Dissertation for Master's Degree

AN ANALYSIS OF PORT COMPETTITIVENESS BETWEEN SHANGHAI AND NINGBO USING AHP

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December 2010

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Chapter 1 Introduction

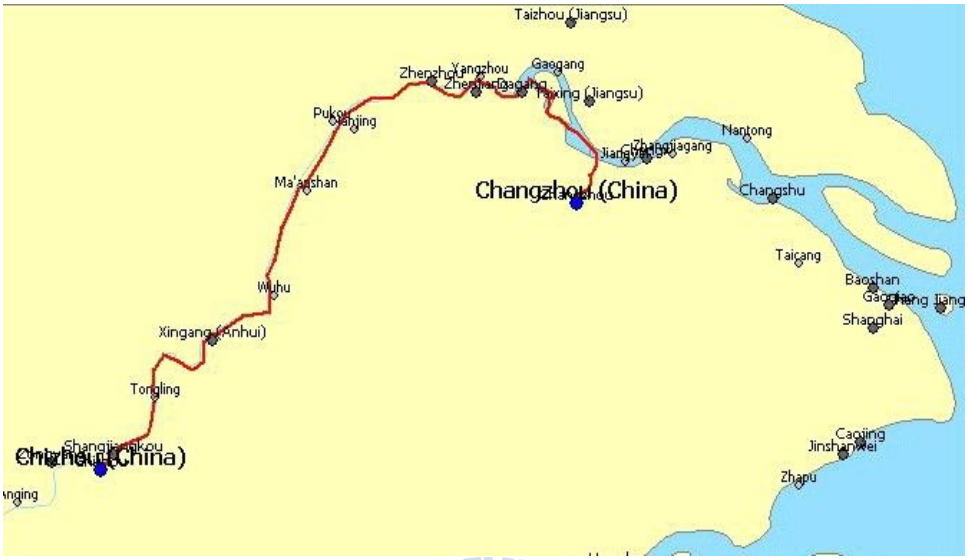
1.1 Research Background and Objective

1.1.1 Background

Yangtze River Delta is a very important economic center in China. It contains Jiangsu Province, Zhejiang Province and Shanghai city. In 2009, China's GDP classed No.3 in the world, therein, 21.4% of China's GDP was devoted by Yangtze River Delta. Thus, it is a region of the most economically vibrant area in China. The annual growth rate of the GDP in this delta is estimated at 11% forecasting to hit 2,335 billion US dollars by 2020. The ports of Shanghai and Ningbo-zhoushan located in this region are two of the top busy ports in China. According to the official statistics, in 2008, the sum of Shanghai and Ningbo-zhoushan[1] port's cargo throughput takes up 20% of China's total cargo throughput.

[1] Supported by the Ministry of Transport of PRC, from 1st Jan, 2006, Ningbo, Zhoushan port merged and started using the name of "Ningbo-zhoushan port" officially, the original names of "Ningbo port" and "Zhoushan port" are not to be used any more.

FIGURE 1-1 : YANGTZE RIVER DELTA



Source: http://www.znnw.com/archives/ningbo-port-eyes-shanghai-listing/

In the above figure of Yangtze River Delta, Shanghai and Ningbo are represented as the most important ports in the Yangtze River Delta port system. By its predominance in the finance, banking, property, automobiles and logistics industry, Shanghai is China's economic center. And Shanghai port serves and is served by vast hinterland in the Yangtze River Delta and the entire Yangtze River valley. These areas are proved to be the powerhouse for the sustainable growth of the Port of Shanghai. Shanghai port is much more famous than Ningbo port in the world.

Ningbo is a growing economic port which provides imports and exports routes for neighboring provincial cities. Ningbo-zhoushan port, as a bright pearl of China ports, has a long history of over 1200 years. During more than 20 years of China's opening and reforms, it emerged magically in the east of China and developed rapidly. From 2000, Ningbo became a world class port with throughput exceeding 1YIK (a hundred million), Moreover, recently ship sizes were getting larger, and the advantage of Ningbo port's

deep water was embodied. Also with the development of regional economy, more and more cargo was transited through Ningbo port, transforming it from Shanghai's feeder port to a large deep-sea direct-call port.

The latest official statistics showed that Ningbo-Zhoushan port achieved a throughput of 417.69 million tons of cargo by August in 2010 while from January to August in 2010, Shanghai completed a throughput of 368.37 million tons of cargo, which means that in terms of the general and bulk cargo port throughput, Ningbo has totally exceeded shanghai. So if Ningbo-zhoushan port has absolutely exceeded Shanghai port and become the better choice for all bulk carriers becomes a hot topic.

1.1.2 Objective

Many people may think certainly Shanghai port would be the better choice because of its natural port condition and famous achievements. But things may not always go as what most people can see from the surface. Ningbo is also well-known in the world. When Shanghai is trying to build an international shipping center, meanwhile, Ningbo port also got the approval from the abroad. Ningbo port was listed into the "world's five best ports" ranking as China's best port by the British magazine (International container).

Shanghai and Ningbo ports have different characteristics, but their geographic positions are so close to each other. The waste of bunker caused by distance differences can be ignored during the process that the ship owners are making decision of which port to call between them. Thus, the external conditions can be considered to take the priority in the process and

causes ship owners always feel hard to make decisions.

The relative competitiveness of the two ports is evaluated on the basis of port condition, price and quality of service, as embodied within the concept of generalized cost as incurred by customers. A critical political dimension is a necessary element of this analysis. Through all these analyses, we can develop a view of the likely future outcome of the competition between these two ports, and give the advice to them for the further development.

The purpose of this paper is to analyze the relative competitiveness of the two neighboring ports, Shanghai and Ningbo-zhoushan ports, so as to figure out their advantages and disadvantages and find a better port of call between them at the stance of the bulk ship owner.

