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Research on capacity development plan of WenZhou shipping company

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RESEARCH ON CAPACITY DEVELOPMENT PLAN OF WENZHOU SHIPPING COMPANY

By

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DECLARATION

I certify that all the material in this research paper that is not my own work have all 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 Professor:

ZHAO GANG

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ABSTRACT

Wenzhou Shipping Company was founded in November 1, 1950; it undertakes Zhejiang's coal and other key industrial and civilian goods transport operations, meanwhile expanding the Yangtze River on coal transportation market, and international bulk cargo transport business. It completed 5.81 million tons of cargo transportation in 2009, with a turnover of 10.735 million ton-km of goods.

Under domestic and international shipping market conditions, Wenzhou Shipping Company will frame 5-year development plan to accelerate capacity development, and adjustment of transport structure, optimize the ship configuration. It will make the capacity to reach 600,000 tons with good economic returns, and has a sustainable development into a larger shipping company.

In this article, the first step is to illustrate the external environment, especially the situation of both domestic and international trade market and shipping market; the second part is to demonstrate the internal environment of Wenzhou Shipping Company, adapt the Correlation Analysis method to evaluate the market situation.

Meanwhile, the paper had a deep study on the method of Kernel Principal Component Analysis (KPCA) to evaluate the technology and economy of ship-type. After analysis and comparison of different ship type plans, the outcome could provide certain theoretical basis for ship investment of Wenzhou Shipping Company. Accordingly, the paper lists out the arrangement about the detailed development plan. Finally, the paper has a risk assessment and risk management about this ship investment, in order to make the plan more feasible.

Keyword: ship investment, method of KPCA, ship-type, risk management

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APPENDIX

Chapter 1: Introduction

1.1 Background Information

In 2010, the global economy experience constant stability and gradual recovery under the worry of "double dip recession", but recovery is slow, the pace of growth in all walks of life have also shown a speed in different rhythm. China's shipping industry showed positive growth in the recovery status. However, the overall development status of shipping industry could deteriorate in 2011. Despite the decline in utilization of slot space, the current fleet capacity and investment in capacity will continue to increase over the previous period; the situation of excess capacity will be exacerbated in the near future.

In addition, China issued a series of measures like raising the deposit reserve ratio, interest rates, and other measures as a response to inflation, leading to decline in steel demand, high inventory, and initiative of iron ore procurement is inhibited. Meanwhile, the integration of iron and steel enterprises will inevitably impact the demand for iron ore in the short term.

In 2011, China will import 5.84 billion tons of iron ore, decreased by 3%, and its occupation of global seaborne iron ore will continue to decline to 58%. China's coal output in 2011 and the total coal consumption will reach 3.35 billion tons and 3.5 billion tons. Other dry bulk trade yearly growth rate is 2.0% on average, and global economic growth rate in 2011 of 4.2% will keep the other dry bulk trade growth rate above the 2.5% level.

Besides, effective supply capacity will reach 539 million deadweight tons, with the

effective number of 8,373 ships, supply growth rate decreased 5.3 percentage. As it goes on, the speed of supply capacity in dry bulk carrier market begins to slow down, but the difference between supply and demand may be greater than that in 2010.

Wenzhou Shipping Company was founded in November 1, 1950; its business is mainly responsible for supplies and transport tasks of Wenzhou City and the key parts of the market goods of Zhejiang province, which is the largest state-controlled southern Zhejiang transportation company. The company has 13 bulk cargo ship of total DWT 300,000 tons, with total existing assets of 1.55 billion Yuan; 1356 registered employees (including crew in ships), including 9 senior, 32 intermediate grade, 720 crew members.

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1.2 The contents and research approach

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1.3 Literature review:

1.3.1 Methods for evaluation of Optimal Ship-type

In the field of technology and economy demonstration of ship, multi-objective evaluation and decision is becoming an important research area.

A ship is a complex object which including power system, control systems, handling systems, so that we often face a complex systems contains many interrelated and constituting factors that in evaluation of technology and economy demonstration of ship. Such as the ship integrated system and fleet composition planning system, it is very difficult to use a single objective function or evaluation criteria for the whole system's evaluation. Under this condition, many workers on evaluation of ship design program have done a lot research work and have gained certain achievements.

In 1970s, American scientist of Operations Research named T.L.Saaty proposed the method of Analytic Hierarchy Process (AHP). This method of structure is very useful on complex decision making problems with multi-objective, by quantifying factors, and reducing the subjective effect from evaluators in order to make the whole evaluation more scientific. By the end of 1982, Xu Shubai firstly introduced the method of AHP into China which is widely used after that. In the field of ship design, China's Lu JinSong, Chen BingKang, Wang Min, who have used AHP method ship program for multi-criteria decision analysis. This method allows the evaluators to make pair wise comparisons to reflect the relative importance of each attribute matrix, so that this method is of high reliability and small difference with the practical.

However, due to the evaluator's knowledge structure, the level of personal preferences and restrictions on judges, which make it difficult to meet the compliance matrix. The AHP method is essentially a linear weighted sum method, so this theory only applies to the utility function with linear additive decision-making objects. General speaking, AHP method is not applicable to the evaluation criteria in decision-making with more than 9 objects.

Over 1990s, the theory of fuzzy mathematics and methods of comprehensive evaluation methods application attract more and more people's attention, which also has been widely used in the ship engineering field. In 1989, Liu Jinqiu applied the fuzzy comprehensive evaluation method to do the economic evaluation in ship technology; 1991, Li Zhan discussed a transport fleet system analysis with fuzzy mathematical programming model; 1993, Hao Gang introduced that the ship design will be made by the method of fuzzy and fuzzy subjective information factor analysis respectively, and established a multi-objective fuzzy optimization model, to

list out optimization examples of the ship structure; in 1995, Tang Xiaosheng applied fuzzy mathematical programming method for the technical and economic analysis of ship main size dimensions.

The method is based on the single factor evaluation by fuzzy operation, the comprehensive evaluation by multiple factors, the advantage of fuzzy factors may be involved comprehensive evaluation system for evaluation of the complex hierarchy of objects with many factors; the drawback of the membership function is that it has no systematic method to determine, what kind of fuzzy operations used to carry out comprehensive evaluation, and definitely this problem need to be further studied.

Besides, people also used some other method of evaluation in the ship engineering field. Based on the nonlinear and complex nature of ship engineering systems design the literature (Sang, 2002) used improved AHP method on multi-objective optimization of ship program decision-making, they built three-scale matrix method to avoid the use of nine was constructed to determine the scale weight matrix choice ambiguity, thereby reducing the designer's subjective effect of decision-making process. (Zhang, 2004) literature dimensional cell system using multi-objective fuzzy pattern recognition model and the multi-objective optimization model of fuzzy relations, established a ship-type optimization model, solve the decision making problems of the process of ship-type optimization programs of multi-level multi-objective fuzzy. (Liu, 1995) gives the literature using Data Envelopment Analysis (DEA) method to determine the frontier production approach, the principle of multi-ship program for multi criteria evaluation method for the relative effectiveness of a brief account of the principle of DEA methods, the method set out the technical, economic meaning, and apply C2R and C2GS2 model to 35000t deadweight Suezmax oil vessels and the type of tanker ship for optimal selection

evaluation. Document (Sang, 2002) presents a new interactive multi-objective decision making method. Based on the preference information on indicators and objective information on the output entropy weight, they used a strict least squares method as a tool to determine the weights to establish the optimal model of multi-objective decision making problems so as to find an effective method.

