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Research on the volume forecasting and economic benefit analysis of developing inland water container transport in Ningbo section of Hang Yong Canal

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By

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DECLARATION

I hereby certify that all the material in this dissertation 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 dissertation reflect my own personal views, and not necessarily endorsed by the University.

(Signature):_______

(Date):___________

Supervised by Professor

Sha Mei

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Abstract

Maritime countries' experience indicates that the inland water container transport is a high-efficiency, energy-saving and low cost transport mode. Thus, any port meet basic requirement of developing inland water container transport never ignores such opportunities. The container transportation in inland water has been adopted early in the 70s of last century. In China, the testing inland water container transport begun in the Yangtze River area in 1976. After that, inland water container volume increased by leaps and bounds. The huge generating container volume will put great pressure on the loading and discharging, road traffic capacity, surrounding environment. A unitary collection and distribution system constraints port economic benefits, and to only rely on one transport mode cannot sustain too long. Currently, many cargo owners are still willing to choose traditional truck to transport containers for its flexibility and speedy. Thus, to the inland water container collection and distribution system, a scientific transport organization combination, a reasonable set of transportation routes disposition, necessary transport software and hardware supporting need to be carefully considered. Generating volume and transport cost per unit are two important aspects to estimate economic strength and transport level. The increasing container generating volume and low transport cost are the advantages of container ship, to make the most of them, a systematic analysis is crucial.

This thesis focus on the economic benefit of Ningbo section of Hang Yong Canal after the Class-Ⅳ waterway been reconstructed. It mainly analyzes the following core aspects of contents. The first aspect focused on the container generating volume aspect. In this part, the principle of forecasting follows the qualitative investigation and quantitative calculation. By adopting multi-factor dynamic production coefficient method to forecast the inland water container throughput from 2011-2015 and collecting the previous accurate GDP data and other influence factors data to forecast. With dynamic viewpoints to analyze each factor variation influence to the generating volume of three main node points of main cargo resource hinterland along Hang Yong Canal, and choose Ningbo section as the typical example to analysis its future economic trend.

The second core aspect focuses on the unit transport cost between truck transport and inland water vessel transport. This part adopted a Required Freight Rate Formula. Put emphasis on the economic rationality of inland water container transport in Ningbo section. Based on the actual situation and statics, calculate the RFR difference value（Required Freight Rate Formula）with different transport mode under respective transport distance from Ningbo to Lanxi (example). Then, summarized the economic benefit developing trend of Ningbo section by RFR and forecasting generating volume.

The third core aspect gives a practical case of inland water transport business of in Ningbo. PHL company’ business challenges, its tactics and strategies. The case is a typical example for those who operate inland water transport businesses in Ningbo. Through the real comparison result, the intent to gain economic benefits in inland water container transport will be the wave of the future.

Key words: inland water, container, economic benefit, Ningbo section, Hang Yong Canal

Menu

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Chapter1 Introduction

1.1 Research Background

Yangtze River Delta region has dense and complex river network, Hang Yong Canal which locates in the south east end of Yangtze River which begins from Hangzhou, connecting with the Beijing-Hangzhou Canal and ends in the outlet of Yong River into East China Sea. Hang Yong Canal's excellent geographical location and potential huge values for its connecting wide and vast developed inland economic zones are worthy of intensive study.

Hang Yong Canal can be divided into three main sections – Hangzhou section, Shaoxing section, and Ningbo section. Ningbo Port occupies a strategic position of container traffic collecting and distribution which connects the estuary and inland waters. Developing inland water container transport can not only enlarge Ningbo section hinterland scope, establish new cargo distributing channel but also release the burden of land route transport. Thus, a cost effective, high efficiency and optimized water transport organization can provide huge cargo volume and bring high value returns.

Most large container terminals of China locate in coastal waters, Ningbo Port is one of them. In the past, about 95% volume of the inland container collecting and distributing of it depends on highway and railway to transport, what’s more, the inland water container transport has not been fully exploited. Such problem cannot be ignored, because the facts are that inland water transport costs much lower than highway or rail and inland water hinterland resources are prosperous.

Seen from the past developing trend of inland transport, Ningbo section of Hang Yong Canal didn’t attract adequate source of container cargoes from Zhejiang Province and neighboring provinces adequately. It only depends on ores, crude oil and liquid chemical transshipment businesses, etc. Such uniformity operation mode cannot give full play to the advantages of extensive hinterland. Thus, to change the situation and accelerate the inland water container transport development is imminent.

1.2 Literature Review

1.2.1 Introduction of Inland Container Transport Business Development

In inland transport, the railway transport has the cost advantage under a long distance transport. Highway transport has the flexibility and convenience advantage under short distance transport. But in the current situation of Ningbo, focusing too much on these two modes is not wise, according to reference report, the transport cost of railway is about half of the highway mode, and inland water mode is half of high, on the other hand, the occupied area of these three modes varies a lot, respectively, less or equal to 10 acres for inland water mode, 50 acres for railway mode and 120 acres for highway mode on average per kilometer.Transport inland container is easier to conduct intermodal transportation, especially to provide "door to door" services. With rational coordination of container transport modes can improve handling efficiency, speed travel turnover, reduce freight costs; speed up the shipping rate, reduce shipping time; improve the quality of freight transport reduce cargo damage goods and save the packing materials, miscellaneous expenses.

1.2.2 The Potential Economic Benefit of Inland Water Container Transport

For inland containerized transport, three issues are of particular relevance. One is port regionalization, which implies a more efficient maritime/land interface, particularly with the usage of inland freight terminals with direct connections to the port through rail or barge services. A second concerns a new generation of inland terminals that will improve the productivity, efficiency and throughput of inland distribution. A third one involves the container itself in terms of new specification and more advanced forms of management.[1]

With reconstruction of new class level waterway completed in Hang Yong Canal, the inland container vessel may greatly reduce the container transport costs. Seen

2 Extracted from Theo Notteboom & Jean-Paul Rodrigue,The future of containerization: perspectives from maritime and inland freight distribution, GeoJournal(2009) 74:7–22

from the economic benefits, the transport cost of container is much lower than highway transport (under the condition that the transport distance over 100km). In general, the RFR of inland water vessel transport is less of 20% (including loading and discharging fee). Thus the potential economic benefits in Ningbo will be prosperous. Seen for the statistics, there were 1.7 billion tons of inland water container volume in the USA in 1995, the inland water vessel mode occupied 20% of all transport modes and the transport costs only occupied 2%[2], thus the economic benefits of this mode could be seen clearly for the economic growth. In Western Europe, inland water transport is also the main collection and distribution way of world's largest port. Such as the way of transport of Port of Antwerp to Europe, the dominating transport mode is inland water transport. In 1999, 27% of the total inland collection and distribution volume in port of Antwerp were undertaken by inland water barge. Another example is the total transport volume in Sky Verde River - Rhine Canal reached 12 million tons in1999. These factors proved the potential driving force of inland water transport for regional economic development.

1.3 Methodology

Multi-factor dynamic product coefficients methods is the most mature and widely-used one in all available container handling capacity prediction models. After predicting foreign trade value, predicted container handling capacity can be got by using product coefficients. However, the very first step, setting future foreign exchanging growth rate, is a step which usually lacks solid logical base, leading to low precision in the middle/long term prediction.[3] Thus, in this thesis, chose 5 years as the time span to predict and solved the logic-lacking problem by using regression model between generating volume and GDP, and then forecasting the container generating

2 Extracted from Ji Bo Xing & Ma Zhi,Thoughts of developing inland water container transport in Wuxi, Wuxi Navigation Channel Administrative Office, JIANGSU COMMUNICATION,2001(4)

3 Extracted from Yang Bo, The Application of the logistics model in the middle/long term container prediction, OCEAN TECHNOLOG, Vol.25, No.4, 2006

volume in Ningbo section from 2011 to 2015 accurately.

RFR formula is applied in the thesis. In the most general sense, a ship is an investment that is to be operated in such a manner that the investors' expectations with respect to returns are met. A freight rate must be obtained so that all expenses are covered, with a remainder sufficient for the returns on investment. In analysis of the economic merit of a shipping project, this rate is often referred to as the required freight rate. Actual freight rates are set by market conditions and inevitably fluctuate during the life of a ship.[4] Comparing unit transport cost under a certain distance between two transport modes can clearly reflect the difference of freight rates.

1.4 Research Purpose

Someone hold the viewpoints that the inland container vessel is slow in speed compared to traditional truck mode, and believe this transport mode is only suitable for large quantity general cargo not for container, truck mode is flexible and speedy. Thus, a specific research of the economic benefit comparison is essential for Ningbo.