1.2 Research Scope

The research is focused on Shanghai and Ningbo-zhoushan port only. This thesis is concerned to the general and bulk cargo in Ningbo-zhoushan and Shanghai port.

One concept should be declared, supported by the Ministry of Transport of PRC, from 1st Jan 2006, Ningbo port and Zhoushan port merged and started using the name of "Ningbo-zhoushan port" officially, the original names of "Ningbo port", "Zhoushan port" are not to be used any more. The merge of these two ports was not for the big cargo throughput. In the history, they belonged to one city. They were separated from 60's in 20th century, so only about 40 years until now. Chinese government decides to merge put them together as one city again. So in this paper, the name of 'Ningbo-zhoushan port' will be used.

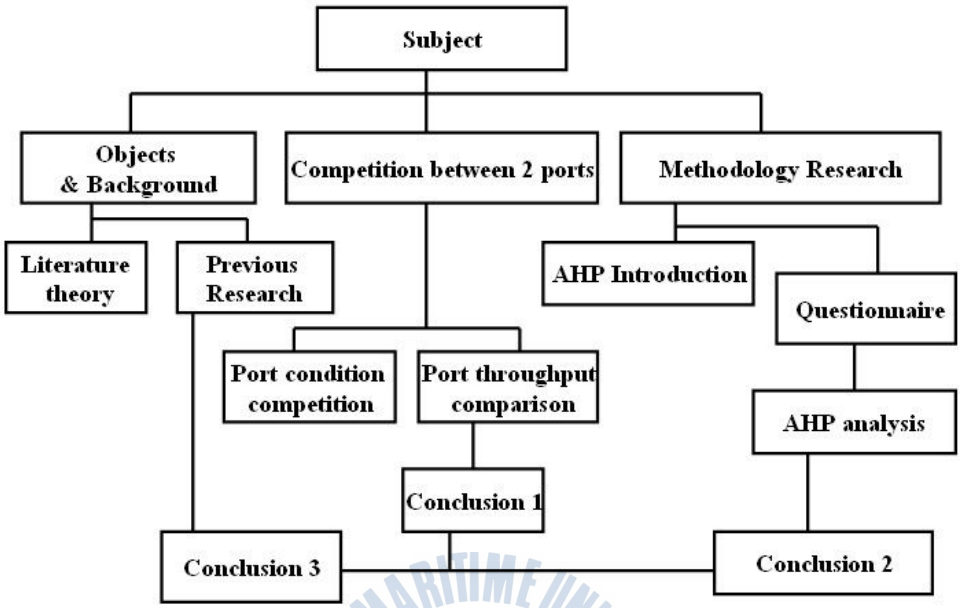
1.3 Methodology and Structure

The thesis is separated into 5 parts:

1. The chapter 1 is an introduction of the research background and purpose of writing this thesis, and also the methodology to be used.
2. The chapter 2 writes about relevant literature of port competition and competitiveness.
3. In Chapter 3, there will be some comparisons based on port cost, port service, port facility and port environment between the two ports.
4. From chapter 4, the main research method of AHP will be introduced. A questionnaire survey on ship operators domestic and aboard, as well as people who are working in the two ports was performed. The responses of questionnaire were collected, which are to be used for the AHP analysis. Through this methodology, we will try to find out the most active factors of deciding the port of call.
5. In the last chapter, the final conclusion will be given.

Author used historical throughput data comparison and AHP analysis to analyze and make clear which the better choice of port of call is for the bulk ship owners under the same ship and cargo conditions. So that ship owners would feel much convenient when doing business with counterpart in Middle China area. Also, it may be referable to the two port's authorities to recognize the shortage or deficiency of their ports, try to avoid the blind investment and find a right way to develop the port.

FIGURE 1-2: RESEARCH STRUCTURE



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Chapter 2 Literature review

2.1 Conceptual Definition of Port Competitiveness

Generally, competitiveness means the ability of doing something. If someone has the required ability, then we say he has the competitiveness to others. [2]

Competition between ports is fierce. The unstoppable rise of cargo traffic flow and the constant drive for specialization, and capacity increase of seagoing vessels have resulted in shipping companies concentrating as much as possible on a limited number of ports of call. Increasingly, connecting services are left to feeders. In this way, shipping companies are able to benefit maximally from the economics of scale that their larger vessels offer, while they are also able to provide more flexible and quicker transport services and sailing schedules. Emerging strategic alliances between shipping companies, meanwhile, have led to a further concentration of demand for port services. It seems that there is clearly a declining trend in the number of players requiring services from ports or container terminals.

Shipping companies are increasingly focusing on an integrated approach to transport in which logistical services are provided on a global scale. Many of these companies have in fact become inter-modal operators. Through the

[2] Shou,Jian-Min, 2007. "An Analysis of the Competition & Development between Ports in Korea and in Shanghai Using the Differential Equation Models", pp. 10-13.

logistics chain they are tightening their grip on cargo flows. Consequently, Shipping companies appear to have become the principal players when it comes to a choice of seaport. It used to be the case that only territorial considerations were taken into account in the selection of ports of call. But increasingly port characteristics are assessed in relation to the global logistics supply. Geographical or territorial aspects are less important than they are used to be. The key consideration today is the summarized transport cost, i.e. the total transport cost (including out-of pocket costs, time costs, reliability etc.) associated with the logistics chain.

In the context of port competition, reference is often made to Verhoeff[3] (1981), who argued that seaport competition unfolds at four distinct levels: competition between port undertakings, competition between ports, competition between port clusters(i.e. a group of ports in each other's vicinity with common geographical characteristics), and competition between ranges (i.e. ports located along the same coastline or with a largely identical hinterland).

The factors influencing competition may vary from level to level. The competitive strength of individual undertakings within a port is determined mainly by the factors of production (labor, capital, technology and power). Competition between ports, port clusters and port ranges on the other hand is also affected by regional factors, such as the geographical location, the available infrastructure, the degree of industrialization, government policy, the standard of performance of the port (measured in terms of proxy variables, such as the number and frequency of liner services, and the cost of transshipment, storage and hinterland transportation).