While the above evaluation and decision method is applied to a variety of ship areas, the traditional decision-making methods are inevitably with subjective preferences of decision makers, leading to the final decision results with some systematic errors. Based on this situation, this paper uses a relatively new evaluation method for a Kernel Principal Component Analysis (KPCA) method and its application in multi-ship program evaluation.

1.3.2 What is Kernel Principal Component Analysis (KPCA)?

A new method for performing a nonlinear form of Principal Component Analysis is proposed (Schölkopf, 1997). By the use of integral operator kernel functions, one can efficiently compute principal components in high dimensional feature spaces, related to input space by some nonlinear map; for instance the space of all possible d-pixel products in images.

This method is under the principle of ensuring that minimal loss of information in the original data of the system, on the basis of relationship of each variable information, compressed multiple variables into a few consolidated variable indicator which reflect the characteristics of the original ones, and do the comprehensive analysis of the system according to the Feature Information Indicators, so as to handle the nonlinear relationship between variables effectively, providing a good mean for solving the multi-index comprehensive evaluation.

Kernel Principal Component Analysis is an extension of Principal Component Analysis (PCA) which uses the technique of kernel methods. By using a kernel, the originally linear operations of PCA can be done in a reproducing feature space with a non-linear mapping.

The basic idea of KPCA is: input data χ k (k =1, ···,l) (l is the number of input data) through a nonlinear mapping Φ, and mapped to a feature space F, then do the linear Principal Component Analysis (PCA) in the feature space F. Through nuclear techniques, it only do the calculation in the original space dot product operation, and do not need the specific form of non-linear mapping, simply select the appropriate kernel function, and then make the first principal component contributed up to 85%.

The Kernel Principal Component Analysis (KPCA) method was applied in the selection process of optimal ship-type. The method was proved to be effective and practicable for a complicated multivariable multi-objective optimization project, by comparing the numerical results in comprehensive evaluation of ship type by KPCA method to those from other common used methods.

1.3.3 Case in Wenzhou Shipping Company

Optimal ship-type selection is a multivariable, multi-objective scheduling problem of system optimization. This paper takes the use of Kernel Principal Component Analysis (KPCA) method, and conducted a comprehensive analysis and evaluation program for the optimal ship-style selection in order to achieve good results.

For ease of comparison, this paper take the operation data of a bulk coal carriers

which sailing from Qinhuangdao port to Wenzhou power plant for example, and use the KPCA method as well as the AHP methods to make comparison to see which method is more effective and practical.

Chapter 2: Analysis of External Environment

2.1 Dry bulk shipping market

Standard transport market analysis is based on three levels of market demand, market supply and market equilibrium, which including the development of market, supply and demand situation of the historical evolution and analysis of future trends factors.

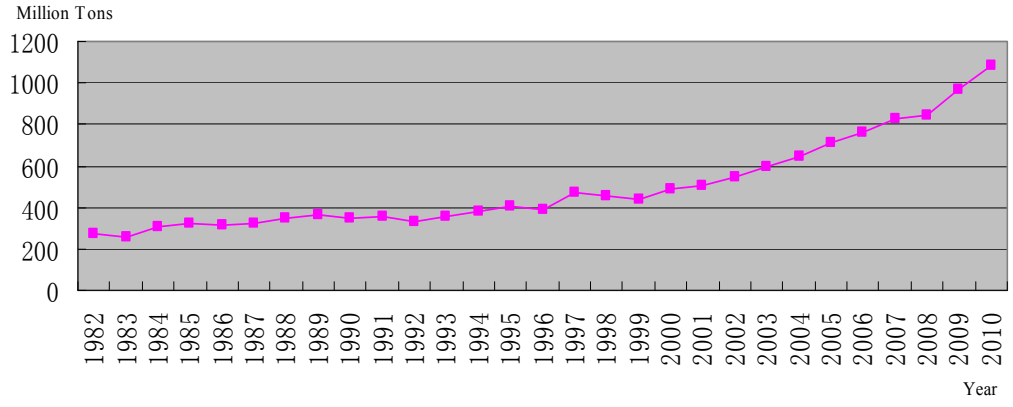
This paper is based on the above theory, combining with the characteristics of world's dry bulk shipping market, which are focusing on selection of iron ore, coal and ship-type such as the Handy size, Panamax, Capesize for analysis.

2.1.1 International dry bulk shipping market

(1) International iron ore transport market

Iron ore transportation in the world occupies an important position in dry bulk transportation, and the vast majority of world iron ore trade is completed by seaborne iron ore trade. Specifically as Figure 2.1 shows:

Figure 2.1: Total Volume of World Iron Ore Trade(1982-2010)



It is clear from above that the volume of the world seaborne iron ore trade showed a rising trend from 1982 to 2010 in general, without significant fluctuation cycle. The total increase in iron ore trade is slowing down in 2008 by the world financial crisis, but the trend of the overall continued to show a stable rise in the next few years, and it reached 1.08 billion tons in 2010.

a. Distribution of the iron ore trade routes: The producer and consumer of iron ore are relatively stable, so the iron ore transportation routes tend to be more fixed. There are 6 routes in the world with each year more than 40 million tons of iron ore shipments: Australia - Japan; Australia - China; Australia - other countries in Asia; Brazil - China; India - China; Eastern Europe – CIS(Commonwealth of Independent States) .

Table 2.2: Main Ship-type from Main Routes of World Iron Ore Seaborne Transport

Routes	Ship-type(Unit:1000 DWT)		
	DWT≦100	100 < DWT < 150	DWT≧150
North America to the North-West Europe	14.29%	71.43%	14.29%
South America to Western Europe	13.33%	33.33%	53.33%
South America to Mediterranean	0.00%	61.54%	38.46%
South America to Japan	50.00%	33.33%	16.67%
Other parts of South America to Southeast Asia	0.00%	77.78%	22.22%
Africa to the North-West Europe	0.00%	100.00%	0.00%
Africa to the Mediterranean	0.00%	50.00%	50.00%
Australia to East Asia, Europe	0.00%	85.71%	14.29%
India to East Asia	0.00%	90.00%	10.00%
India to the Mediterranean	0.00%	100.00%	0.00%

b. ship-type of each routes: it is obvious that the main ship-types of the maritime transportation of iron ore used in almost routes are concentrated in the range of 100,000 to 150,000 DWT.