The thesis exploited in detail in analysis the future economic benefits of Ningbo section of Hang Yong Canal based on the forecasted generating inland water container volume of Ningbo section. In another aspect, by comparing the unit transport cost between inland water container vessel mode and truck mode to get the price difference data from the same node point to another. Then with a practical case of PHL company to illustrate the real challenges and difficulties in inland water container transport in Ningbo and the transition process from truck transport to container vessel transport of PHL. Then to combine all aspects mentioned above with a summary of the economic benefits of inland water transport in Ningbo section in the future. With these systemic analysis, more emphasis will be put on the development of inland water container transport in Ningbo section and provide a reference value for enterprises of transport along Hang Yong Canal.

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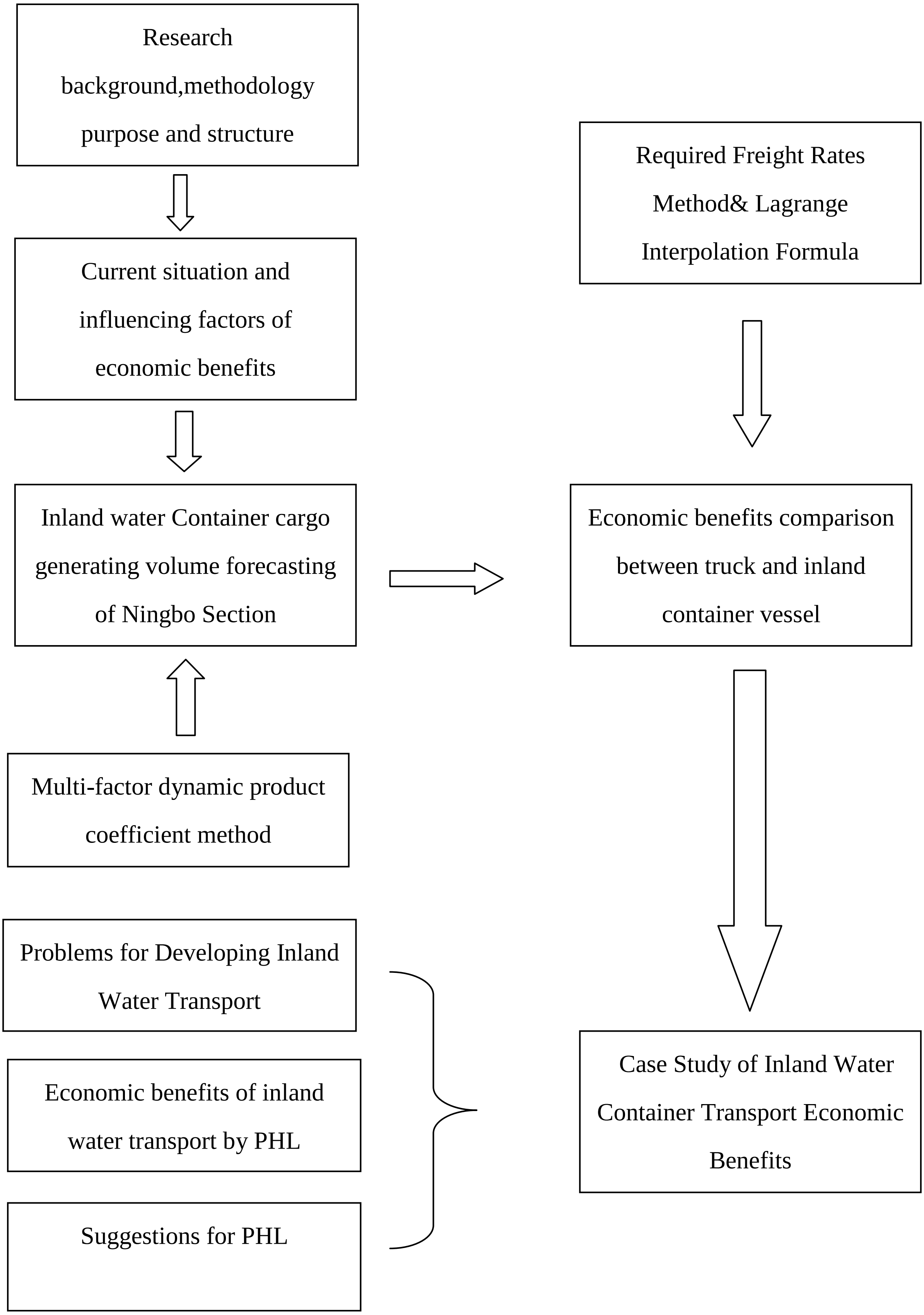
4 The definition of RFR is extracted from the following website:
http://www.britannica.com/EBchecked/topic/540904/ship/64222/Ship-operation?anchor=ref528307

1.5 Research Structure



Chapter2. Introduction of Current Situation and Influencing Factors Analysis of Economic Benefits in Ningbo Section

2.1 Introduction of Network of Hang Yong Canal and Hinterland Node Points

Hang Yong Canal locates at the south river bank of Hangzhou Bay, it's the main channel of the extension part of the Grand Canal which across the Qiantang River from Hangzhou city to Ningbo city. It is also the only waterway transport artery in east Zhejiang Province. The canal starts from Hangzhou, meanwhile connecting Qiantang River in the upstream and Cao-e River in the middle stream, and ends in the estuary of Yong River in Ningbo Port. This canal goes through Hangzhou city, Shaoxing city and Ningbo City of which are the economically developed cities The Hang Yong Canal works as the main estuary channel of the Grand Canal. In 1983, the total channel was constructed under the level condition of 40 tonnage level waterway, but actually it only adopted 25 tonnage class vessels to go through namely the waterway is only of 7 to 8 class-level. Due to low transport capacity and much complicated transshipment process and obstacle of dam hinder, it resulted in a tedious transport cycle time and high cost and finally lost the time and economical effectiveness advantages comparing with the highway and rail transport.

Figure 2.1 Network Structure and Node Points of Hang Yong

2.2 Reconstruction Project of Hang Yong Canal

The Zhejiang Province government set the reconstruction project as the key project of the Tenth Five-Year Plan for Zhejiang Province Economic and Social Development in 2000. The project ended in the year of 2007 and the total reconstruction costs more than 7 billion Rmb which is the largest investment transport project of Zhejiang province. After the reconstruction, the canal overall span reached 243 km and equipped with Class-Ⅳ waterway, and the navigation capacity reached 500 tons .The total volume even exceeded the capacity of Xiao Yong Railway[5] and played a positive role to improve the construction and optimization of the collection and distribution system of the rear part hinterland of Ningbo Port.

2.3 The Current Situation of Ningbo Section

Ningbo section of Hang Yong Canal starts from Anjia Du of Yuyao city, goes along with the Yao River into Ningbo city and ends in estuary of Yongjiang River. According to the Overall Planning for Ningbo Port，the length of the section reaches 94 km, the width of the canal surface is about 250 to 300m, together with a good depth of water which adopts 3000 tons sea vessel. Ningbo Port locates at the eastern part of Ningbo section, and the total coastline length reaches about 170 km of which 139.1 km namely 81.8% is deep water coastline. In 2007, the Class-Ⅳ waterway has been constructed and dredged up, which made the Hang Yong Canal successfully connected the Grand Canal and Qiantang River, Xiao Shan Yong Inland River which allows 500 tonnage-class container vessel goes directly from Hangzhou to Ningbo. Further, it connects the hinterland railway lines including Zhejiang-Jiangxi line, Hangzhou-Ningbo high-speed highway, and Shanghai-Hangzhou high-speed rail line. Thus the extensive radiation areas support to build Ningbo port as a sophisticated integrated transport network. After 2007, the total cargo throughput (not only container cargo) increases at more than 10% of growth rate annually. In the first quarter of 2011, the total cargo throughput of Ningbo Port exceeded 100 million tons and container

[5] Xiao Yong Railway is the only outbound rail line of Ningbo connected with Hangzhou the total length reached 147 kilometers, 66.5 kilometers of which lies inside Ningbo. It was constructed in 1937. The transportation volume to be 13 pairs of passenger trains, and 13,000,000 tons cargo.

Extracted from http://www.calstatela.edu/centers/apbi/ningbo/english/envir-basic2.htm throughput more than 3,343,000 TEU[6], and most of which came from northern Zhejiang Province. But the burden of highway is still at the saturation point. The major highway Xiaoshan section and Shaoxing section of Hang Yong Highway are 10 meters wide but its daily vehicle flow reaches 25 thousand on average which brings huge pressure on the collection and distribution. Therefore, to developing inland water container transport can not only relieve container gate-in/out process burden, but also can collect more container cargo resources and enlarge hinterland advantages.

