of 2015, SITC Container Ship Company is operating 12 core liner routes in Asia which contain Southeast Asian ports, the density of schedule for a day on average 2 routes departure from Shanghai port.

Route	Route code	Port rotation	Ship in operation
Korea line on Monday	**NSE**	Qingdao - Busan - Shanghai - Manila (north) - Qingdao	MERATUS JAYAPURA/HYUNDAI SPRINTER/HYUNDAI STRIDE/LOS ANDES BRIDGE
Southeast Asia line on Saturday	**PCI**	LaemChabang-Ningbo-Shanghai- Jakarta- Singapore-Ho Chi Minh City	NORTHERN VIGOUR
Haiphong line on Tuesday	**CJV5-S**	Haiphong - Da nang - Hong Kong -Shanghai - Ningbo - Hong Kong - Haiphong - Da nang	AKARI/BAGAN STAR
Southeast Asia line on Wednesday	**VTX2-S**	Shanghai - Ho Chi Minh City - Bangkok- Laemchabang	SITC SHANDONG/ SITC ZHEJIANG
Haiphong line on Thursday	**CKV**	Pyongtaek - Daesan - Qingdao - Shanghai - Xiamen - Hong Kong - Haiphong - Da nang - Ho Chi Minh City - LaemChabang - Jakarta	ANITA L/FSL SANTOS/VAN HARMONY/SITC HAKATA/SITC HAIPHONG
Haiphong line on Friday	**CJV6-S**	Tokyo - Kawasaki - Yokohama - Hitachinaka - Shanghai - Shekou - Hong Kong - Haiphong	SITC TOKYO/SITC KAOHSIUNG/SITC KOBE
Southeast Asia line on Wednesday	**VTX3-S**	Shanghai - Hong Kong - Ho Chi Minh City - Sihanouk - Bangkok - Laemchabang	SITC FUJIAN/ SITC LAEM CHABANG/ARABIAN EXPRESS

Manila line on Friday	**CPX1**	Tianjin - Qingdao - Busan - Shanghai - Xiamen - Subic - Manila (north)	MERATUS JAYAPURA/SICILIA/CRESCO/CHAMPION
Manila line on Saturday	**CPS**	Ningbo-Manila-Shanghai-Manila -Ningbo	HYUNDAI HARMONY/HANSA SALZBURG
Southeast Asia line on Saturday	**VTX1-S**	Bangkok - LaemChabang - Manila (north) - Shanghai - Ningbo - Ho Chi Minh City - Bangkok - LaemChabang - Manila (north)	ASIAN ZEPHYR/ASIAN GYRO/WISDOM GRACE
Haiphong line on Sunday	**CJV3-S**	Tokyo - Yokohama - Shimizu - Busan - Shanghai - Shekou - Hong Kong - Haiphong	SITC YOKKAICHI/SITC FANGCHENG/SITC KWANGYANG
Southeast Asia line on Sunday	**CKV2**	Xiamen - Incheon - Qingdao - Shanghai - Hong Kong - Ho Chi Minh City - Sihanouk - Bangkok - LaemChabang	SITC JAKARTA/SITC BANGKOK/SUNSHINE BANDAMA/HANJIN BELAWAN

Fig2.2.2 SITC Container ship Southeast Liner routes and fleet

This chapter analyzes the Chinese Southeast Asia liner transport market operating environment. First a Southeast Asia to China the status quo and development trend of container liner shipping market are analyzed, and the analysis results show that with the rapid development of China and ASEAN trade, the growth of trade will lead to the development of the regional container cargo. Secondly to China a liner shipping has carried on the analysis of supply and demand, analysis results show that China is now a Southeast Asia liner shipping field that demand is greater than supply, the future will certainly have plenty of capacity in the area of liner shipping market, liner shipping market especially enterprise which focus on ASEAN trade in the region has great potential for development.

3.Liner route optimization model

3.1The principle of Container liner transportation feeder network building

Container liner transportation network construction, not only to improve the service level of the whole network system, but also to meet the needs of port container transport, more important is how to maximum the total operating income under a certain level of capacityin the transport system under the premise, so that you can in a short period of time from the regional container transport hub connecting point in the process of regional container liner shipping network building, according to the following principles:

(1) Routes capacity should avoid repetition

For composite destination outside one or two areas, each region to choose one or two hub port of call, through a hub port and use feeder network to cover that region.

(2)Related route to cooperate with each other in order to reduce costs

The container transport market competition is very fierce, the market capacity supply is greater than demand, excess capacity caused by freight rates fell sharply, in the case of income increase, to improve efficiency can only is to reduce internal tapping into when adjusting and optimizing course, pay attention to the route between the switching of each other, maintain the goods circulation channels, with small capacity, maintain the original market, achieve the purpose of cost savings.