(2) International coal transportation market

In the past 27 years, the seaborne trade of coal was growing up with the world economy continuous growing. Specifically as Figure 2.3shows:

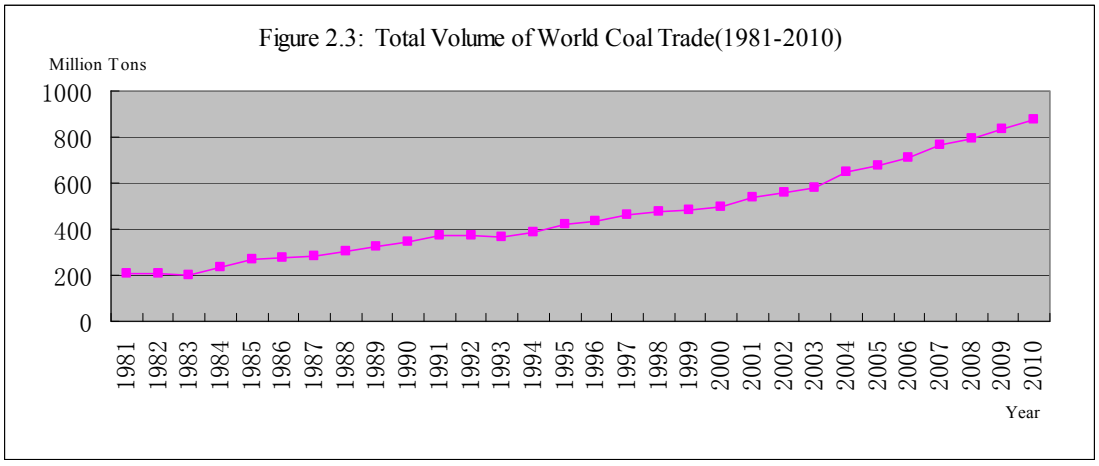


Figure 2.3: Total Volume of World Coal Trade(1981-2010)

It is clear from above that the world seaborne coal trade showing an upward trend line, no significant fluctuation cycle. 2008 increase of just 3.3%, the growth rate slowed down significantly. It will continue to rise in the future, but the speed of growth will slow down.

There are several major coal import areas as: Asia, 42% of the total; Europe, 18%, 40% for elsewhere. Japan ranks first in Asia, In addition, the 2008 European coal import and export shipping trade is 151.1 million tons, of which imports the largest amount of coal in the countries is Germany, followed by Britain and Spain.

The traditional coal exporter are Australia, the United States, Russia, China, Canada,

also includes Indonesia, Colombia, Vietnam and other countries. In 2010, the volume of Australian exports of coal in first place, 2.15 billion tons, accounting for 28% share of the international market; followed by Indonesia, South Africa, Colombia and other countries.

There are several routes of more than 5 billion tons on seaborne coal trade: the CIS - European Union route, routes between South East Asia, Southeast Asia - Far East, Southeast Asia - Oceania routes.

Table 2.4: Main Ship-type from Main Routes of World Coal Seaborne Transport

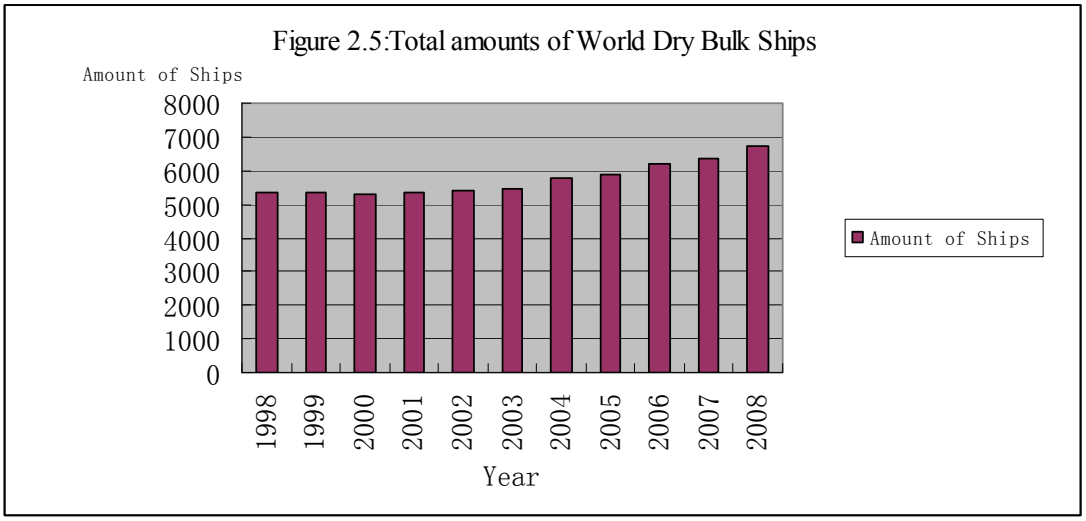
Routes	Ship-type(Unit:1000 DWT)		
	DWT≦50	50 < DWT < 100	DWT≧100
South America to Mediterranean	100%	0.00%	0.00%
North America to the North-West Europe	0.00%	100%	0.00%
US / Caribbean Sea to the north-western Europe	4.82%	22.89%	72.29%
South Africa to the North-West Europe	66.67%	33.33%	0.00%
Southeast Asia to the North-West Europe	0.00%	36.36%	63.64%
Southeast Asia to the Mediterranean	33.33%	66.67%	0.00%
Australia to the Mediterranean, Europe	12.90%	32.26%	54.84%
Australia to Asia	41.18%	5.88%	52.94%

From Table 2.4 we can find that the main ship-type of South America routes is 50,000 DWT; Australia route often use 10,000 DWT or even bigger ships; Southeast Asian routes often use the ships of 50,000 to 10,000 DWT.

2.1.2 The fleet capacity of world dry bulk

With the growth in the size of dry bulk cargo transport of the world in recent years, the world's dry bulk carrier capacity is increasing gradually, as shown below in

Figure 2.5:



As we can see from the above chart, during the 10 years of dry bulk carrier capacity experience a linear upward trend without obvious cycles. In 2008, there is a 4.87% growth in the number of vessels with a total increase of 6.5% DWT. It is expected that in 2010 the world total dwt of dry bulk cargo will reach 70.18 million tons in 2011 to reach 86.5 million tons.

The total number of dry bulk fleet of ships and capacity increases every year, including: the fleet tonnage experience a decline obviously in the number of Handysize, but slow growth in capacity, and large tonnage vessels like Handymax, Panamax and Capesize but the number of vessels increased year after year, capacity increased rapidly, which fully reflects the world dry bulk fleet of large-scale trends.

The number of vessels in the composition of the ship, fleet handysize the total number of vessels accounted for 42.6%, Handymax, Panamax and Capesize were 27%, 18.2%, 12.2%, indicating that: in the current world of dry bulk cargo transport fleet of small boats in the number handy-type dominant position;

The composition of the capacity of a Capesize vessels have the highest proportion, at 37.9%, which further illustrates the dry bulk fleet of large-scale development trends; The average age structure, Handysize the highest average age of the ship, reaching 18.2 years, with tonnage increases, the average age decreases, Handymax, Panamax, Capesize turn the average age of was 15.7 years and 11.1 years, 10.4 years, indicating that: the new ships in recent years, mainly in ship tonnage of the larger ship, the tonnage of the smaller bulk fleet of aging show some trends.

From above information, we find that in the new ship building market, the various types of ship, whether in quantity or in the capacity scale, in the past few years showed an upward trend, peaking in 2008. Ship orders meet a rapid decline in 2008. The mainly reason is outbreak of financial crisis worldwide in 2008, the imbalance occurs between supply and demand on the dry bulk shipping market, and the excess capacity in market, the owner are all dealing with the crisis so that a large number of orders are canceled.