2.4 SWOT Model and Strategy

From 2007 to 2011, transport container business in Ningbo section has met with rises and falls in many aspects. The following model illustrates the current conditions of Ningbo section by SWOT model and set different strategy suggestions for the future development.

6 Extracted from Chinese Port Research Report of 2011

Internal Factors / External Factors	**Strength Factors** (1) Geological location (2) Growing regional GDP and investment, export and consumption indicators	**Weakness Factors** (1) Poor use of port shorelines (2) Poor inland water port infrastructure conditions
Opportunity Factors (1) Supporting national policies (2) Attracting huge overseas investment	**SO Strategy** Relying on investment and supporting policy to enlarge economy of scale and establish international image.	**WO Strategy** Put emphasis on advancing infrastructure and hire professional human resource to optimize management of shorelines
Threats Factors (1) Fierce competition from Shanghai and potential container cargo source loss (2) Limited empty space for inland container volume	**ST Strategy** Expand market coverage and give prominence to regional dislocation competition. Cooperate with Shanghai Port to avoid vicious competition and develop comprehensive logistic network to collect more inland water containers.	**WT Strategy** Integration of human resources and reform the resource deploy Based on possessed resource to enlarge cargo collection and reduce unnecessary fees.

Figure 2.2 SWOT analysis and strategy

2.5 The Importance of Port Economy to Regional Economy

The throughput volume of ports is not only an important sign to measure the status of trade level, but also a barometer of a national or regional prosperity. The main port competition in the world is gradually manifested the container generating volume as the core comprehensive competition capacity among ports. Inland water container transport and hinterland economy are of mutual interdependence. Port economy has become the balance strength of the hinterland economy development. As to the port economy depends largely on the scale of regional economy especially for the export-oriented economy for Ningbo port as an typical example, also it depends largely on the hinterland container generating volume and transport conditions, and unit transport cost etc, which all influence the development of inland water container transport. According to the past experience, the hinterland container generating volume and unit transport cost are the two major indicators to judge the level of port economy and even to the regional economy.

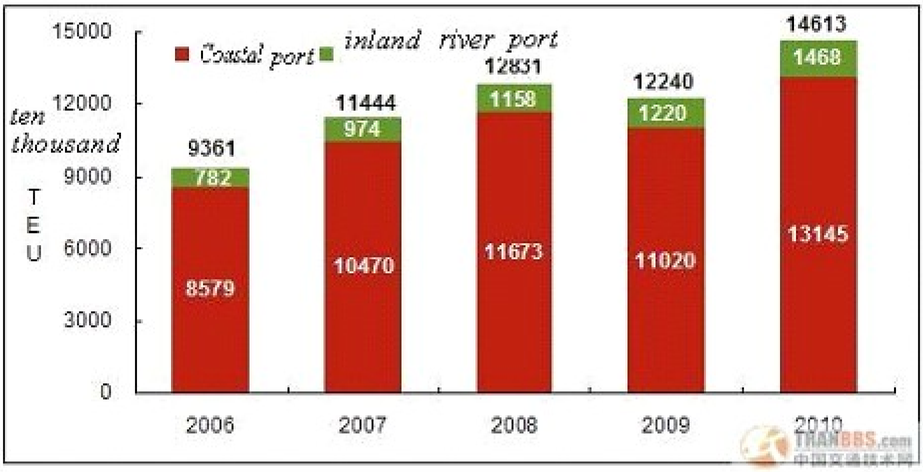


Figure 2.3 Throughput comparisons between coastal ports and inland water ports in China

2.5.1 Influencing Factors to Generating Volume of Inland Water Container Transport

The container generating mechanism is reflected by the structure of factors generating the container volume, interact relationship and level of influence and level of management. The generating volume also reflects the total volume demand to the regional trade development, and it acts as the important part of terminal planning and its feasibility study for references. Inland water container transport is generally believed that the main influence factors include: port geographical location, hinterland economy, policy environment, port capacity for loading and unloading cargos and the collections and distribution systems. The contents of them cover regional GDP, total industrial output, population and export-import volume etc.

2.5.1.1 Geographical Position Influencing Factor

Ningbo Port locates in the intersection part of Yangtze River and East Sea. The hinterland of it nears Yangtze Delta economy zones and shoreline economic zones, the conjunction part forms T configuration layout. Ningbo port rolls ports, railways, highways, civil aviation and pipelines transport modes of transport into one and act as the international transport hub. Together with reconstruction project finished, Ningbo Port enjoys the perforation of Qiantang River, New An River, Lan river, Qu river, hinterland of western Zhejiang Province and the Grand Canal, thus it can make the most of its natural deep water edge to adopt container cargo directly from the Yangtze Economic zones and even containers from Beijing to further consolidate and enhance the status of international main line port position.

2.5.1.2 Hinterland Economy Developing Level Influencing Factor

In the past the year of 2010, Ningbo port cargo throughput reached 630 million tons ranking first in the world. In the first quarter in 2011, the economic report of Ningbo Municipality indicated that by preliminary calculation, the first quarter regional GDP reached 119.27 billion Rmb which reached 10.4% growth compared to the same period of last year. The rest important economic indicator such as the Gross Output Value of Industry, investment, import-export volume, consumption and per capita income were also increased by two-digit growth in percentage.

Investment, export and consumption are the troika for economic growth. In the first quarter of 2011, the fixed asset investment accumulated to 45.9 billion Rmb which reached 30.9% growth compared to the same period of last year, the growth rate raised by 13%. In export business aspect, the total amount of city import-export trade business reached 21.87 billion dollar which reached 24.1% (export -12.72 billion dollar with 24.7% risen and import - 9.16 billion dollar, with 23.4% risen). In the consumption aspect, the total sales of consumer goods reached 196.26 billion which reached 25.2% compared to the same period of last year.[7]

2.5.1.3 Policy Environment Influencing Factor

The inland water transport development in Ningbo will cover a long growth stage. Due to the investments are huge, payback period is long which will bring some difficulty in inland water container vessel capacity enlargement. The government policy gives support to deal with these situations and give preferential policy to capacity supplement, financing, taxation, regulatory fees etc.

In March 1st 2011 the beginning National Twelfth Five-Year Plan, Chinese Ministry of Transport issued a document, of which accelerating the Yangtze River developing the inland water transport by the State Council suggestions. Of which illustrated 6 main outlines and 8 major tasks. The document reinforced 7 protection measurements to promote inland water transport. One of the suggestions indicated to expand central government funding support, also to urge local government to establish stable fund source provisions. In June 5th 2011, the Fourth China Open Forum which clearly suggested to set Ningbo Port sea area, islands and city area as the core parts to rely on and generally to form Chinese national marine economy[8] zone to meet international competition of the same business. In consideration of the unique advantageous conditions for the marine economy, in the recently released plan for developing the marine economy, Ningbo points out that the city shall build a comprehensive pilot ocean development zone, with which, the city aims to explore

7 The relevant data collected from http://news.cnnb.com.cn/system/2011/04/26/006914016.shtml

8 Modern marine economy is the economic integration of land and sea. In essence, it is an outbound-oriented economy, open economy.

new ways for the comprehensive development of the ocean and islands, and to promote the development of the marine economic development zones in Zhejiang.[9]

2.5.1.4 Inland Water Port Infrastructure Condition Influencing Factor

On average, the levels of waterway of Ningbo section are relatively low except for Yao River and Yong River's dimensions, the others are all in a small scale in width and depth. Most them are near standard Class-Ⅵ,Ⅶ. On the other hand, the bridge, hinder dam, ship elevators are too much to block the freely flowing of the transport. According to relevant data, some density of the number of bridges reached 2 per mile, thus it reduce the full speed of the vessel and influence the time effectiveness.

2.5.2 Influencing Factors of Freight Rates of Inland Water Container

In general, the influencing factors to inland container transport unit cost cover cargo species, supply and demand, competitors, transport cost and vessel type etc.

2.5.2.1 Competitor Influencing Factor

Shanghai Port enjoys great prestige of international shipping and financial centre. In 2010, the total container throughput of Shanghai port reached 29.069 million over Singapore and ranked No.1 in the world. TEU With the completion of Hangzhou Bay Bridge, it shortened the actual distance of south coast of Hangzhou Bay (including Ningbo, Shaoxing) to Shanghai Port and Yangshan Deep Water Port. Thus it increased the possibility for container cargo flowing to Shanghai Port. According to the actual data, 80% of the containers shipped from the Beilun Port area of Ningbo, with the construction of the Hangzhou Bay Bridge, the distance between these two ports were shortened by 137 km, for Shaoxing, the distance been shortened by 60km. Thus, with a more a professional international Port-Shanghai Port, the container will more possible flow away and result in the traditional hinterland cargo source loss.