[3] Verhoeff (1981) is perhaps the first scholar who discussed seaport competition in a comprehensive manner, he claims these is "hardly any literature on the subject"(Verhoeff 1981, P.49)

This traditional approach to port competition must now make way for an approach based on competition between logistics chains, in which ports (and port undertakings) are merely links. As the most important consideration is the overall cost of the transport chain, it is inevitable that, besides throughput, the industrial and commercial functions (including warehousing and distribution of goods), as well as hinterland transportation will come to occupy an increasingly important position.

Competition between ports belonging to different ranges involves just a very few types of goods flows. Consequently, the crucial question is what determines the choice of port? Why is one port preferred to another? Which undertakings located in that port are chosen? And which hinterland transport modes?

Port competition is traditionally regarded as competition between and within ports. This definition would appear to be incomplete, and it is therefore hard to assess. The operational context of the concept needs to be extended.

It should be noted in this respect that Verhoeff's levels of competition also interact with one another, so that they can not be considered independently. Verhoeff's definition of port competition does not take into account the traffic structure of ports or port undertakings. Goss (1990c, p.74) rightly asserts that the competition of the traffic flows is essential in the context of port competition: '(…) many commodities are exported from several countries, whose ports are therefore in competition'. Verhoeff's definition fails to distinguish between ports and port undertakings in terms of the

goods (i.e. the type of traffic) in which they specialize. He considered them to be comparable units. Clearly, though, an undertaking in a container port is not in competition with a maritime concern specialized in liquid bulk or forestry produce. Port competition is further influenced by other factors, such as the type of management, the know-how of port authorities and managers, the well-considered application of EDI, government intervention, the existence of niche markets, and the generation of added value. In other words, a modern definition of 'port competition' must incorporate all aspects relevant to the constituting terms 'port' and 'competition'. After all, ports are considered to be the competing entities. One can only arrive at an operational definition by combining the above mentioned aspects meaningfully. In the present study, we shall employ the following definition of port competition:

A conceptual definition of 'seaport competition': 'Seaport competition refers to competition between port undertakings, or as the case may be terminal operators (the competing players involved in the organization of entire transport chains) in relation to specific transactions (the object, taking into account the origin and destination of the traffic flows concerned). Each operator is driven by the objective to achieve maximum growth in relation to goods handling, in terms of value added or otherwise. Port competition is influenced by (1) specific demand from consumers, (2) specific factors of production, (3) supporting industries connected with each operator, and (4) the specific competencies of each operator and their rivals. Finally, port competition is also affected by port authorities and other public bodies.'

Firstly, there is competition between operators. This type of competition may be summarized as 'intra-port competition at operation level.' In recent

years, operators within ports have increasingly tried to diversify their activities, offering various services in the total logistics chain. As a result, operators are now often present in several ports, and they are involved in the handling of various traffic categories.

Intra-port competition can however be put in an even broader context, as port authorities and undertakings may also compete within a single port, albeit indirectly. This form of 'mixed competition' occurs if a port authority has stakes in a port undertaking or terminal operator'. This competition could affect the competition between two hub ports in a similar geographical position.

Secondly, there is competition between operators from different ports (level 2: 'inter-port competition at operator level'). This second level of port competition occurs mainly between operators within the same range serving more or less the same hinterland. However, Verhoeff (1977) and Goss (1990c) have both asserted that competition may also involve port ranges as such. Competition in the Hamburg-Le Havre range is usually restricted to competition within that range. Only rarely are ports belonging to other ranges involved, as there is very little overlap between the hinterlands of ports from different ranges. Consequently, operators within a given range usually do not feel threatened by operators from other ranges, and there is no evidence whatsoever of competition at this level.

Thirdly, there is competition between port authorities-be it national, regional or local-which directly affects the determinants of port competition (particularly the infrastructure in and around a port). This is of course crucially important for the competitive position of operators. This is level 3:

'inter-port competition at port authority level'.

Implementation of this theoretical framework also requires a reconsideration of the 'main port' concept, which is based on ports' competitive position. In the economic literature, it is traditionally suggested that a main port is a market leader in several or even most traffic categories. Moreover, it is usually claimed that such ports provide the best services and handling facilities for a broad range of goods. Such an interpretation of the main port notion is rather misleading, as it is an illusion to believe that a port can easily become a market leader in several, let alone all, traffic categories.

The fact that many ports in the world specialized in several traffic categories requires that, unlike the notion of main port, the definition of a main port should be reinterpreted as a hub port. It concerns the dominance of one port over others in relation to a specific traffic category.

A great many players are involved into port competition, both conceptually and operationally. Consequently, port competition and port management is influenced to a very considerable degree by a multitude of related – sometimes conflicting – interests.

Three types of port competition may be discerned, i.e. intra-port competition at operator level (competition between port undertaking within a single port), external port competition at operator level (competition between port undertakings from different ports), and inter-port competition at port authority level.

2.2 Previous Research

There are many researchers who have done the research on the selection of better port of call domestic and abroad. At the beginning of this study, many previous researches which are based on the port selection study have been collected. Seen from the collection of the many researches, regarding to port selection, mostly are talking about port cost, including tug hire cost, piloting cost, cargo handling cost, escorting cost also if the vessel is too huge and so on. Besides port cost, port service is also popular, including agency service and port authority's support. Port facility is almost talked by all of the authors, port equipment's level, capacity and working speed is very important to the port. And, port environment, which decides the safety for vessels entering the port. The detailed researchers and their research scope and contents showed as Table 2-1, and Table 2-2.