It is noteworthy that, at present, the global ratio of old bulk ship 40% of the total amount and there are more and more international restrictions on the old ship. IMO Bulk Carrier Safety Working Group has submitted proposals to limit old bulk carrier transport iron ore, coal and grain and other goods. In addition to the provisions of IMO, international conventions and classification societies make the inspections and checks becoming increasingly strict for more than 20 years old ship. Affected by this, shipping companies will have to step up to the old boat out. Therefore, the future will accelerate the dismantling of ships; especially small tonnage bulk carrier in the market share will decrease accordingly.

2.1.3 Performance of dry bulk shipping market

From an overall sight, the ship charter market rates rose in the total and reached a peak in 2008, after a slump in the second half of 2009.

The rental price of Handysize relatively flat in change, which fell in the second half of the state in 2007. It experienced a gradual rise in the second half of 2008 until June 2009 began to go down. Its future trends will show a low consolidation trend, whose rally is weak.

The time charter price changes of Handymax vessel are similar to Handysize vessels. If the effect of financial crisis eliminates as soon as possible, it will be more chances for Handymax vessels rather than Handymax vessels, there are more market demand for a good development prospect.

Panamax is currently a highly competitive ship-type in dry bulk market. Capesize ships market will continue to run at low position, and it will be stable after 2009 and may rebound.

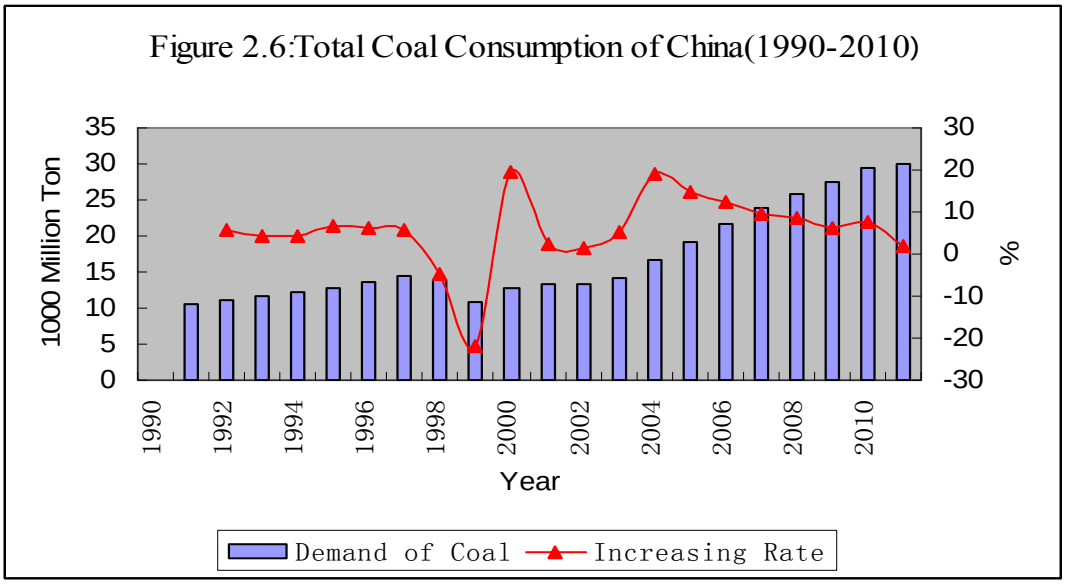
Based on the above analysis of the dry bulk transport market, we can find the following conclusions: Firstly, the three main bulks of iron ore, coal and grain shipments overall trend of the future will show a slow rise, the main importer and exporter of little change. Secondly, as transport demand growth slow down, the three major routes of the freight and charter market showed a downward trend. The future will show a downturn in dry bulk shipping market consolidation trend, including: Handysize and Capesize dry bulk carriers is weak rebound in chart market, while the Handymax and Panamax dry bulk vessels market situation relatively strong rebound. Thirdly, in terms of capacity expansion, Handymax and Panamax vessels as of

strong compatibility, and less idle capacity which can be as a good investment choice.

2.2 Coal demand of market and freight

China's energy structure has been dominated by coal for a long time, so that China has become the world's largest coal consumer, accounting for the total world coal consumption of 36.9%. In recent years, as China's rapid economic grow quickly, the demand for coal also rising rapidly. The Figure 2.6 shows China's coal consumption situation from 1990 to 2010 as follows:

Figure 2.6:Total Coal Consumption of China(1990-2010)



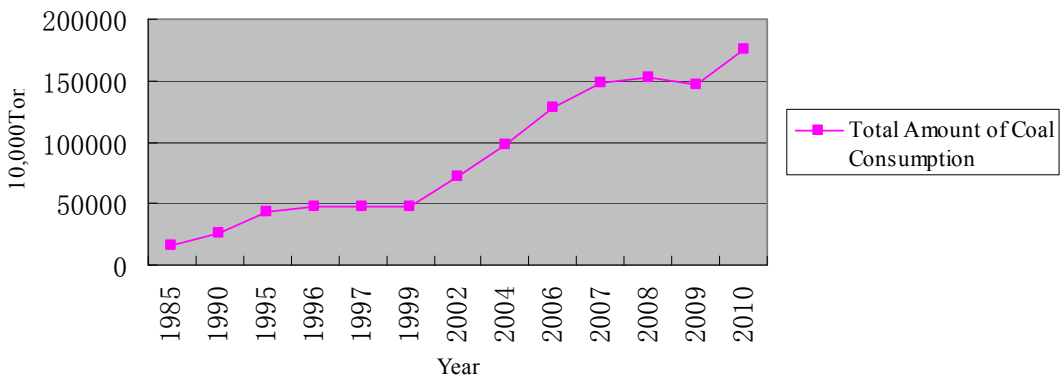
As we look into the constitution of China's coal demand, the electricity, iron and steel, building materials and chemicals are the major coal consuming industries.

The electricity, steel, building materials and consumer of coal chemical industry accounts for the proportion of the national total coal consumption in 1990 from 52.8% to 92.7% in 2010, for which there is a need to make a specific analysis.