9 Extracted from http://english.ningbo.gov.cn/art/2011/5/29/art_421_472121.html

2.5.2.2 The Supply and Demand Relationship Factors in the Shipping Market

The supply and demand relationship is the determinant factor of container transport freight rate. Seen from the demand aspect, according to the customs statics in 2010, China's foreign trade volume show rapid resumption of growth, the total export volume reached 989739 million dollars, increased by 35.4% compared to previous months. In the capacity supply aspect, the liners controlled a certain amount of capacity. These two aspects promoted the freight rate increased of Chinese liners.

2.5.2.3 The Transport Cost Factor

To container liner enterprises, the freight rate is composed of transport cost, tax and duties and profits. The transport cost occupies a very high portion of transport freight rate which is usually more than 90% and act as the main body of freight rate. In 2010, the freight rates were higher compared with 2009, except for the influence of the market. It is also involve the liner operations, increase of management cost aspects and so on.

2.5.2.4 The Port of Origin and Port of Destination Factor

The difference of port of origin and port of destination involves inland water port depth, conditions of loading and discharging operation, levels of PD, distance for charging freight rate between ports, the voyage operation times, whether it needs to go through the canal, whether there are refueling port along the shipping route and the local fuel prices and so on. These influence the quantity of freight rates and economic benefits.

2.5.2.5 Vessel Type Factor

The different vessel types determine different freight rate. Because the sea worthiness and cargo worthiness varied by the vessel type, thus the freight rates are correspondly different. The technical condition, protective security are also different. So, it usually depends on the vesssel society to determine the freight rate and insurance. etc. The compositions of the project cost are also different, thus the directly related freight rates are bound to be various.

2.5.2.6 The Quality and Quantity of Cargo Factors

The quality and quantity of cargo determine the container freight rate. Obviously, the precious cargo freight rate is higher than cheap cargo freight rate. In the quantity aspect, stowage factor influence the utilization of slots, thus the freight rates varied. The lower quantity cargo freights are usually higher than a large batch of cargo freight rates. The quantity also influences the utilization of tonnage of a vessel and slots. When vessel capacity wastes to some extent, the freight rates will be higher.

Inland water container transport involves not only the hardware aspects such as inland waterway, port construction, but also involves software construction aspects such as transportation systems planning, transport market analysis and open up, regional cooperation, and so on. Uner the condition of port scale enlargement, increasing throughput and rapid development of container transport system, Ningbo should take the above factors into account and make a good use of inland water transport and develop as a modern multiple-purposes international port.

2.6

Chapter 3 Inland container market analysis and volume forecasting

3.1 Demand of Inland Water Container Cargo Analysis

Ningbo port's geographical position is very close to the international shipping center Shanghai port, it has a criss-cross, extends in all directions of inland water transport network, and also links Ningbo Beilun Port area and the Grand Canal directed to Beijing. It enables organic connection between transport passage of eastern coast of China and the Grand Canal, these two inland water networks are water transport arteries of two major north-south water transport. And thus form the overall water transport in the "two vertical and three horizontal" pattern. With the adjustment of port infrastructure updated and reconstruction of the waterway channels, it soon will form the situation of set Hang Yong Canal as the main artery together with river-sea, lakes as the comprehensive inland transport network. Thus the Ningbo pivotal Port will become the leading role, the other cities and counties of large, medium, small ports groups to match.

In addition, Hang Yong Canal is the extension part of the Grand Canal to Ningbo, which is the main channel of Ningbo estuary. It connects Hangzhou, Shaoxing, Ningbo, the three most economical developed areas. According to 2010 statistics, the total container volume of these three areas accounted for 69.4% of the total container volume of Zhejiang Province.[10] The export volume of Ningbo occupied over 70% of the total amount which illustrated Ningbo section is the main economic hinterland and it had a huge demand for container cargo.

To predict the container generating volume of Ningbo section can advocate the position and function adjustment and does a significant help to make full advantage of its low cost and sustainable characteristics. Therefore, in this chapter the next 5 years

10 The relevant statistics extracted from Economic and Social Development Statistical Communique 2011 of Zhejiang Province

container volume of Ningbo Port will be forecasted.

3.2 Generating Volume Node Points Selection Principles

The node point of transport network represents the container volume generating cradle. Thus it is crucial to select network node point properly. Although a meticulous selection of nodes is more realistic, the processing amount of data processing will be too complex and error-prone, meanwhile, it will also bring great difficulty to statistics resource collection work. Thus, I select the nodes by relatively large scope including Hangzhou, Shaoxing, and Ningbo the three major cities. Because to set the economical developed central city as the primary node may concentrative, objectively reflect the main container flowing volume.

3.3 Principles of Container Volume Forecasting

Currently, the forecasting methods are various such as time series, linear regression analysis, the gray comprehensive assessment, artificial neural network etc. But many methods only consider the historical data and set the future is the analogy of history. Its assumptions are that the external factors are stable, the structure is unchangeable, the notions and concepts are also of little change. Thus, to rely solely on the results of these methods cannot predict the result accurately and reflect the truth, the forecasting results hence have a large deviation. This thesis will use multi-factor dynamic product coefficient method to predict the hinterland container volume and thus provide reference basis for Ningbo section.

The route of multi-factor dynamic product coefficient method in this thesis is: rely on the social development planning and trends of hinterland economy indicators, as well as the development trend of export-oriented economy to forecast per cent pack, PCS/CTN (percentage of container packing rates), and container generating volume per 100 million dollar trade volume. Then, forecast regional generating container volume. Through diverging different transport mode, and form the predicted result of container of each mode.

3.3.1 Structure of Multi-factor Dynamic Product Coefficient Method

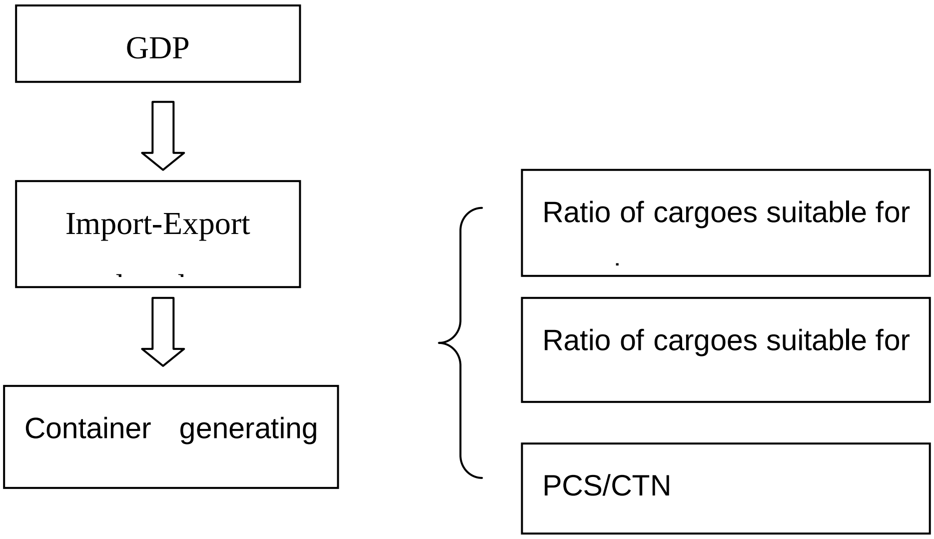


Figure 3.1 Structure of forecasting steps

3.3.2 Steps of Multi-factor Dynamic Product Coefficient Method

Multi-factor dynamic production coefficient method is considering all factors related to container generating volume with a comprehensive and complete way. It analyzes the variation of each factor with a dynamic viewpoint and discovers the relation within factors and quantifies the degree of association.

The mathematical formula is **W=P*K1*K2*K3**

W stands for container generating volume (10 thousand TEU)

P stands for import-export volume (100 million USDs)

K1 stands for ratio of cargoes suitable for container currency amount (%)

K2 stands for PCS/CTN of cargoes suitable for container (%)

K3 stands for the production coefficient of goods suitable for container volume (10 thousand/ 100 million USDs)

To P, in essence, the scale of container generating volume is closely related to regional import-export trade volume. The larger scale of import-export trade is, the more cargoes are suitable for container transport, thus the container generating volume increased.