Table 2-1: Previous Research on Port Selection

Author	French(1979)	Peters(1990)	Lu(2000)
Factors of port selection	Port facility Port service Land transport ability Port management Economic scope Port strategy World economic	Port service Port equipment's capacity Port facility condition International politics Social environment World economic Transport and discharge	Transport time Cargo turnaround speed Berth schedule liability Customs concision Level of cargo working system Labor's work ability and professionalism
Author	Lee Jia Bing (2009)	Bruning & Lynagh(1984)	Gibson(1993)

Factors of port selection	Post tariff Post service Port system Port congestion Cargo operation speed	Cargo operation speed Cargo operation charge Cargo transport speed Cargo damage claim	Port strategy Emergency dealing ability
Author	Machow & anafani(2001)	Tengku (1995)	Chiu(1996)
Factors of port selection	Distance from berth to pilot station in water Distance from terminal to cargo factory Vessel calling frequency Calling vessel's size	Port safety Cargo safety operation Vessel schedule liability Service level Emergency dealing speed	Customs passing speed Documents dealing time Cargo damage claim Labor's work ability and professionalism
Author	Wilingale (1991)	Slack(1985)	Murphy (1989)
Factors of port selection	Distance from berth to pilot station in water Port facility Terminal operation Port authority's support Port's system level Port scale	Vessel calling frequency Distance from terminal to cargo factory Cargo resource Port facility Port scale	Overweight and over length cargo dealing ability Cargo resource and backhaul Cargo damage claim Port facility

Table 2-2: Previous Research on Port Selection

Author	UNCTAD(1992)	Murphy (1992)	Starr (1994)

Factors of port selection	Geographic position Port service Port cost Port socialism and economic Port safety Port system level	Port facility Cargo damage claim Cargo operation charge Water depth Cargo discharge ability	Geographic position Railway transport on land Port facility Labor force sufficiency
Author	Suthiwartnarueput (1988)	McCalla(1994)	Collison(1984)
Factors of port selection	Port cost Vessel schedule liability Cargo operation speed Vessel call frequency Damage claim	Port facility Railway transport on land	Vessel schedule liability Documents dealing time Port service level
Author	Tong zon(2001)	UNCTAD(2004)	Lirn(2003, 2004)
Factors of port selection	Geographic position Transport speed Restriction to cargo Information system Port service	Port service Port cost Information system Space of Storage Port safety	Port cost Vessel schedule liability Cargo operation speed Vessel call frequency Damage claim
Author	Song(2004)	Chang (2006)	Shou Jian Min (2007)
Factors of port selection	Port facility Cargo damage claim Cargo operation charge Water depth Cargo discharge	Port safety Cargo safety operation Vessel schedule liability Service level	Port cost Port safety Port service Information system Port facility

	ability		

Source: Made by author on reference of previous researches

Table 2-3: Previous Researches Collection on Port Competition

Research variable	Measurement items	Reference
Port cost	Port charge	Suthiwartnarueput (1988), Lirn(2003, 2004), UNCTAD(2004), Choi, Yong-Rok(2004), Shou Jian Min (2007), Yo Ki Tae(1999), Lee Jia Bing (2009), UNCTAD(1992)
	Cargo operation charge	
	Lightening charge	
Port service	Port productivity	Tong zon(2001), Lee Jia Bing (2009), UNCTAD(1992), French(1979), Peters(1990), Young Gull Kim (2009), No Yo Jin(2007), Shou Jian Min (2007)
	Agent service	
	Port authority's support	
Port facility	Water depth	Lirn(2003, 2004), McCalla(1994), Starr (1994), June Hyun Kyung Lee (2009), Katie M. Chamberlin (2003), UNCTAD(2004), Song(2004), Shou Jian Min (2007)
	Berth condition	
	Cargo handling equipment	
Port environment	Cargo availability	UNCTAD(1992), Machow & anafani(2001), Ying, Y.; Xian-cheng, L.(2007), Tong zon(2001), Lee Jia Bing (2009), No Yojin (2007), Yo Ki Tae (2004), Song(2004)
	Inland transport connectivity	
	Weather condition	

Source: Made by author on reference of previous researches

Chapter 3 Comparison between Shanghai and Ningbo-Zhoushan Port

3.1 Comparison on Port Condition

Both Shanghai and Ningbo-zhoushan port are comprehensive, multi-functional port with small, medium and large berths. They are the two world-class big ports in Yangtze Rive Delta. Good conditions of cargo collection and distribution are provided. Both are directly deserved by a large net of Railway and highway, with possibility of water-to-water and water-to-land Transshipment and also joint transport of sea, road and railway can be carried out at the port. Business scope covers the discharge, storage and transfer of quantity kinds of general and bulk cargo.

The two harbors are located in both sides of identical port territory, only 9 miles away from each other, and use the same navigational water way, anchorage as well as economical hinterland. But it is not easy to say exactly which one is a better port due to the difference in administrative area delimits and managing system, the two ports become irrelevant in layout, construction and management. For a long period, they have many conflicts in the aspect of ships, navigational way and contains. Here list the comparisons of their different characteristics in different aspects.

3.1.1 Port Cost

Port costs in mainland China are based closely on a standard rate specified by the Ministry of Transport of PRC (People's Republic of China). For handy size vessels, the most basic charges will occur, so the port cost between Shanghai and Ningbo port are almost the same. But it differs too much for the Panamax vessels. The port cost listed in Table 3-1 is for handy size vessels.