2.2.1 Coal demand of Electricity Industry

China's energy generation is based on coal, the current composition of coal consumption in electricity generation still accounts for more than 90%. China's power industry is showing the rapid development of trend: from 2008 to 2010, three years, the thermal flux of growth were 14.7%, 12.9% and 15.3%, the corresponding growth rate of installed power generation capacity of 8.4% 12% and 17.1%; According to preliminary statistics for 2007, the national thermal power installed capacity reached 554 million kilowatts, an increase of 69 million kilowatts, an increase of 14.3%, while thermal power amounted to 2.7 trillion kilowatt-hour more than in 2007 increased 327.8 million kilowatt-hour, an increase of 13.8%. National thermal power installed capacity in 2008 reached 2.779 billion kilowatt-hour more than 79 billion kilowatt-hours more than in 2009, an increase of 2.17%. The rapid expansion of the power industry lead to higher demand for coal, given from 1985 to 2010 China's coal consumption is as follows:

Figure 2.7:Total Amount of Coal Consumption



It is very clear from Figure 2.7 that the electric power industry depends primarily on coal demand growth rate of coal-fired generating capacity. Despite the rapid expansion of the power industry in recent years, but still difficult to meet growth in electricity consumption, power shortage still exists. To alleviate this tension,

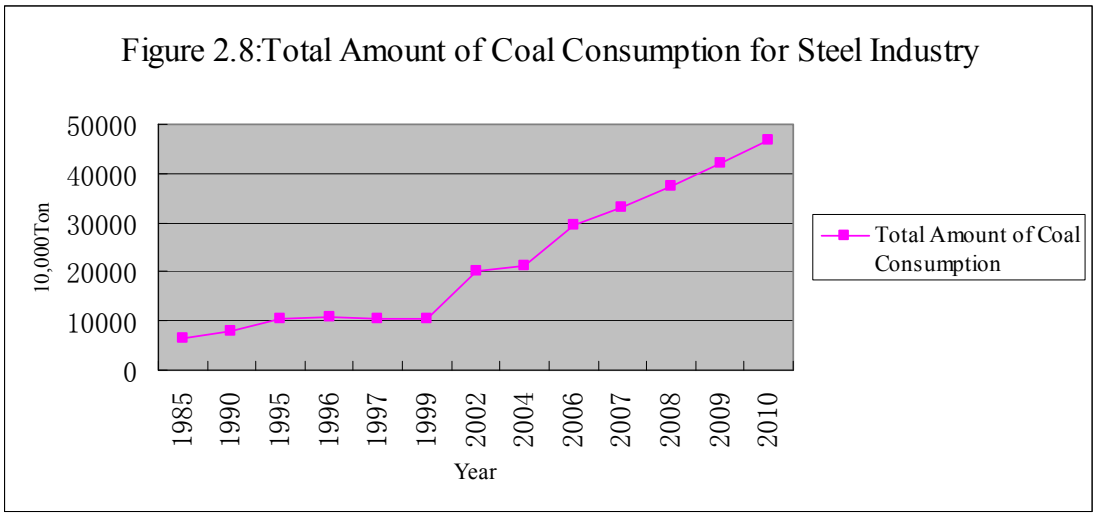
according to the "Eleventh Five-Year" electric power industry development plan, in 2010 the national power generation capacity will reach about 850 million kilowatts of electricity is about 3.8 billion kilowatt-hour. Thus in 2010 the coal power industry's demands for 1,550 to 1,680 million tons.

For China from 2010 to 2020 the power industry trend, according to some of the existing research results and data analysis is expected to need in 2020 generating capacity of the country is 4.3 biillion kilowatt-hour, the corresponding installed capacity is about 950 million kilowatts. Resulting projected coal demand in 2020 for the power industry from 1,950 to 2,150 million tons.

Based on the above analysis, we believe: China's coast within the next few years will continue to increase coal transportation, but the rate will gradually slow down.

2.2.2 Coal demand of Steel Industry

As we look into China's steel industry energy consumption structure, we can easily find that it is dominated by coal, primarily coking coal, fuel, coal and coal for blast furnace injection. In 2010, China's steel production reached 538 million tons, the world number one. This high growth, naturally, bring a lot of coal demand, given from 1985 to 2010 China's steel industry, changes in coal demand as follows:



It is very clear that the steel industry in China coal demand was high in recent years, an increasing trend, but the annual increase in volatility, expected in 2009 by the global financial crisis, the growth rate will slow down, but the overall trend of demand growth unchanged.

Coal demand in the steel industry, mainly determined by the pig iron production and consumption, according to the relevant departments predicted that by 2010 China's pig iron production of about 530 million tons in 2020 from 490 to 520 million tons or even more. Iron and steel industry energy consumption per ton of steel is usually comparable to the energy consumption and overall energy consumption per ton said. Under the "Steel Industry Development Policy", in 2010, the comparable energy consumption per ton of steel industry-wide will be reduced to 685kg standard coal per ton of standard coal comprehensive energy consumption will be reduced to 730kg; comparable energy consumption in 2020 will be reduced to 640kg per ton of standard coal, the comprehensive energy consumption will be reduced to 700kg per ton of standard coal. As a result, predicted by 2010, coal demand in the steel industry in 2020 were 360 to 390 million tons, from 350 to 370 million tons.

2.2.3 Coal demand of Building Materials Industry

The main products are building materials industry, cement, plate glass, and a variety of wall materials, chemical materials, including cement accounts for about 50%. China has become the world's building materials production and consumption power, cement, plate glass, construction ceramics, sanitary ceramics production has ranked first in the world for many years.

Building materials industry is energy-intensive industries, the building materials industry in China coal demand increased rapidly since 2006, but in 2007 down quickly. According to "Building Industry Development Policy", in 2010, China's cement output was 1.5 to 1.6 billion tons; in 2020 reached 17 million tons. As a result, China's building materials industry forecast demand for coal in 2010 from 480 million to 510 million tons; demand 800 million tons of coal in 2020.

2.2.4 Coal demand of Chemical Industry

In chemical industry there are many energy-intensive products like ammonia, caustic soda, soda ash, calcium carbide and phosphorus, 5 products, whose total energy consumption accounts for 65% of the total chemical industry consumption.

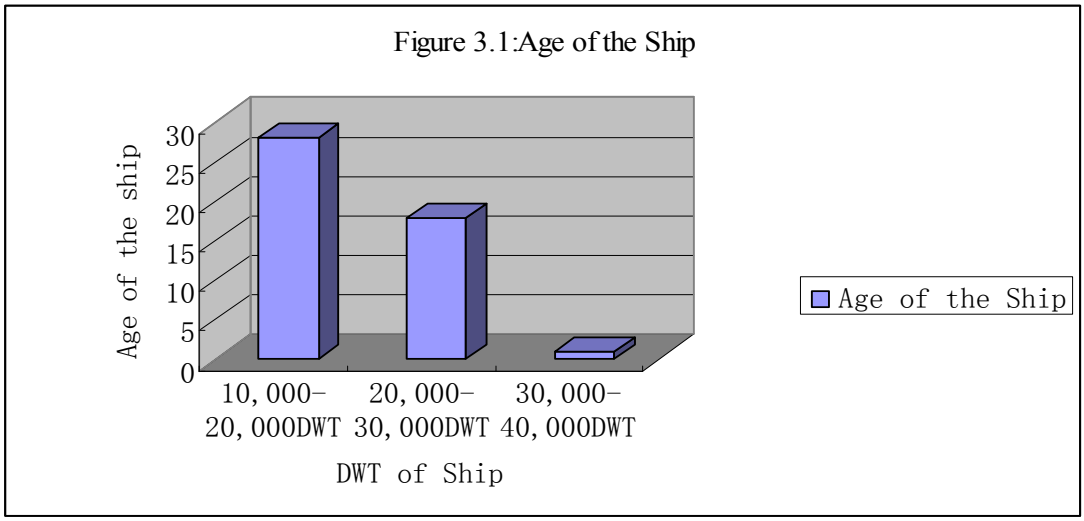
China's chemical industry's energy use efficiency and lower than the 15% foreign. Chemical industry coal demand forecast for 2010 from 140 to 170 million tons; 2020 270 to 360 million tons.