To K1, the cargoes which suitable for container are made up of specific cargo species, the volume depends on regional structure of economy and export-oriented economy namely depends on the industry structure. The proportion of import-export trade cargoes suitable for container in past years of economic hinterlands is in accordance with the value of manufactured goods / import-export trade volume.

To K2, it is the value of container cargo freight/total freight of cargoes suitable for container transport.

To K3, it is proportion of cargoes suitable for container transport * generating coefficient of cargoes suitable for container transport = proportion of cargoes suitable for container transport*generating container volume per unit trade* PCS/CTN

Year	2006	2007	2008	2009	2010
Import-Export Volume	1391.5	1768.3	2111.5	1877.3	2534.7
Export Volume	1009	1282.9	1542.9	1330.1	1804.8
Import Volume	485.4	485.4	568.6	547.2	729.9

Figure3.2 Foreign trade list of Zhejiang Province Unit: 100 million USDs

Year	**P** Unit:100 million USDs	**K1**	**K2**	**K3** Unit:10 thousand/100 million USDs
2006	1391.5	85%	93.58%	0.372
2007	1768.3	85.43%	94.23%	0.364
2008	2111.5	85.25%	94.17%	0.363
2009	1877.3	85.67%	94.37%	0.373
2010	2534.7	81.29%	95.07%	0.369

Figure3.3 Container production related factors table of Zhejiang Province

Node Point	**GDP** (100 million USDs)	**P**	**K1**	**K2**	**K3**
Ningbo	3964.1	678.4	94.9%	95.2%	0.341
Hangzhou	4781.16	434	95.2%	96.4%	0.339
Shaoxing	2222．95	270.2	92.1%	93.0%	0.343

Figure3.4 The inland container transportation hinterland of Ningbo of 2008

One-dimensional linear regression forecasting of P

3.4 Forecasting of Inland Generating Container Volume

The follow result indicate the relationship between GDP and P

Based on the regression result extracted from the internet

Result: GDP=13253.97+1.611XM[11]

T: 4.0235.245

sig0.001 0.00R2=0.91 DW=0.284

Based on the internet, the result shows that Chinese import and export volume has a positive correlation between GDP value, and relationship is more closely to demonstrate a significant linear relationship. Thus in the thesis I choose One-dimensional linear regression forecasting model for P. The following figure is the summary of GDP and P from 2006 to 2010 of which the data are actually and precisely extracted from the Statistical Yearbook 2005-2010 of Zhejiang Province.

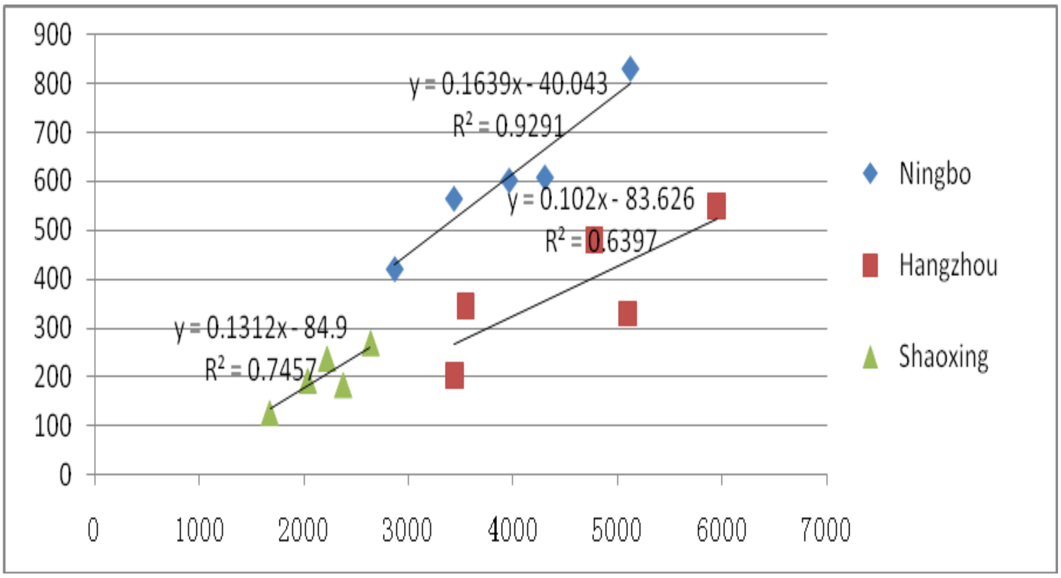


Figure3.5 Regression Empirical Formula of Ningbo, Hangzhou, Shaoxing

7.ExtractedfromMerchantTimesNo.26,2007

http://www.qikan.com.cn/Article/sysd/sysd200726/sysd20072618-1.html

Year	Ningbo Section		Hangzhou Section		Shaoxing Section	
	GDP	P	GDP	P	GDP	P
2006	2864.49	422	3440.99	203.4	1678.19	126.9
2007	3433.1	565.09	3550	345.7	2039.4	192.9
2008	3964.1	602	4781.16	480.65	2222.95	238.2
2009	4305.01	608.247	5098.66	329.54	2375.46	184.3
2010	5125	829.04	5950	549.8	2636.761	270.2
Regression Empirical Formula			Ningbo Section: **Y=0.1639x-40.043**			

Figure3.6 Regional GDP and Import-Export Volume of the three node points from 06-10

According to the Twelfth Five-Year Plan of Government Work Report of China in 2011, the next five years' GDP increase amount is no less than 9.5%[12]. Thus I choose the predicted GDP value increased by 9.5% annually. According to the regression result, Ningbo section import-export volume – GDP formula is **Y=0.1639x-40.043, the x value from 2011 to 2015 will be (1+9.5%)*5125=5611.875, 6145, 6728.8, 7368, 8067.9, the corresponding import-export volume – P will be 879.7, 967.1, 1062.8, 1167.6, 1282.3.**

Forecasting of K1

K1 follows the economic hinterland over the years of the proportion of foreign trade container cargo containers accounting for imports and exports of manufactured goods volume. The actual manufactured goods volume data cannot be easily collected, considering the current K1 in 2011, thus I use regression model taking P and past K1 value as parameters to forecast K1 roughly of 2011 – 2015, respectively, **95.1%, 96.2%, 96.7%, 97.1%, 97.4%.**

[12] Extracted Government Work Report of China http://www.cfi.net.cn/p20110314000623.html

Forecasting of K2

In addition to those who are recognized as not suitable for container transportation, bulk cargo, etc, the general cargo can be carried in containers. Therefore, the relevance of K2 will change with the structure of goods and container types. The trend is the K2 increasing. According to relevant data, 2011 to 2015 will fluctuate at (95.2% - 97%). **Seen from the past increasing trend from figure3.3 the increasing degree is 0.37% ((95.07%-93.58%)/4*100%), then K2 from 2011 to 2015 will be 95.45%, 95.80%, 96.15%, 96.51%,96.87%.**

Forecasting of K3

For K3, it is the ratio of cargo suitable for container *generating container volume per unit trade* PCS/CTN which is proportional to the product of K1 and K2. Thus K1 is inversely proportional to K1*K2 thus I also use One-dimensional linear regression model to forecast **K1 of 2011 – 2015 will be 0.349, 0.347, 0.346, 0.344, 0.342.**

Result of W (10 thousand TEU)

According to the equation of container generating volume:

W=P*K1*K2*K3

The final forecasting result of Ningbo section generating volume is listed as below:

Parameters	2011	2012	2013	2014	2015
P	879.7	967.1	1062.8	1167.6	1282.3
K1	95.1%	96.2%	96.7%	97.1%	97.4%
K2	95.45%	95.80%	96.15%	96.51%	96.87%
K3	0.349	0.347	0.346	0.344	0.342
W	**278.7**	**309.3**	**341.9**	**376.4**	**413.8**

Figure 3.7 Forecasting Results

Seen from the above chart, the container generating volume from 2011 to 2015 will be 278.7, 309.3, 341.9, 376.4, 413.4 (10 thousand TEU) in Ningbo section.

Chapter 4 Analysis of economic benefits of inland container transport

4.1 Current Transport Structure of Ningbo Section

The current import-export container cargoes are mainly by highway and inland water to reach Ningbo port and then to be loaded on the specialized container vessel to the elsewhere in the world. With the specific inland water container vessel put into use, a certain portion of the generating containers will surely be transported through inland water. For one of the main node points along Hang Yong Canal – Ningbo section, it corresponded with the highway mode (329,104 National Highway, Hang Yong Highway), the railway mode (Xiao Yong Railway), and inland water container transport mode (Hang Yong Canal after reconstruction). Currently, the container transport along Hang Yong Canal is mainly undertaken by inland water container vessel and highway truck, the facilities of Xiao Yong Railway are not suitable for loading containers (Ding Wu Xong, Discussion of Container Transport development in Hang Yong Canal 2001(04)). Thus the economic benefits comparisons are between truck and vessel.