(3)Port of call should avoid repetition and deviation 、

Route port, including course callings which dock port and the affiliated port of the order of content in a route opened up and optimization process, port of call is very important, according to the seaborne trade business conditions change, it is necessary for ship company being based on factors such as the specific situation of the shipping market supply of goods, timely adjust the route port, port call different

scheme, its economic effect is different "liner can gain the best affiliated ports is defined as the maximum profits of the affiliated ports, which are discussed in this paper to benefit maximization as the ultimate goal, in general, large selection of port numbers on both ends of the liner routes, orderly arrangement between the ports of the multiple constitute the basis of the different ship affiliated port project, the arrangement of the total number is big, in the design of rotation, should according to voyage route condition, reasonable arrangement, try to avoid deviation, in order to save time in the voyage and fuel costs, at the same time, the liner to meet capacity, load capacity and schedule constraints, the method by hand it is difficult to obtain the best, even better affiliated port scheme, therefore, it is necessary to establish a liner port of call

Mathematics model, and through the computer to solve, in order to obtain the calculation of auxiliary ship company to dispatch decisions.

(4) On both ends of the route at least each should link more than one port

This is obviously regularity and unless that short distance between the high speed ship, such as high-speed passenger ship will use a point-to-point routes, in general, container liner routes on both ends of routes will be affiliated port 2 or more than two port, in order to make sure the cargo set up this principle is to prevent when select the permutation and combination of port, only choose course end port such a situation.

(5)The main characteristics and problems of near sea routes

Compared to the ocean routes such as Asia-Europe,America, there is low barriers to entry into business near sea routes and capital scale, ship investment requirements for operators are relatively loose. Routes between China and Japan, in particular, between the two countries is open for a route opened up, those who have international shipping management qualification of shipping company, as long as through is reported to the routes can be engaged in the course of operation, without

any limitation. This makes some middle and small shipping enterprises in China have launched a boat, although the airline's container traffic has doubled in five years, but also doubled its capacity.

3.2Model proposed by the theoretical basis and parameters

In order to meet the requirements of the actual development with the ship model is set up, from set out actually, under the assumption that the ship company has selected route, vessel size can meet the requirements of transportation, under the condition of the ship operating costs as the main target fitting model to set up new routes, on the one hand, it can make up the existing with the shortage of the theory of ship, and the actual close to on the other hand, because the company operating in the process of route once established it is difficult to change, with the ship is one of the important requirement, can effectively guide the practice, to make the meaning of the theoretical work more clear.

3.2.1The main assumptions

(1)Assume that for a certain period of time, the number of ships is fixed. In a particular operating period, company will not buy or sell the ship within the time period, maintaining the number of vessels.

(2) Suppose that once for a long term sure liner order must be affiliated port, voyage time is equal to the same time call neighboring twice for the same port.The port of time and the canal time is constant

(3) In different loading period (in different load cases), regardless of the space utilization ratio, the ship speed is the same

3.2.2The theoretical basis of the model

This model is to minimize liner fleet operating costs, due to meet the needs of

the carriage of goods by ship, in the case of current freight rate more flexible, income is difficult to decide, thus minimizing cost is equal to the profit maximization. The operating cost of liner shipping can be divided to two main parts: fixed cost and variable cost, so as long as consider variable costs is the key to reduce total costs, the main consideration are fuel cost port disbursement and the canal cost. The starting point is to minimum the total variable cost to on various routes, so as to achieve the goal of profit maximization and finally achieve the purpose of optimizing the allocation of the liner shipping route.

3.2.3 The parameters of the model

（1）Capacity

Capacity refers to the total amount of containers are transported, the main work is to put the container liner shipping from one port to another port, in order to achieve the demand of the customer supplies communication; Traffic generally determined by the demand of customer, if there is no large fluctuations in the total traffic volume and the economic situation on a certain route traffic basic maintain a relatively stable level; If the world economy, the influence of traffic as the customer's needs change, also in line with the ship may be adjusted according to the traffic on the process of the number of distribution on the route, that is to say, a route is determined, on the route capacity will determine the number of fitting, and the total traffic volume decided to use the total number of the vessel, the shipping company can according to the total capacity to buy or sell the company's ship, in order to achieve the company the number of ships and the capacity of matching, this adjustment can avoid the waste of traffic or use the waste on the ship.