Table 3-1: Shanghai Ningbo Port Cost Comparison (Bulk Cargo)

No.	Item	Shanghai	Ningbo
1	Piloting charge	NRT x 0.805 x 2	NRT x 0.5 x 2
2	Tug hire	Lumpsum	Depends on tugs
3	Escorting charge	Rmb11000/time	Rmb 23,040 /tug
4	Port dues	NRT x 0.71	NRT x 0.71
5	Dockage	NRT x 0.23 x Port Stay	NRT x 0.23x Port Stay
6	Line handling	Rmb213 x 2	Rmb213 x 2
7	Quarantine fee	Rmb2000	Rmb2000
8	Transportation	1,000	1,000
9	Communication	2,000	1,500
10	Sundries of Frontier, Customs,	3,000	2,500
11	Agency fee	Cargo Q'ty/mt x 1.24 +NRTx0.8x2	Cargo Q'ty/mt x 1.24 + NRTx0.8x2
12	QDA (for discharging only)	Cargo Qty x US$0.37/mt	0
13	Lightening charge	Usd 4.5/mt	0

Source: Made by author on reference of previous researches

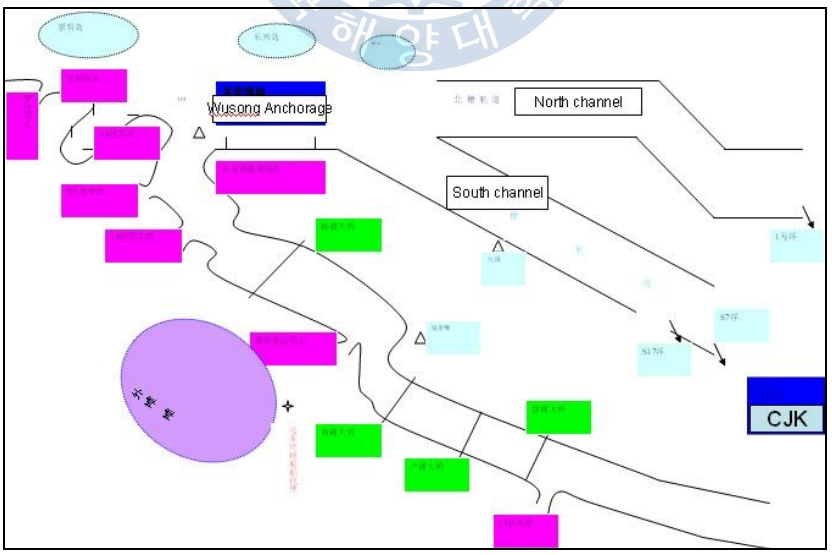
Piloting charge

Piloting tariffs are all based on a Ministry of Transport of PRC standard rate. Generally, for distance from POB (pilot on board) to berth less than 10 nautical miles, the rate is 0.5 RMB per net ton, like Ningbo port. For any distance above 10 nautical miles, the rate for the rest of the voyage is 0.005 RMB per net ton per nautical mile.

There are two passages to enter Shanghai port. As we can see from Figure 3-1, one section is from CJK (ChangJiangKou) to Baoshan pilot station, piloting rate for this passage is 0.605, while the other is from Baoshan pilot station to the berth, with the piloting rate 0.20/NRT. Thus, pilot rate in Shanghai is 0.805/NRT.

Piloting distance in Ningbo is relatively shorter than in Shanghai, thus it is normal the piloting charges payable in Ningbo are less than those prevailing in Shanghai.

FIGURE 3-1: SHANGHAI CHANNEL



Source: Chinapage.com

Tug tariffs for Shanghai and Ningbo-zhoushan port are given in Table 3-2.

Table 3-2: Shanghai Port Tug Tariff (RMB)

Shanghai				Ningbo	
Category	Area 1	Area 2	Area 3	All areas	Calculation
Panamax/ Capesize				92160	(4800H.Px0.48x 5 hrsx 4 tugs)x2times
A (> 220M)	41230	46075	52820	69120	(4800H.Px0.48x 5 hrsx 3 tugs)x2times
B (> 180M, =< 220M)	28025	34200	40090	69120	(4800H.Px0.48x 5 hrsx 3 tugs)x2times
C (> 155M, =< 180M)	19095	27550	33440	32256	(4800H.Px0.48x 3.5
D (> 122M, =< 155M)	14250	26695	31445	21888	(3800H.Px0.48x 3.0
E (> 95M, =< 122M)	10165	13585	17480	18432	(4800H.Px0.48x 4 hrs x 1 tug)x2times
F (=< 95M)	8360	12540	16625	14592	(3800H.Px0.48x 4 hrs x 1 tug)x2times
Remark	In Lumpsum according to berth area			Not fixed, depends on the exact tug using situation	

Source: *Made by author on reference of previous researches*

Escorting charge only occurs to large vessels. In Shanghai port, it is about Rmb11000 besides the tug hire charge. In Ningbo port, at present, only VLCC is forced to be escorted with one tug more with horse power 4800kw inward and outward. For vessels with DWT over 150,000mts, it is necessary to use 2 tugs for assisting both inward and outward.

Item 4,5,6,7,8,9,10 listed in table 3-1 are a very small part compared to tally charge (table 3-1 is based on bulk cargo, no tally charge), piloting and tug charges which are the three major port costs incurred in calling at a

mainland Chinese port. And the charge of item 4-11 is more or less the same in different ports. The balance can be ignored.

QDA

QDA exists in Shanghai port for discharging cargo only. The rate is US$0.37/mt of cargo weight. It is not necessary in Ningbo port. This said of QDA is only for discharging.

There's another kind of QDA, which is charged for berthing. It is not necessary to pay but if the ship owner wants the vessel to take berth earlier than other vessels which arrive at the same time or even earlier, especially when meets with port congestion, this QDA should be paid by ship owner to the terminal side directly and which is always really expensive but cheaper than the vessel's hire. And this is not opened to all ship owners. It depends on the relationship between the local agent and the terminal officers, thus it is kind of under table transaction.

Lightening charge

Vessel with draft over around 12 meters should discharge part of the cargo at Lvhuashan anchorage before entering Shanghai port due to the insufficient water depth of the channel. The cargo will be discharged onto barges directly until the draft is below 12m, and then transported to other ports alongside Yangtze River. But the transportation charge by barge is too much expensive. Only discharging fee is about USD 4.5/mt for iron ore. Suppose to lighten 20,000mt on a Panamax ore vessel, discharging charge would be USD90000, not including barge's transportation charge. No matter ship owner or cargo owner to pay this charge, it is too expensive. Neither of them is willing to pay it. Thus, for Panamax and or Capsize vessels, Ningbo port with the deep water depth is the better choice. Here's the comparison of

channel depth in table 3-3.