4.2 Analysis Characteristics of Each Transport Mode

The main competitors of container transport mode include rail and highway transport. In different stages of inland water container transport, the competitors vary. Seen from the current situation, rail and highway mode still have their advantages under certain conditions.[13]

The advantages of rail transport are the large transport volume, low tariffs, high efficiency and safety. For a long time, the railway transport of goods dominated our national economy development position and has been widely recognized by cargo owners. In addition, the network of railway can extend into internal hinterland, thus it

13 Extracted from Fang Yi(2003), Research on Container Transport System Development Planning of Hang Yong Canal, Shanghai Jiao Tong University, 2003

enjoys an absolute advantage under long haul inland container transport. The disadvantage is that the railway cargoes are mainly bulk goods, the container cargo volumes are no more than 2% of the total volume. Because the demurrage/residue time of container in the hinterland is too long to collect an enough amount, to the shipper and consignee, they can not undertake such time efficiency loss. On the other hand, the vacant containers need to be returned back. Hence, it will increase 50% of the returning freight cost. Currently, the railway transport cost of container is more than 70% the same cargo of the truck transport cost on average. Thus, in Ningbo section, transport container by railway mode is not economical and time efficient.

The characteristics of highway container transport are high speed the flexibility, which is quite suitable for short-distance transport and door to door transport services. Ningbo section is near sea located in economical zones where share huge generating volume of cargo suitable for container. Further, to a logistic company, it requires less original investment, quick capital turnover, and the payback period is short. But it also have some drawbacks, such as the unit container transport cost is high, high tolls, low volume, serious environmental pollution, poor security and be vulnerable to weather, road traffic conditions, etc. The most weakness of truck mode is the economical effectiveness is restricted by economical transport distance. Even on a high level highway, a reasonable economical transport distance shall be less than 400 to 500 km. [14]

The advantages of inland water container vessel transport are sufficient and concentrated container cargo volume along the coast and river areas, thus it is easy to organize a large volume of the nearest container freight station in one voyage. To the road and railway transport modes, vessel mode has larger volume demand, low unit transport costs which is easier to obtain better economies of scale effect. What's more, it can coordinate vacant containers flexibly, and is suitable to accomplish water-land or river-sea multimodal transport, etc. The weakness is that because

14 The economical container transported distance data are extracted from 2003 asian highway handbook http://www.unescap.org/ttdw/Publications/TIS_pubs/pub_2303/Full%20version.pdf

inland water container transport is still at the cradle times in Ningbo section, the freight rate is not standard and reasonable, variable ship schedule and long transport periods. Compared with the above transport mode, the hardware aspect and service aspect are still of low level.

Through the above comparative analysis and former forecasting result, the inland water container vessel mode in Ningbo section will keep a high growth momentum. On the one hand is that China's national economy keeps high growth paces, and the supporting facilities of ports and other software aspects will be advanced. On the other hand, based on low unit transport tariff, the quality of time effectiveness will be recognized and accepted increasingly.

4.3 Container Vessel Transport Cost Calculation

4.3.1 The Required Freight Rates

The traditional required freight rates of transport cost in China are composed of ship depreciation, crew wages, repair costs, fuel costs, port charges, material fees, insurance freight and management costs and so on. To complete these items is essential. According to the international practice, it divides the required freight rates into three main items with different vessel running modes. Namely, capital cost of required freight rate, operation cost of required freight rate, voyage cost of required freight rate. In this thesis, it followed the international practice to calculate the required freight rates in technical economics mode of argumentation. The following figure shows the compositions of inland water vessel transport and highway truck transport costs.

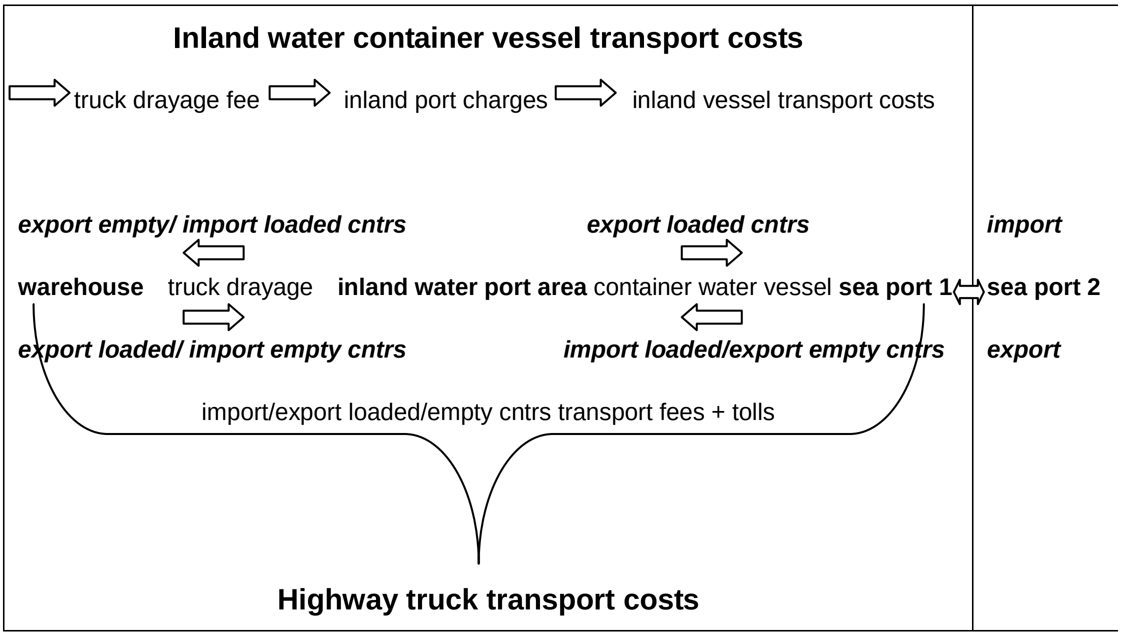


Figure4.1 Transport composition cost comparison between truck and vessel

The Required Freight Rate Formula

The Required Freight Rate indicates the minimum transport freight of each unit container (or cntr/km), comparing with the unit transport cost indicator, the time value factor is taken into account , the formula is indicated as follows:

$$RFR = \frac{(P-L)\times CR + Y + Li}{1-t} \div Q$$

P - Ship investment cost (10 thousand rmb)

L – Ship depreciation value (10 thousand rmb)

Y – Running freight annually excluded depreciation (10 thousand rmb)

Q – Container volume loaded (TEU)

t – Tax rate

I - Loan interest rate (fixed asset loan interest rate set as 6.26%)

CR – Coefficient of investment return

$$CR = \frac{i(1+i)^n}{(1+i)^n - 1}$$

4.3.2 Calculation of the Required Freight Rates

In this thesis, I set Lanxi (one node along Hang Yong Canal) to Ningbo Port as the inland water shipping route to calculate the final RFR. The water distance and highway distance between these two points are 300 km and 281 km [15], respectively.

1. Considering the Class Ⅳ waterway after reconstruction, the largest container vessel to pass the waterway be set as the 500 tonnage weight class (Inland Water Standard for Navigation (GBJ139-1990)).
2. Suppose the speed in under economical speed.
3. Considering container volume and PCS/CTN factors to adjust the basic transport costs.

The Calculation Process

Shipping route selection – ship type selection (500t supposed) – collecting P, L, Y, Q, t, I, CR value from port and carrier – calculate RFR – compare RFR with truck transport cost/TEU

Parameters：

Vessel dwt (TEU)	500 t/ 36 TEU
Fuel Cost (RMB/ton)	2900
Consumption ratio of fuel per unit (g/horsepower*h)	165
Engine power (Kilowatt)	325
Fixed cost per day (Rmb/day)	14929.2
Fuel cost per day (Rmb/day)	7464
Voyage cost (Rmb/day)	157
Y	Management cost+ Direct revenue+ Port charges
Q	1/CNTR volume per ship annually *ship quantity

15. The distance data extracted from
http://zjnews.zjol.com.cn/05zjnews/system/2006/03/30/006543002.shtml
http://www.checi.cn/way_to/beilunqu/977/

i	6.26%
t	Refer to current tax rate
CR	6.26%(1+6.26%)exp5/ ((1+6.26%)exp5 -1))=23.9%
P	Refer to the current VSL cost
L	TTL vessel investment *4%
Port handling charges	Refer to inland water port expenses standard
Port charges	6% of the running revenue

Figure4.2 Parameters for Consideration

Final Calculation Result

Items	Indicators
Vessel type	500 t
Shipping route	Ningbo – Xiaoshan
Fuel cost (rmb /t)	4400
Ship running cost	5335.53
Running cost per day	6122.1
Shipping distance (km)	300
Speed	Economical speed
Cost per voyage per ship	204.37
PCS/CTN	95%
CR	23.9%
RFR	**925.6**

Figure 4.3 RFR Result

Seen from the result, the Required Freight Rate of container vessel (500t) is 925.6 Rmb /unit*km.