(2) The numbers of vessels

The numbers of vessels refers to the total number of ship company current plan on the total number of liner on every course, for a number of vessels on the routes

refers to the plan on the number of vessels on the certain routes, the ship is the total number of an important index that reflect the strength of the ship company general, if a company has a lot of liner ship, and ship type are more reasonable collocation, show the shipping company has the very strong management ability, has the certain pricing power in liner shipping

(3)the variable operation cost model

The variable operation cost model to calculate the operation variable cost, and is not included in the process of the operation of the fixed fee:

Such as the crew wages, ship management fees, ship maintenance replacement cost, etc. Just include the cost of a change in the process of operation of the operation variable cost projects include:

A) fuel (fuel, power generator fuel) :

Fuel is a larger proportion in the operation and variable cost expenses, liner sailing on the sea need to rely on the host to push and host fuel consumption is mainly crude oil; Of auxiliary engine in the process of electricity needed light oil as a fuel, container liner speed quickly, the consumption of fuel quantity is large, and as the price of crude oil rising fuel costs also constantly improve, variable cost and fuel has become in the liner shipping business a very big spending

B) The canal cost:

For container ships from Asia to Western Europe through the Suez Canal, for flights from Asia to the east coast of America need through the panama canal. No matter by what is need to pay a certain across the river, canal customarily called canal cost

C) the port disbursement:

Including the handling charge, pilotage, tug fee, berth fees, fees and other tonnage tax, light maintenance, garbage disposal, the health and quarantine and other miscellaneous fees

Q : The total capacity of all the liner routes

Q_{ij} : The capacity of vessel i on j route

V : The number of the total vessels

V_{ij} : The number of vessel i on route j

b_{ij} : The fuel cost of vessel i on route j

r_{ij} : The canal cost of vessel i on route j

h_{ij} : The port disbursement of vessel i on route j

bd_i : The daily fuel assumption of vessel i

f_b : The price of bunker per ton

s_j :The total voyage distance of vessel i

v_i :The speed of vessel i

f_p : Each port average per net ton port disbursement

3.3 The propose and calculation of the model

The objective function $MIN\sum_{t=1}^{n}(b_{ij}+r_{ij}+h_{ij})$ (j=1,2,……m)

The constraint：
$$\begin{cases}\sum_{i=1}^{n}v_{ij}=v \\ \sum_{i=1}^{n}Q_{ij}=Q \\ V_{ij},Q_{ij},b_{ij},r_{ij},h_{ij}\geq 0 \quad (j=1,2,\ldots\ldots m)\end{cases}$$

Assumes that total amount and ship the goods under the premise of a certain assigned to run on various routes of ship as long as meet the cost of fuel costs across the river and port disbursement of the sum of the minimum can reduce the operation variable cost to a minimum, the company can achieve the profit maximization, also can be done with the scientific nature of the ship.

(1) The calculation of fuel costs

According to the requirements of energy conservation and emissions reduction, assuming that ship moving at a constant speed, lower than the same type of ship sailing speed and fuel consumption level is essentially the same. Reason for fuel costs mainly depends on the type and range of the single ship, namely single ship bd basic is fixed, the daily consumption of half the total fuel consumption mainly depends on the distance S of the routes

$$b_{ij}=\sum_{i=1}^{n}\sum_{j=1}^{m}bd_i x(s_j \div v_i)\times f_b \quad (i=1,2\ldots\ldots n;j=1,2\ldots\ldots m)$$

(2) The calculation of the port disbursement

Port disbursement includes many content, includes ship's tonnage dues, tug fee,

pilotage, unmoor fee and so on.The algorithm of container shipping port fees on shipping net tons estimate, specific as follows:

$$h_{ij} = \sum_{i=1}^{n} \sum_{j=1}^{m} NT_i \times p_j \times f_p \text{ (i=1,2……n;j=1,2……m)}$$

(3) The canal cost:

Due to Southeast Asia regional, the canal cost is temporarily not involve the cost, so it is not discussed in detail.

4.Case Study

4.1 The present situation of SITC in ship deployment on Southeast Asian routes

Until the April of 2015, SITC Container Ship Company is operating 12 core liner routes in Asia which contain Southeast Asian ports, the density of schedule for a day on average 2 routes departure from Shanghai port. Only choose several of the representative for the convenience of argument analysis , the core representative Southeast Asian routes are selected the following several routes:

Route	Route code	Port rotation	Ship in operation
Southeast Asia line on Saturday	PCI	LaemChabang-Ningbo-Shanghai-Jakarta- Singapore-Ho Chi Minh City	NORTHERN VIGOUR
Southeast Asia line on Wednesday	VTX2-S	Shanghai- Ho Chi Minh City-Bangkok- Laemchabang	SITC SHANDONG/ SITC ZHEJIANG
Southeast Asia line on Wednesday	VTX3-S	Shanghai - Hong Kong - Ho Chi Minh City - Sihanouk - Bangkok - Laemchabang	SITC FUJIAN/ SITC LAEM CHABANG/ARABIAN EXPRESS
Southeast Asia line on Saturday	VTX1-S	Bangkok - LaemChabang - Manila (north) - Shanghai - Ningbo - Ho Chi Minh City - Bangkok - LaemChabang - Manila (north)	ASIAN ZEPHYR/ ASIAN GYRO/ WISDOM GRACE

Tab 4.1 SITC in ship deployment on Southeast Asian routes

4.2The present situation of Cargo Volume and Cost Statistic

Ship on every route configuration mainly is allocated according to the quantity of the goods on the line, the data in table 4.2.1 below is Cargo Volume Statistics of SITC in Southeast Asia in 2013

Route	TEU	Bunker ton/day	NT	TEU/Year	Vessel number	Vessel utilization ratio
VTX1-S	2100	65	37800	145600	3	0.9
VTX3-S	750	28	11704	124800	3	0.8
PCI	1200	40	20048	93600	1	0.75
VTX2-S	380	16	5908	52000	2	0.95

Tab 4.2.1 Cargo Volume Statisitc of SITC in Southeast Asia in 2013

Each form in the cost of a route is to point to different sailing boat will produce different cost in different routes, mainly according to the fuel consumption of different ships on different routes and moored in the port when the cost of the statistics of the cost

TEU	Route	VTX1-S	VTX3-S	PCI	VTX2-S
	Distance	5500	1600	1800	960
	Port of call quantity	9	6	6	4
	Berthing day	8	3	3	2

	Total time / Voyage time (day)	21/13	7/ 5	7 / 5	7 / 4
	Speed (knot)	16	14	14	13
2100	Cost (US)	932800	502700	502700	356800
750		340004	175336	175336	126224
1200		530648	280432	280432	200288
380		183758	93172	93172	67448

Tab4.2.2 Cost Statistic of Southeast Asia Service

4.3 Use the optimized model to deploy the ships

Objective function : $MIN\sum_{t=1}^{n}(b_{ij}+h_{ij})$ (j=1,2,……m)

The constraint：

$$\begin{cases}\sum_{i=1}^{n}v_{ij}=v \\ \sum_{i=1}^{n}Q_{ij}=Q \\ V_{ij},Q_{ij},b_{ij},h_{ij}\geq 0 \quad \text{(j=1,2,……m)}\end{cases}$$

$$MIN\sum_{t=1}^{n}(b_{ij}+h_{ij})=\sum_{i=1}^{n}\sum_{j=1}^{m}bd_i x(s_j \div v_i)\times f_b + \sum_{i=1}^{n}\sum_{j=1}^{m}NT_i \times p_j \times f_p$$

(i=1,2……n;j=1,2……m)

Assuming that fuel costs are USD500 per ton, average port disbursement USD 1.5 per net ton

Objective function:

$MinZ$ = （ 65*13*500+37800*9*1.5 ） X_1 +(65*5*500+37800*6*1.5) X_2 + (65*5*500+37800*6*1.5) X_3 +(65*4*500+37800*4*1.5) X_4 +(28*13*500+11704*9*1.5) X_5 + （ 28*5*500+11704*6*1.5 ） X_6 + （ 28*5*500+11704*6*1.5 ） X_7 + （ 28*4*500+11704*4*1.5 ） X_8 + （ 40*13*500+20048*9*1.5 ） X_9 + （ 40*5*500+20048*6*1.5 ） X_{10} + （ 40*5*500+20048*6*1.5 ） X_{11} + （ 40*4*500+20048*4*1.5 ） X_{12} + （ 16*13*500+5908*9*1.5 ） X_{13} + （16*5*500+5908*6*1.5）X_{14} +（16*5*500+5908*6*1.5）X_{15} +（16*4*500+5908*4*1.5） X_{16}