Chapter 3: Internal Environment Analysis

3.1 Structure of Wenzhou Shipping Company's fleet

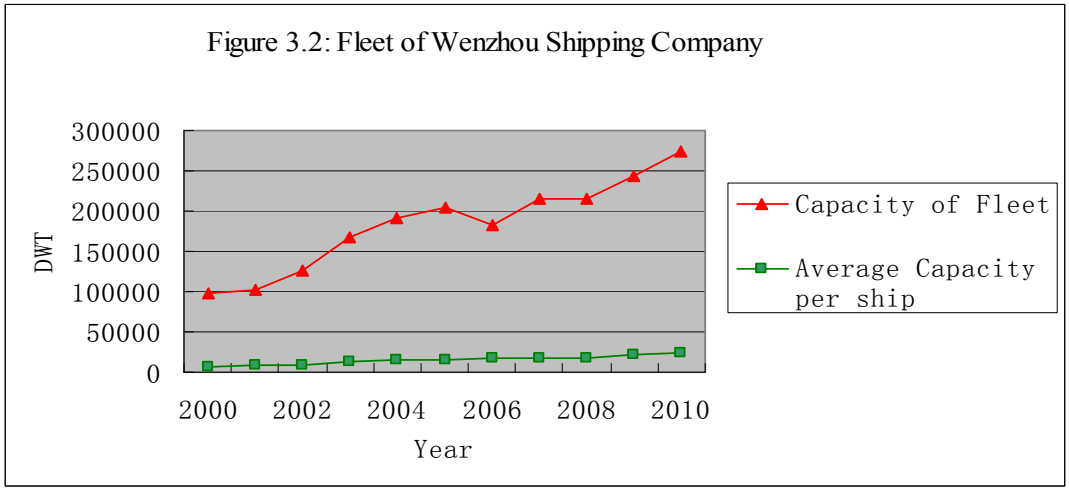
Currently Wenzhou Shipping Company is operating their own ships 12, whose average age is 20 years, of which more than 25 years old ship 4, with total capacity of 58,263 tons, 22.69% of total tonnage. We can see that the following chart:

Figure 3.1:Age of the Ship



We can see very clear that from Figure 3.1 the main fleet of Wenzhou Shipping

Figure 3.2: Fleet of Wenzhou Shipping Company



Company vessels, there are many more old boats, new boat is currently only one.

We can also find the average capacity of Wenzhou Shipping Company is under a

relevant low standard from Figure 3.2.

To sum up, we will get the following conclusions based on the situation of Wenzhou Shipping:

(1) Average vessel tonnage is relevantly small

In recent years, the dry bulk market has become increasingly the bulk of the cargo ship large-scale direction. Wenzhou Shipping only has one ship of 30,000 tons at present; it is difficult to meet the coal transport market whose demand is for large-scale ship.

(2) The structure of the ship's age is irrational

As the dry bulk shipping market, the new ship of the fleet have a stronger competitive advantage, it is an important measure control to test the modern shipping fleet. In general, the ideal age structure of the ship fleet as follows:

Table 3.3 Ideal age structure of the ship fleet

Ship's age	0-4 years	5-9 years	10-14 years	15-19 years	＞20 years
World Average	58.25%	7.68%	11.51%	9.71%	12.85%
China Average	54.60%	14.25%	12.41%	9.26%	13.45%

Source: "China Shipping Information" (1999.04)

Accordance with the above criteria, we can find that: the current aging fleet of Wenzhou Shipping is a serious problem; the existence of a large number of over-aged vessels will definitely cause a great threat for freight transport efficiency.

3.2 Operating performance of Wenzhou Shipping Company

When we make a comparison with other company the industry, we can see clearly about the difference between them as following Table 3.4:

Table 3.4 Comparison between Wenzhou Shipping Company and Other Companies

	Wenzhou Shipping	Large size Company	Medium size Company
Total Ships	12	85	21~50
Total Fleet	260,359DWT	5,000,000DWT	600,000DWT
Total Income	RMB114,480,000	USD1,040,000,000	RMB800,000,000
Income/DWT	RMB440	USD211.6	RMB1,520
Total Profit	RMB15,310,000	USD570,000,000	RMB145,200,000
Profit/DWT	RMB58.8	USD83.2	RMB241

After we take the all information above in to consideration, we will find several points for Wenzhou Shipping Company.

Firstly, there is a steady growth from 2005 to 2007 on the size of Wenzhou Shipping, in 2007; and the total capacity exceeded 200,000 tons in 2008, reached 260,000 tons in May of 2009.

Secondly, by the comparison with other size of enterprises in this industry, we find that: the capacity of Wenzhou Shipping is relatively small; there is a big gap between Wenzhou Shipping and the medium-sized shipping companies in the total traffic revenue and profits, but with good business performance in income and transport capacity from the unit.

3.3 Financial status of Wenzhou Shipping Company

Based on the balance sheet and income statement of Wenzhou Shipping Company from 2006 to 2010, we can see the company's operating capabilities, profitability and solvency of the three aspects of the financial status and operating results.

3.3.1Operating capacity of Wenzhou Shipping Company

As we calculated it of 2006, the total turnover in 2006 of Wenzhou Shipping is 0.48 times, 0.51 times in 2007 and 0.42 times in 2008.At the same time, the Wenzhou Shipping's revenue growth rate is 4.7% in 2006, compared with 40.7% in 2007, 371.4% in 2009, which to some extent, reflects the stability of Wenzhou Shipping business growth.

3.3.2 Profitability of Wenzhou Shipping Company

According to the statistics from Wenzhou Shipping in 2005, the company's return rate on total assets was 8.74%, 6.19% rate of return on net assets, these two indicators show the operating results in 2005 as well. In 2008 the company's return rate on total assets was 5.5%, return on net assets was 4.4%, and the operating profit was -57%. This relatively low operating profit margin reflects the Wenzhou Shipping growth in profits.

3.3.3 Solvency of Wenzhou Shipping Company

The assets and liabilities ratio of Wenzhou Shipping was 70% in 2005, and the current ratio was of 0.73. In 2006 that was 70.6% and the current ratio was of 0.35. The balance of 2007 was 71.4%, a current ratio was of 0.89. In 2009 the balance was 74.6%, a current ratio of 0.72. We can see from the above statistics: Wenzhou Shipping has a stable financial status, which is more stable in long-term solvency, and also strong in short-term liquidity.

Chapter 4: The Capacity Development Plan of Wenzhou Shipping Company

4.1 The demonstration of suitable ship for Wenzhou Shipping Company

By October of 2007 the total capacity has reached to 215,561 tons deadweight, which compared to 2000 increased about 118%, the average load of 17,963 tons per ship, specifically as the Table 4.1 shows:

Table 4.1 Total Ships and Capacity of Wenzhou Shipping by years

Year	2000	2001	2002	2003	2004	2005	2006	2007
Total Ships	14	13	13	13	13	13	11	12
Total Capacity	98572	102933	126526	167806	190299	204409	181561	215561

Wenzhou Shipping Company completed in 4.665 million tons cargo in 2006, with the cargo turnover of 7.95 million ton-km, and got 281 million revenue, yearly increase was of 102% compared to 2000, 149% and 173% separately.