Table 3-3: Water depth comparison

Port	Shanghai		Ningbo	
Channel	South	North	South	North
Basic depth	5.5m	10m	19.5m	8.2m
Draft limitation	8m	12m	23m	11m

Source: *Made by author on reference of previous researches*

There is a time limit for berthing/un-berthing due to the water depth. Suppose one vessel's draft is over 9.5m but below 12m (channel depth limitation) after loading, she has to take the high tide to sail out of Shanghai port, but there're only twice high tides in every 24 hours. Especially some terminals like Longwu terminal in Shanghai doesn't support night navigation, if the vessel missed the high tide in daytime, she has to wait for another day to sail. That's a big loss of time and money to ship owners.

By broadly comparing the cost associated with the port calls of ships of similar size, it is self-evident that Ningbo possesses a definite price advantage.

3.1.2 Port Equipments

The list of major port facilities of the two ports are given in Table 3-4 and Table 3-5.

Table 3-4: List of port facilities of Shanghai (2009)

Terminal	Berth Length	Berth No.	Depth limit	Capacity (mt)	Purpose	Facility (Unit)
Minsheng	1,077	6	10	10,000	Grain, Sugar, Coal	4
HuishanTerminal	666	5	6.5	7,000	Steel product	2
Nampu (No.4)	695	4	10	10,000	Wood, G.cargo	6
Xinhua (No.8)	1,758	10	11	25,000	Steel, General, Bulk	12
Zhanghuabang	540	3	10.5	10,000	Ore, general Cargo	9
Jungonglu (No.10)	743	4	10.5	10,000	Steel, Ore, Cement	8
Baoshan (No.14)	670	5	9.5	15,000	Wood, G.cargo	8
Longwu (No.15)	1,002	6	9	10,000	Steel, General Cargo	8
Luojing Terminal	463	1	11	35,000	Iron ore	2
Baosteel Terminal	1,048	1	12	100,000	Ore, Coal	8
Baosteel Terminal	1,110	3	10	25,000	Steel, General, Slag	11
ZMPC	1,100	3	8	20,000	S.plate, Machinery	3
Total	10,872	51	12	100,000		81

***Source**: Constructed by author using information from various sources*

There are totally 88 terminals in Ningbo-zhoushan port, with length of all 19,174 meters, including 61 large terminals of over 10 thousand tons, 37 super-huge type deep-water terminals of 50 thousand tons. Here we only list the general & bulk cargo terminals as following:

Table 3-5: List of port facilities of Ningbo-Zhoushan (2009)

Terminal	Berth Length	Berth number	Depth limit	Capacity limit	Purpose	Facility (Unit)
No.3 Stevedore Terminal	330	3	5.8	3,000	General Cargo	8
Zhenhai Public Terminal	2,527	13	7.7	10,000	General, Domestic coal, Chemical	18
Belun 1st stage	1,721	6	20.5	200,000	Coal, Ore, Fertilizer	3
Beilun 2nd stage	414	2	12.5	50,000	Coal, Ore	6
Shining Gold	250	14	14	50,000	Grain, G.cargo	2
Samsung Port	270	2	5	5,000	Heavy cargo	
Electric Plant Port	274	1	13	50,000	Coal	
Laotangshan (zhoushan)	831	4	15	50,000	Bulk, General	9
Duntou (zhoushan)	97	1	6	5,000	General	3
Total	6,714	46	20.5	200,000		49

***Source**: Constructed by author using information from various sources*

According to the two tables, it is obvious that no matter the number/length of berth or the major facilities in Shanghai port are nearly about twice as much as in Ningbo-Zhoushan port. But the water depth in Ningbo-zhoushan port is much deeper than Shanghai port, as well as the capacity limit. It is an attractive to the ship owners and or cargo owners if a port has many berths, but that's only for the handy size vessels. To the owner of huge vessels such as Panamax, they will consider the berth depth/capacity at first, because if a vessel cannot even enter the port, all of other factors will have no sense.

That's the biggest superiority of Ningbo-zhoushan port.

3.1.3 Port Service

Service is a complex concept. Both work speed and hinterland for developing of cargo resources can be classified into service realm.

Work speed is pretty important, when decide a port. The first thing the ship owners consider is the work speed of the terminal for their cargo. We can find a comparison of the different cargo's work speed between Shanghai and Ningbo-zhoushan port from Table 3-6.

Table 3-6: List of Cargo and Work Speed of Two Ports

Shanghai		Ningbo-Zhoushan	
Production	Speed (per day)	Production	Speed (per day)
S.Coil	2500-3000mt/gang	S.Coil	2000mt/gang
S.plate	700mt/gang	S.plate	1000-1500mt/gang
S.Pipe	1500-2000mt/gang	S.Pipe	2000mt/gang
Cement	1000mt/gang	Cement	1500-2000mt/gang
W.pulp	2000-2500mt/gang	W.pulp	2000-2500mt/gang
I.ore	2500-3000mt/gang	I.ore	10000mt/gang
Coal	20000mt	Coal	
Log	900-1000cbm/gang	Log	1000-2000mt
Deformed Bar	2500-3000mt/gang	Deformed Bar	1500-2000mt/gang
Soda Ash	5000-6000mt	PTA	1800mt/gang
Sero-Crome	1500mt/gang	Fertilizer	1500-2000mt/gang
Steel Slab	2500mt/gang	Barley	1500-1800mt/gang
Boric Acid(Bu)	1200mt/gang	Pet Coke	2500-3000mt/gang
Wood chips	3000-4000mt/gang	Fluorite (bulk)	3000mt

Copper Slag	2400mt	Fluorite (bag)	4500mt
		Petro (Liquid)	6000mt

Source: *Made by author on reference of previous researches*

Seen from the table, operation of general cargo like steel products in Shanghai is faster than Ningbo-zhoushan port, while the bulk cargo such as iron, coal, Ningbo-zhoushan port is really much faster. Especially the iron ore's discharging. It achieve 10,000mt/gang, to a large vessel, at least 5 gangs should be arranged. Thus discharging rate is 50,000mt/day which is really much faster than all of other ports in China. It arrives at a professional level of discharging iron ore.