4.4 Highway Truck Container Transport Cost Calculation

The highway container transport freight covers from collecting empty containers to loading containers in the warehouse and reach Ningbo Port. It also called drayage fee. Because it is a traditional container transport mode which experienced market fierce competition, thus the freight rate in the thesis is just collected from common unified market freight rate.

Considering the influencing factors to truck mode are too much, according to relevant resources, the transport cost of highway transport is 80% of the transport freight rate. (Yu He Xi, Engineering Economics, 2002,Liu Hong Jun, Freight Forward, 1997). Thus, the unit cost of truck transport container per hundred mile as namely C of can be calculated as the following formula:

$$C=0.8F$$

F – Unit container charges of truck mode

According to actual charge statistics and past data, the unit container charges is 6 Rmb/km, then the C can be calculated as the following formula:

$$C=6L$$

L- The transport distance (km)

To combine the above two formula and set C as

$$\mathbf{C=4.8L}$$

Then the RFR of highway transport (by truck) from Ningbo to Xiaoshan is 4.8*281=1348.8 rmb/TEU. Thus, freight rate difference is 1348.8-925.6=**423** rmb/TEU. Comparing with real unit container transport price difference diagram (Yang Ren Fa, Guo Hui Ling, Li WeiWei, Tab.1, Feasibility Analysis of Container Shipping in Hangzhou-Ningbo Canal[16]), the forecasted freight rate difference is very close to the real statistics as the following chart.

[16] The diagram is extracted from Yang Ren-fa, Guo Hui-ling and LI Wei-wei, Feasibility Analysis of Container Shipping in Hangzhou-Ningbo Canal, NAVIGATION OF CHINA, Vol.32, No.2, Jun. 2009

Vessel Type	Lanxi-Ningbo	Xiaoshan-Ningbo	Shaoxing-Ningbo
500t/36 TEU	-424 rmb	-216 rmb	-193 rmb
500t/24 TEU	-110 rmb	-24 rmb	-40 rmb
300t/16 TEU	-311 rmb	-170 rmb	-116 rmb

Figure 4.4 Diagram of Cost Difference in Ningbo-Xiaoshan

Seen from the above calculation result, the transport cost of inland water container vessel is much lower than that of the highway truck transport between Ningbo port and Xiaoshan, the freight rate difference is 423 Rmb/TEU. Considering the generating container volume forecasting result in the former chapter, the future of Ningbo section will generate more and more containers. Thus, with the economy of scale effect, the total container cargo transport cost difference between vessel and truck will be enlarged and the reconstruction of Hang Yong Canal will be worthy surely. Thus the advantage of transport cost of inland water container vessel can be beneficial and widely accepted.

4.5 Lagrange Interpolation Formula to Estimate Diversion Ratio of Water/Land Tendency

After gained the unit cost of inland water and highway transport, we should estimate the ratio of water and highway mode diversion. Although, from the microscopic view, the tendency of choosing transport mode is influenced by multi-factors including accidental factor and inevitable factors. In macroscopic perspective, the main indexes are freight and time, by considering these two indexes may focuses on major.

It is difficult to use a simple formula to solve the transport mode selection tendency by complex time and freight rates index. On the other hand, even under the condition of stable freight, cargo owners will judge in different view of time value. Considering these issues, by a sampling survey and generating a chart of the tendency of cargo owner and then to choose probabilistic method by applying Lagrange Interpolation Formula to estimate the ratio of water/land tendency diversion.

4.5.1 Premise for Lagrange Interpolation Formula Model

Due to the reason that the investigated cargo owners located around the node points, the point - point diversion ratio will presents various Lagrange Formula characteristics, getting precise result needs detailed investigation and analysis required huge data and fund. To get a macroscopic result, I omit invaluable details and select Ningbo-Xiaoshan section as the targeted sample and use unified Lagrange Interpolation Formula to indicate the general transport mode diversion ratio for Ningbo.

4.5.2 Calculation of Diversion Ratio

The purpose to investigate ratio is to estimate the influential level of the freight rate difference to cargo owners.

Investigation region: Ningbo-Xiaoshan section.

Investigation contents and process: percentage of transport modes.

Influence factors: freight rate difference (423 rmb/TEU)

Freight rate difference per 100 mile between inland water and highway	0	400	800	1000
Percentage of highway (%)	100	50	25	20
Percentage of inland water (%)	0	50	75	80

Figure 4.5 Transport Mode Diversion Ratio[17]

Lagrange Interpolation Formula

[17] Figure 4.5 extracted from Zhen Shi Yuan (2002), Inland Water Container Volume Forecasting.

$$L_n(x)=\sum_{i=0}^{n}\frac{(x-x_0)\Lambda\ (x-x_{i-1})(x-x_{i+1})\Lambda\ (x-x_n)}{(x_i-x_0)\Lambda\ (x_i-x_{i-1})(x_i-x_{i+1})\Lambda\ (x_i-x_n)}y_i\text{:}$$

Tendency for highway mode formula

$$L_h(x)=\frac{(x-400)(x-800)(x-1000)}{(0-400)(0-800)(0-1000)}\times 100\%+\frac{x(x-800)(x-1000)}{(400-0)(400-800)(400-1000)}\times 50\%$$
$$+\frac{x(x-400)(x-1000)}{(800-0)(800-400)(800-1000)}\times 25\%+\frac{x(x-400)(x-800)}{1000(1000-400)(1000-800)}\times 20\%$$

Tendency for inland water mode formula

$$L_w(x)=\frac{x(x-800)(x-1000)}{(400-0)(400-800)(400-1000)}\times 50\%+\frac{x(x-400)(x-1000)}{(800-0)(800-400)(800-1000)}\times 75\%$$
$$+\frac{x(x-400)(x-800)}{1000(1000-400)(1000-800)}\times 80\%$$

Lh, Lw stand for the probability of selecting highway and inland water mode respectively. X stands for RFR difference between Inland water/highway.

Then input x=423 Rmb/TEU and get

Lh =48%

Lw =52%

Thus, the probability for inland water transport mode is 52% which is higher than 48% for highway transport mode which means the tendency for selecting inland water transport rises.

Chapter5 Case Study of Inland Water Container Transport Economic Benefits in Ningbo Section

5.1 Problems for Developing Inland Water Transport in Ningbo Section

In theory, the inland container transport can be regarded as the same mode of truck trailer in container gate-in and gate-out. The process can be divided into different sections on sea. If we adopting open mode of transport, take the former chapter as an example, from Xiaoshan to Ningbo, a round-trip voyage takes about 2 days, adding all other aspects (ship repair, fuel replenishment etc), it takes 3 days for a voyage. Thus, for a carrier company, deploying 3 ships can ensure the fixed schedule on each day. Each shipping schedule will be available to all cargo owners near Xiaoshan for Ningbo port of destination. But this idealized transport mode brings great difficulty in actual operations. The first problem is empty container collection and turnaround. Inland water container transport cannot realize flexibility of single unit turnaround as trucks. The second problem is berthing. An inland water container vessel usually berth in a fixed position of port area, if the loading containers scatter on different artery vessels, meanwhile they berth in different loading area, this will definitely influence for collection and turnaround. Due to the above reasons, PUHAI Shipping Co., LTD (PHL) which operating Ningbo to Xiaoshan shipping routes as its one business branch, choosing another scientific combination mode of transport.

5.2 Introduction of PHL Shipping Company

Shanghai PUHAI Shipping Co., LTD is a subsidiary company of China Shipping Group. PHL specializes in container transport services. PHL was originally founded as a small feeder operator on January 1st, 2000. Eleven years passed, in particular, PHL has successfully accomplished the record-high throughput of 1,050,000TEUs in 2011, which builds the unbeatable status and reputation in the domestic feeder market. PHL has two wholly-owned subsidiary companies Shanghai PUHAI Lines (HK) Co., LTD and Shanghai Inchon International Ferry Co., LTD. The slogan of PHL is " Service dominating, Customer first, Effective and Efficient". It dedicates to provide high -quality container transport services for every client. The outstanding achievements made PHL won "The Best Coastal Feeder Operator in China Freight Industry Awards" 4 times and “The Best Inland Water Carrier”. At the end of November 2008, total assets of PHL reached 967 million Rmb and the net assets reached 568 million Rmb. In 2007 PHL has a container (COC) increased by 26.49% comparing with 2006. Companies adhere to the efficiency, market-oriented, and increase international cooperation and vigorously develop the owner box (SOC) market, make efforts to improve profitability.