4.2 Analysis of suitable ship type based on KPCA method

How to select the best ship-type is a multivariable, multi-objective optimization of system scheduling problem, in the past it mainly solved by the designer's experience to judge. With the development of science and computer technology in ship industry, more and more studies begin to try the method of using mathematics and system science and multi-criteria evaluation of optimization methods to solve the problem of the best ship demonstration.

Kernel principal component analysis (KPCA) method is a relatively simple operation; and its applicability has been verified in practice as a reasonable approach to some

certain problems. In recent years, this method has a large number of applications.

By using the KPCA method for reference in a comprehensive analysis and evaluation of ship type for the real ship's multi-program selection, and achieved good results, so as to search for multiple attribute decision making is an effective method.

4.2.1 Introduction to the method of KPCA

This method is under the principle of ensuring that minimal loss of information in the original data of the system, on the basis of relationship of each variable information, compressed multiple variables into a few consolidated variable indicator which reflect the characteristics of the original ones, and do the comprehensive analysis of the system according to the Feature Information Indicators, so as to handle the nonlinear relationship between variables effectively, providing a good mean for solving the multi-index comprehensive evaluation.

The basic idea of KPCA is: input data χ k (k =1, ···,l) (l is the number of input data) through a nonlinear mapping Φ, and mapped to a feature space F, then do the linear Principal Component Analysis (PCA) in the feature space F. Through nuclear techniques, it only do the calculation in the original space dot product operation, and do not need the specific form of non-linear mapping, simply select the appropriate kernel function, and then make the first principal component contributed up to 85%.

a. Model Principle

First, the original space is projected into by a nonlinear transformation Φ with the feature space F, assuming that it satisfies the following condition:

$$\sum_{i=1}^{l} \Phi(x_i) = 0$$

$$K' = \frac{1}{l} \sum_{j=1}^{l} \Phi(x_j) \Phi(x_j)^T$$

It is obviously that K' values of all the characteristics of λ (λ ⩾ 0) and eigenvectors of V satisfies the relation of:

$$\lambda V = K'V$$

We make the definition of matrix K, of which is:

$$K_{ij} = \left[\Phi(x_i) \bullet \Phi(x_j) \right]$$

After that we can get the result that:

$$l\lambda\alpha = K\alpha$$

By solving the Eigen value type $\lambda_1, \lambda_2 \ldots, \lambda_l$ and the corresponding features

Vectors as $\alpha^1, \alpha^2 \ldots, \alpha^l$, let's assume that:

$$v^k = \sum_{i=1}^{l} a_i^k \Phi(x_i)$$

For the selection of principal components, we simply calculating a test point Φ (x) Feature vector in F, the projection v^k

$$\left[v^k \bullet \Phi(x) = \sum_{i=1}^{l} \alpha_i^k \left[\Phi(x_i) \bullet \Phi(x) \right] \right]$$

$$= \sum_{i=1}^{l} \alpha_i^k K(x_i, x)$$

At this time the comprehensive evaluation function of KPCA is

$$F(x) = \sum_{k=1}^{r} \sum_{i=1}^{l} \omega_k \alpha_i^k K(x_i, x)$$

In this function: the variable *r* should satisfy the relation: $\frac{\sum_{i=1}^{r}\lambda_i}{\sum_{j=1}^{l}\lambda_j} \geq 85\%$.

ω_k --is corresponding to the contribution rate of first *k* principal components.

If $\sum_{i=1}^{l}\Phi(x_i) \neq 0$, then K can be expressed as K^*, where satisfy the relation of:

$$K^* = K - AK - KA + AKA$$

And here satisfy the condition: $(A)_{ij} = \frac{1}{l}$.

b. Specific evaluation steps of KPCA method

(1) We use standardized methods to initialize the input sample X, then we get a matrix K;

(2) Solve the matrix K^*,

$$K^* = K - AK - KA + AKA$$

(3) Find the Eigen values of matrix K^*/l as λ_i (i = 1, 2, ···, l) And the feature vector V_i (i = 1, 2, ···, l);

(4) Find the corresponding m-PCA Eigen values and eigenvectors λ_r and Volume V_r (r = 1, 2, ···, m);

5) Make the evaluation of samples obtained for each evaluation function.

4.2.2 Normalized of decision matrix

As A = {A1, A2, ···, A n}, evaluate program strengths and weaknesses of the index set is denoted by G = {G1, G2, ···, Gm}, then the matrix Y = (yi, j) n × m that the alternatives The decision matrix of the index set:

$$Y = \begin{pmatrix} & & \\ y_{11} & y_{12} \cdots & y_{1m} \\ y_{21} & y_{22} \cdots & y_{2m} \\ \vdots & \vdots & \vdots \\ y_{n1} & y_{n2} & y_{nm} \end{pmatrix}$$

In order to eliminate incomparability between the "efficiency" and "cost-based" indexes, we normalized the decision matrix. We define the normalized decision matrix Z = (z ij) n × m, for different types of indicators, and select one of the following formula for processing.

For the Efficiency indicator of G:

$$z_{ij} = \frac{y_{ij}}{\max\left\{y_{ij} / 1 \le i \le n\right\}} \quad \text{i=1, 2… n}$$

For cost-type index of G:

$$z_{ij} = \frac{\min\left\{y_{ij} / 1 \le i \le n\right\}}{y_{ij}} \quad \text{i=1, 2… n}$$

4.2.3 Application in suitable ship-type selection

(1) The required freight rate

Required freight rate (RFR) is the unit of the ship used to represent the transport freight traffic necessary revenue. Required freight rate (RFR) is often used for freight rates for two indicators: one is actual shipping rate of known cases, when we evaluating the profitable projects and programs for the feasibility and merits of the standards. Secondly, when the actual freight rate is unknown, it can be used as the basis for development of freight rates.

For the convenience of calculation, we assuming the operating costs of each year during the study period are equal, and the same amount of annual transport capacity. So RFR is calculated as following function:

$$RFR = \left[C_Y - C_2 + C(A/C, I_0, N) - C_L(A/F, I_0, N)\right]/Q$$

C_Y is the total operating costs of the year, $C_Y = C_1 + C_2 + C_3 + C_4 + C_5 + C_6 + C_7 + C_8 + C_9$; we take C_1 for the cost of the crew; C_2 for the annual depreciation charges; C_3 for the annual cost of repairs; C_4 is The annual premium; C_5 for the fuel costs of year; C_6 for the materials fee of annual run; C_7 for the annual costs of materials; C_8 is in port charges; C_9 for the annual management fees and other charges; C_L for the salvage the ship, take C_L = C×10%; I_0 as the discount rate, taking 12%; N is the depreciation period for the ship, take N = 20; C for the ship cost; Q is a single ship in volume; V_C is cargo capacity for the voyage; T_n year of operation for the ship time, taking 310 days; T_1, T_2, respectively, for a voyage full load and ballast in sailing ships of the time; T_3, T_4, respectively, for a voyage in the port of loading and discharge port parking time.