The major income of Ningbo INDEX (main business) is from container, iron ire, oil, integrated logistics and other business, total 5 blocks. Therein, iron ore and oil's throughputs take the first place among all Chinese ports.

The main general and bulk cargo business of Ningbo port covers handling, storage and transshipment of imported iron ore, Crude oil, Petro chemical(liquid), Coal and other bulk such as Lumber, Fertilizer, Cereal, Cement, Coke, Sulphur and general goods like Steel Products.

3.1.4 Cargo Resource

The major comparative advantage of Shanghai port is its huge hinterland - Yangtze River Delta area. Yangtze River Delta Economic Zone is the economic region in China that includes Shanghai municipality, Zhejiang and Jiangsu Province. The region accounts for 20 percent of China's Gross Domestic Product and is responsible for one third's its imports and exports.

The Yangtze River Delta (hereunder: YRD) economic zone refers to 16 cities in Shanghai, southern Jiangsu, eastern and northern Zhejiang. As been shown in Figure 3-2, they are Shanghai, Nanjing, Suzhou, Wuxi, Changzhou, Yangzhou, Zhenjiang, Nantong, Taizhou, Hangzhou, Ningbo, Huzhou, Jiaxing, Shaoxing, Zhoushan and Taizhou.

FIGURE 3-2: MAIN CITIES IN YANGTZE RIVER DELTA

Source: http://www.ce.cn/kfq/zht/2006/jjzx/chj/200607/07/t20060707_7648346.shtml

The YRD[4] Economic Zone is dominated by Shanghai, China's financial center and other important economic hubs like Nanjing, Suzhou, Hangzhou, Ningbo and Xuzhou. The vast interior of the YRD is heavily industrialized with advanced transport infrastructure such as highways, expressways, airports and ports.

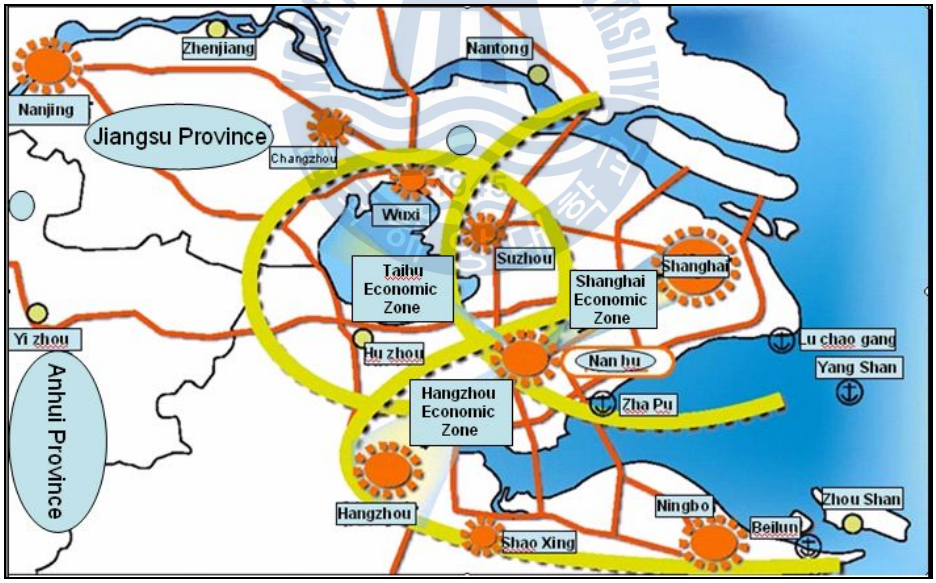
The hinterland of Ningbo-Zhoushan port is much smaller than Shanghai port. Ningbo Port's business mainly comes from companies based in

[4] Yangtze River Delta

Zhejiang, Jiangxi, and south of Anhui province. While Shanghai's shipping customers are from Shanghai, Jiangsu, Anhui and along the Yangtze River. It can be seen from Figure 3-3, there is a client overlap in regions like north of Jiangxi province, south of Jiangsu Province and north of Zhejiang Province. The overlapping hinterland is called Hang-Jia-Hu plain (Hangzhou, Jiaxing, Huzhou).

Cargoes generated from Hangzhou, Jiaxing, and Huzhou are mostly exported or imported through Shanghai port. Due to the under development of railway transport in Ningbo, road transport is the main way for cargo collecting and distributing.

FIGURE 3-3: YANGTZE RIVER AREA



Source: http://www.ce.cn/kfq/zht/2006/jjzx/chj/200607/07/t20060707_76486.shtml

Take Shaoxing city as an example. On the geographic position, Shaoxing port is 280km'way from shanghai port and 150km's way from Ningbo port, though 130km's much nearer, Ningbo port has no attraction to Shaoxing city.

To obtain the huge cargo resources provided by the overlapping hinterland, Ningbo government has realized traffic is the most important to develop from 2006. They were trying the best and did many efforts on the sea-rail multi-transport modal and it had successfully completed by 21st Jan 2009.