5.3 Inland Water Transport Business of PHL

During the start-up stage and the developing period, the company adopting truck to assist transporting containers, after 2004, the revenue margin of this mode cannot optimize the economic benefits, because the volume was increased and the capacity of truck cannot met such huge demand. Currently it owned 41 vessels in operation, the total capacity are over 20 thousand TEU. In 2004, PHL built 12 standard inland water container vessels (202 TEU) according to the China Ministry of Transport Standard. Thus the fleets have achieved modernization and large-scale operations. Up till now, the shipping routes have covered domestic coastal routes, the Yangtze River and main inland water ports of Southeast Asia. PHL has formed the transshipment centers of domestic coastal areas of Shanghai, Ningbo, Tianjin, Dalian, Qingdao, Lianyungang, Xiamen port. In the Yangtze River area, PHL sets Wuhan, Nanjing, Zhangjiagang port as transshipment centers. In the Southeast Asia area, PHL sets Port Kelang as the transshipment center and forms a container feeder transport network and service system which won a good reputation in Asian transport market.

PHL is the most extensive scopes in China Mainland, together with most vessels, most operating feeder routes feeder shipping company. In recent years, based on the previously established reputation, PHL transfers from pure feeder service provider to artery-feeder combination service provider, and generally opened up new shipping routes from China to Southeast Asia, to South Korea, and to Japan. The regional service power has been enhanced and thus did help to lay a solid foundation for the western country markets. PHL insists on diversified fleet developing mode, by sale, lease, reconstruction and other means to adjust the fleet structure gradually. Currently, the company has formed 202TEU type ship dominated, proper time or voyage chartering ship as supplement way to enlarge inland water container fleet capacity. After the 253TEU type vessels been reconstructed and put into use for river-sea intermodal transport which will further improve inland water container transport network and enhance its capacity and competitive strength. The relationship of mode proportion – year economic benefit growth rate as illustrated as below:

Year / Mode Proportion	2000	2001	2002	2003	2004
Inland Water Capacity Proportion (%)	79%	86%	91%	97%	98%
Highway Truck Capacity Proportion (%)	21%	14%	9%	3%	2%
Rate of Economic Benefits Growth year-on-year (%)	17% growth	30% growth	43% growth	37% growth	28% growth

Figure 5.1 Transport Mode Capacity Proportion Transfer - Economic Benefits of PHL

Seen from Figure 5.1, with the transformation from a truck-vessel carrier to a pure inland water vessel carrier, the economic benefit growth rates of PHL kept increasing, the wise selection of mode transformation did a great help to expand the fleet scale and optimize the economic benefits year-on-year.

5.4 Measurements of PHL to Optimize Economic Benefits

Due to each transport mode parties operate in separate ways, this leads to the difficulty of normal competitions and cooperation in intermodal container transport. On the other hand, the laws and regulations are not sound enough for coordination of transport organizations. Under such situations in China, PHL put emphasis on exploiting container resources and adopt co-operation strategy to optimize each process of transport organization. Due to the speed aspect weakness of inland water container vessel, PHL positively coordinate with the cargo owners, port authorities, freight stations and customs to make sure to reduce speed disadvantage and enhance the convenience of the process work. By integrating port aspect, vessel aspect, cargo aspect under good atmosphere cooperation with joint ventures, thus inland water container transport of PHL can achieve complementary and mutual benefits.

Further, to raise process efficiency, PHL opened a new path in 2005 by adopting FOS EDI system which is a comprehensive information management system for future business development. This system emphasizes on the checking running organization and business, it supports seamless data interchange with important cargo owners, agencies, customs, terminals and trailer truck companies and other partner parties to share standard EDI/XML format resources. On this basis, PHL can achieve seamless multimodal container transport intersection and realize "one stop" container shipping and logistics services. Through FOS system, PHL can also manage and analyze the overall operating situations to integrate and optimize the business process, reducing labor intensity, rise work efficiency and exploit relevant partners interface (such as agencies, customs, terminals, EDI centre and container truck companies).

PHL FOS project is developed in three phases. The first phase was tested in January 1st 2005, and put to use in 2006. During that period Phase Ⅰ system run smoothly and effectively. After realizing its value in practical business performance and management effectiveness, PHL improved it in Phase Ⅱ which tested in March 2007, and put to use in January 1st , 2008 formally. After launch, FOS system phase 2 had stood the test of more aspects and achieved more than 12 module functions and finally been recognized by other colleague of the same occupation. Then in 18th May

2011, PHL held a FOS system phase Ⅲ acceptance conference, which indicated the information level of PHL shipping business has stepped into a new stage.

Except for advanced EDI system to increase efficiency, PHL also signed slot lump sum agreement with SUNISCO, JCA Shipping and China Shipping which are all trunk line shipping companies. The agreement formulated the organization of container sources duty allocation and promoted to offer a certain amount of empty containers transshipment business in Ningbo port transition for inland water trunk line container shipping company. PHL will be in charge of organizing container sources and ensure the total amount of inland container been transported to the designated berth within trunk line complying with fixed shipping schedule. This mode can be called river-sea cooperating transport mode and optimize economic benefit.

5.5 Suggestions for PHL

PHL may cooperate with those whose trunk schedules have more with concentrated inland container volume, and thus will become more stable to organize container resources and effects river-sea cooperating transport mode. After several years, the cost-effectiveness, convenience and security will be demonstrated to more cargo owners who will be more willing to accept inland water channel. Considering the Class Ⅳ waterway just been reconstructed for only 4 years, the ship type selection for this condition is only 500t class according to GBJ 139-90. PHL can select the most time-effective and economical effective type after systematic analysis to cooperate with trunk shipping companies. On the other hand, because one inland water shipping schedule can only meet one trunk shipping schedule, this situation will result in great pressure on container cargo organization. Thus PHL may choose a scheduling intersection way with several trunk shipping schedules and will become more flexible and easier to gain benefits.

Summary

According to relevant materials, the cost of inland water container transport is 1/6 of railway transport, 1/10 of railway transport, 1/70 of air transport. The volume is also huge, for example, a 144TEU volume is nearly equals to two special train capacity volume as well as 70 container trucks capacity volume. Due to the unit transport volume of highway truck mode is low, if to choose direct exchange after the truck reaches the port area, then the truck will have to wait for the vessel to come. Then the process will bring inconveniences. If to choose indirect exchange, the container has to be stored on CY again and waiting for vessel to load. These situations will bring huge benefit loss to highway mode. Thus the speedy and flexibility of truck mode do not mean economic benefits.

Developing inland water container transport is a hot spot area in China, especially after the Twelfth National Economic and Social Development Five-Year Plan has been launched in 2011 which indicate to put great emphasis on developing inland water transport. Thus Hang Yong Canal – Ningbo section inland water container transport are expected to hold high hopes after reconstruction.

Hang Yong Canal is the main collection and distribution channel for realizing river-sea, river-canal, truck-vessel container intermodal transport, the transport organization coordination will be complex. By analyzing the transport freight rates of different transport mode can help to gain economic benefits and establishing good reputation for collecting more hinterland cargoes. Seen from the forecasting generating container volume in chapter 3, the total generating volume fluctuating with GDP and industry structure, the main trend of future will keep a stable growing momentum in the next five years. The economic benefits difference will be RFR difference 423 RMB/TEU * Generating Volume 278.7, 309.3, 341.9, 376.4, 413.4 (10 thousand TEU) = 117890, 130833.9, 144623.7, 159217.2, 174868.2 RMB in difference amount between inland water vessel and truck from 2011-2015 for Ningbo-Lanxi. If choose inland water transport, this difference reflects the great potential economic benefits in the future for Ningbo.

There are many studies and researches of transport organizations, but the research scopes are usually wide and general. This thesis aimed to concentration on specific area – Ningbo section transport economic benefits aspect, proving the result with precise data and practical case. The forecasting method and calculate ways are scientific and strict. The total contents established an analytical frame by combing different aspects and analysis based on my understanding.

Due to my limitation of my capability and time limitation, there are still some shortcomings in the frame. These factors need further discussion and revised.

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