(2) Production of capacity by unit

Production of capacity by unit = annual cargo turnover / capacity of vessels

(3) Navy constant (A_C):

$$A_C = W^{2/3}v^3 / P_B$$

In here: W is the ship displacement; v for the speed of ship; P_B as the power of main engine.

(4) Ship Performance (E_{SH})

$$E_{SH} = W_D v_s / F_c$$

In here: W_D for a ship capacity of load; F_C fuel consumption per hour for the main engine; v_s as a service speed.

(5) The ratio of power/load (R_P)

$$R_P = W_D / P_B$$

We select the 4 types in this paper to demonstrate ship which are Handysize,

Handymax, Panamax, Capesize. Table 4.1 lists out the typical parameters from four kinds of ship as following.

Table 4.2: The typical parameters from four kinds of ship-type

Ship-type	*Handysize*	*Handymax*	*Panamax*	*Capesize*
Capacity(10,000tons)	3.5	5.2	7.4	10
Length of Ship(m)	185	199	230	243
Width of Ship(m)	31	32.5	32.2	41
Draft(m)	9.5	11	13.95	14.5
Speed(kn)	13.5	14	14.5	14.5
Power(kw)	6040	7940	9000	10700
Rp	26	34	40	48

We take the route from Qinhuangdao to Wenzhou Power Plant to make the analysis between each ship-type.

Table 4.3: The typical indicators from four kinds of ship-type

Ship-type	*Handysize*	*Handymax*	*Panamax*	*Capesize*
Capacity(10,000tons)	3.5	5.2	7.4	10
RFR	10.037190	8.5999390	6.8212996	6.070682
Production of capacity	2.196	2.196	2.163	2.082
R_P	5.79	6.58	8.22	9.35
E_{SH}	4. 36153	5. 13882	6. 43800	7. 25000
A_C	5. 48	6. 08	7. 50	7. 71

By using the method of KPCA, we can get the result after comprehensive evaluation as following:

Table 4.4: Comprehensive Evaluation of four ship-types by KPCA

Ship-type	*Handysize*	*Handymax*	*Panamax*	*Capesize*
Capacity(10,000tons)	3.5	5.2	7.4	10
Result	- 1. 39631	- 0. 48825	0. 867019	1. 507136

As we can see, the ship-type is ranked by the size of capacity, which first place is Capesize and then Panamax. So if there is possible we'd better buy bigger ship-type in order to achieve the economy of scale.

4.3 The Capacity Development Plan of Wenzhou Shipping Company

According to the above analysis, we suggest Wenzhou Shipping Company to lunch a three-year development plan on shipping capacity from 2010 to 2012. The plan must focus on the development of ships above 30,000 DWT, on the basis of the scale, the company's shipping capacity to form the structure, in order to respond to different ports or the transport needs of the market.

Firstly, by the end of January 2010, there are 10 cargo ships existing of Wenzhou Shipping, the total capacity reached 226,500 DWT; There are four vessels under construction (one is 27,000 DWT, another one is 47,000 DWT, and the other two are 57,500 DWT); Of which 3 will be completed in 2010 production (27,000 tons, 47,000 tons, 57,500 tons), the last one of 57,500 tons will be completed in 2011.

Secondly, Wenzhou Shipping Company should plan to purchase a 50,000DWT second-hand ship with 10-15 years age in 2010; and start the construction of two ships which will be completed in 2011 production.

Thirdly, Wenzhou Shipping Company should purchase a ship of 50,000 tons with

10-15 years age in 2011.To the end of 2011, a total of 15 vessels with a total capacity as 562,500 tons.

Fourthly, start the construction of one ship with 50,000 DWT, which will be completed production in 2012. To the end of 2012, a total of 16 vessels will be a total capacity as 612,500 tons.

Chapter 5: Risk Management of Shipping Investment

5.1 Investment and financing of Shipping Industry

As one of the most popular investment, there are several way to form this investment like private fund, government loans, bank loans, securities financing, financial leasing and associated financing. Because Wenzhou Shipping Company much more tender to use financial leasing way.

As a mean of popular financing around the world for 50 years since the 20th century, financial leasing was originated in the United States, with the rapid development within the world, it has played an important role particularly in large equipment, high-tech products field.

As a unique form of credit, finance leasing has the following three characteristics:
(1) Separation of ownership and usage. It means that the ship is owned by the lesser on the lessee term, meanwhile the lessee have the right to use;
(2) The combination of financing and leasing ship, financial leasing integrates borrowing money and borrowing things together, in order to purpose of finance, it runs in obtaining rental ship, at the same time achieving the purpose of financing;
(3) The flexibility of the payment. Lessee may settle the amount of time in terms of the rent in the form of adopting a more flexible method of payment.
Shipping industry is highly capital-intensive industry, no matter the manufacturing or lease purchase of the ship requires a huge amount of investment, and compared to engineering projects, high-tech industry the shipping industry is of a higher risk of on ship financing.

The risks of ship financing, including risk of interest rate, currency risk, political

risk, credit risk and third party liability risks.

5.2 The risk of ship financial lease and countermeasures.

5.2.1 Financial risks and countermeasures

Financial risks mainly refer to the risks which are raised from changes of interest rates and exchange rate during the financial leasing. On one hand, shipping companies should actively try to apply for the financing loans; on the other hand they should raise more money, it also may lead to lower risks.

5.2.2 Credit risk and liability risks and their preventive measures

Credit risk is the finance lease commitments respective parties can not because the other party all or part of the risk of loss resulting performance. With the economic and social development, credit unprecedented attention, especially in ship trading, ship leasing and credit loans, especially in areas of high finance. The activity like credit assessment, credit investigations before the whole transactions have taken by the enterprise.

5.2.3 Political risk and countermeasures

Political risk is because of political or government to adjust macro-control policies such as war, revolution or civil unrest, government expropriation or confiscation, the state implemented the import, export or foreign exchange controls, and exchange restrictions and so on. Especially for the subject matter of the ship finance lease ships sailing in the waters of the world, a variety of international and domestic law by the legal norms of the constraints, the political risk, but also worldwide, the study related to the preventive measures it is very necessary.

(1) Buy a commercial insurance which include the political risk insurance.

(2) Take the insurance of Ship-owners Mutual Assurance Association insurance.

(3) Make relevant risk assessment for country's financial and maritime laws and regulations.

Chapter 6: Summary

This paper uses the spreadsheet technique to do the economic analysis, and adapt the theory of technology and economy demonstration of ship-type as a suitable approach to do the investment decision while evaluating relationship between the ship industry and the market situation.

Based on the theory of ship style economic analysis, and analyzes the sensitivity of the NPV influenced by the three factors: freight rate, ship price and fuel cost. It may serve as a reference for shipping enterprises in fleet development decision. The paper uses the method of Kernel Principal Component Analysis (KPCA) to evaluate the technology and economy of ship.

After analysis and comparison of different ship type plans, the outcome could provide certain theoretical basis for ship investment of Wenzhou Shipping Company. Accordingly, the paper lists out the arrangement about the detailed development plan. Finally, the paper has a risk assessment and risk management about this ship investment, in order to make the plan more feasible.

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