Constraint equations：

$X_1+X_2+X_3+X_4+X_5+X_6+X_7+X_8+X_9+X_{10}+X_{11}+X_{12}+X_{13}+X_{14}+X_{15}+X_{16}$ =9

2700*0.9*(365/21) × X_1 + 750*0.9*(365/21) × X_5 + 1200*0.9*(365/7) × X_9 + 380*0.9*(365/21)× X_{13} ≤ 145600

2100*0.8*(365/7) × X_2 + 750*0.8*(365/7) × X_6 +1200*0.8*(365/7) × X_{10} + 380*0.8*(365/7)× X_{14} ≤124800

2100*0.75*(365/7) × X_3 + 750*0.75*(365/7) × X_7 + 1200*0.75*(365/7) × X_{11} + 380*0.75*(365/7) X_{15} ≤93600

2100*0.95*(365/7) X_4 + 750*0.95*(365/7) × X_8 + 1200*0.95*(365/7) × X_{12} + 380*0.95*(365/7)× X_{16} ≤52000

$X_1+X_2+X_3+X_4$ =3

$X_5+X_6+X_7+X_8$ =3

$X_9 + X_{10} + X_{11} + X_{12} = 1$

$X_{13} + X_{14} + X_{15} + X_{16} = 2$

$X_1 + X_5 + X_9 + X_{13} \geq 1$

$X_2 + X_6 + X_{10} + X_{14} \geq 1$

$X_3 + X_7 + X_{11} + X_{15} \geq 1$

$X_4 + X_8 + X_{12} + X_{16} \geq 1$

According to the objective function and constraint conditions, the use of linear programming to solve software solution:

TEU	VTX1-S	VTX3-S	PCI	VTX2-S	Vessel Constraint	Vessel number
2100					=	3
750					=	3
1200					=	1
380					=	2
Route Constraint	>	>	>	>		
Vessel on each route	1	1	1	1		

TEU	VTX1-S	VTX3-S	PCI	VTX2-S
2100				
750				
1200				
380				
Capacity Constraint	0	0	0	0
TEU/Year >	140000	120000	90000	50000
TEU/Year <	150000	130000	100000	60000

Objective Value	0

Tab4.3.1 Solution Process in Microsoft Excel

The results are as follows:

The objective function optimal value: 3342827.082

Variables	The optimal solution
X_1	0.896151337
X_2	1.369863014
X_3	0.733985649
X_4	0
X_5	1.654169671
X_6	0
X_7	0
X_8	1.345830329
X_9	1
X_{10}	0
X_{11}	0
X_{12}	0
X_{13}	0
X_{14}	0
X_{15}	2
X_{16}	0

Tab4.3.2 Solution Results

TEU	VTX1-S	VTX3-S	PCI	VTX2-S
2100	1	1	1	0
750	2	0	0	1
1200	1	0	0	0
380	0	0	2	0

Tab4.3.3Optimization of vessel deployment

These results are in conformity with SITC in Southeast Asia at present capacity in SITC, on the basis of the existing ship set relatively reasonable routes in Southeast Asia area. But VTX1-S capacity investment slants big, because the operating cost is too high.On the basis of the existing capacity, if SITC wants to further reduce the cost of Southeast Asia, gain high line benefit,the following matters should pay attention to:

First of all, the VTX1-S lines can be considered for ship together with other shipping companies, reduce fixed costs and other costs of the investment; Second, the VTX2-Sline can further extend space; finally, according to the container liner company in southeast Asia area with ship optimization study, it is wise to further improve the liner's space utilization, or freight increase sale income in these liner routes, toimprove course benefits.

Through the above measures, Southeast Asia routes now in the rational can further use of resources. But because of the company in southeast Asia in the above capacity is limited, in the entire southeast Asia area of the market share is lower than the other main shipping companies, so further reasonable input capacity, the development of southeast Asia regional network, accelerate the circulation of box,

improve the workplace of southeast Asia share, trunk lines for further provide supply is SITC's future development direction.

5.Summary and conclusion

5.1The summary of the dissertation

To increase the container market share in Southeast Asia area, balance regional box needs, and to replenish the trunk box, how to develop the Southeast Asia region is the mainstream of container liner company faces. Because the liner company's enterprise culture, development strategy, different route layout, and so on and so forth, so each input capacity in Southeast Asia area and the Settings are different. This paper analyzes the route of southeast Asia, the affiliated ports, freight volume and capacity situation, to predict and judge of container volumes in southeast Asia, according to SITC container liner company summarizes current operating conditions, traffic volume, using linear programming according to SITC container liner company's southeast Asia routes set were analyzed, and at the same time put forward the south-east Asia region with the best of the shipScheme and operation strategy and management advice.

5.2The shortage of the paper

This article focuses on to SITC company route laying in Southeast Asia area and optimization solutions do simple discussion, so analyze the problem of not enough thoroughly, especially not for liner capacity enlarged volume, cost and benefit to forecast and measure. Because the benefits are the lifeblood of the enterprise survival and development, the future course of efficiency is to determine whether the key factors to further develop and expand. If benefit is in good condition, SITC Company will undoubtedly continue to expand its investment in SoutheastAsia; Such

as benefit condition is bad, the expert need to continue the course layout optimization and renovation.

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