First is the Yong-Tai-Wen expressway, which makes the cargo from important international trade places Wenzhou, Taizhou to Ningbo directly, and it connects to Wen-Fu railway to the south, so as to extend to Fujian Province, another important exporting place. Meanwhile, Yong-Jin railway is under programming, after finish building, cargo from Yiwu city (a place full of Chinese traditional small commodities) will be transported to Ningbo directly. Another significance of the building of this railway is to attract cargo resource from Jiangxi Province. This railway will connect with Shangrao, Yingtan and Nanchang city in Jiangxi Province.[5]

FIGURE 3-4: MAIN WAY OF CARGO COLLECTION

Source: http://www.ce.cn/kfq/zht/2006/jjzx/chj/200607/07/t20060707_7648356.shtml

[5] http://news.163.com/09/0917/08/5JD9LA4D0001124J.html; http://news.qq.com/a/20080920/000608.htm;

Hang-Yong highway connects Hangzhou and Ningbo. Hu-Hang highway which connects Hangzhou and Nanjing finished construction by 2010. Another project is under programming, which is 150km's Hangzhou Bay Railway Bridge which estimated to be invested over 2.9 billion US dollars. Once the bridge is built, the whole coastal railway will open.

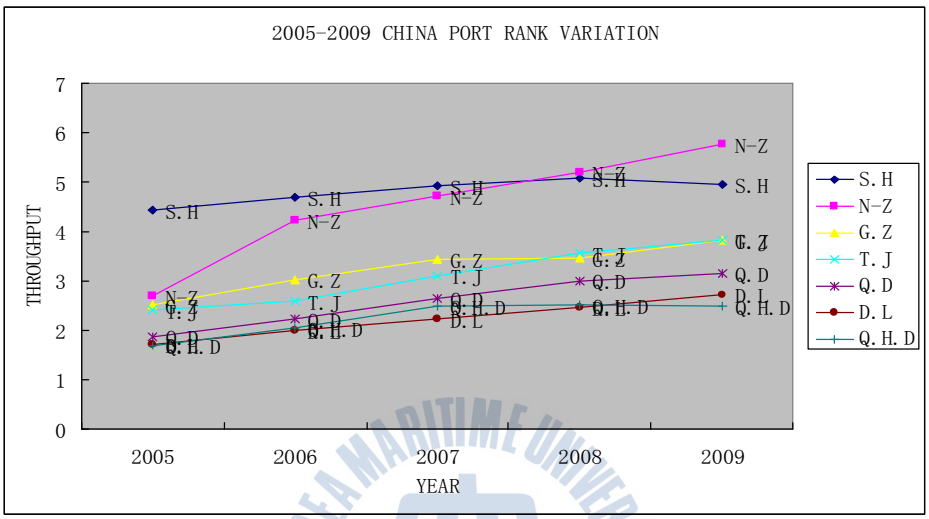
The third longest bridge in China which lists after Hangzhou Bay Bridge and Donghai Bridge, Jintang Bridge is a highway bridge built on Zhoushan Archipelago, with a length of 26,540 meters, connecting Jintang Island and Ningbo.

But in Shanghai, situations are different, as Shanghai already has a long time's development, most of the land resource has been utilized, it is not easy to built a new railway in the city connects to the terminal. “Though Shanghai is still trying and already suggested the State Council to consider building a railway in Shanghai connects to the main port, but still need some time as the government needs to research further more”, reported by a journalist. [6]

[6] http://bbs.railcn.net/viewthread.php?tid=263245

3.2 Present Achievement on Cargo Throughput

FIGURE 3-5: 2005-2009 CHINA PORT RANK VARIATION



Source: *Made by author on reference of previous researches*

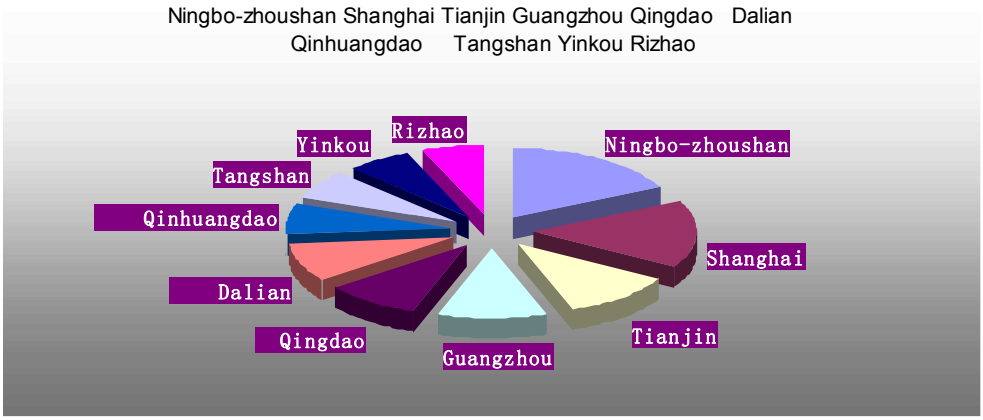
Figure 3-5 explains the cargo handling capacity of different ports in China. We can see that cargo handling capacity in Ningbo-Zhoushan Port has been the second biggest port in China for several years until 2008. In 2008, finally it has surpassed Shanghai and became the No.1 port in China. During the period from 2005 to 2006, the cargo throughput of Ningbo port has bumped up. In 2006 Ningbo port and Zhoushan port are merged together to form one port, which is Ningbo-zhoushan port. Though, before the merge, Ningbo port was already the No.2 in China. After that, the cargo throughput kept increasing, even in the financial crisis period from 2008 to 2009, while Shanghai port's cargo throughput decreased. But Ningbo-zhoushan port's cargo throughput kept increasing and now is holding the No.1 position steadily.

Table 3-7: China Mainland Ports Rank from 2006 to July.2010

Rank	2005		2006		2007		2008		2009		2010 30th/
	Port	Throughput	Port	Throughput	Port	Throughput	Port	Throughput	Port	Throughput	Port
1	**Shanghai**	**4.43**	**Shang hai**	**4.70**	**Shang hai**	**4.92**	**Ningbo -zhoushan**	**5.20**	**Ningbo -zhoushan**	**5.77**	**Ningbo -zhoushan**
2	**Ning bo**	**2.69**	**Ningbo -zhoushan**	**4.24**	**Ningbo -zhoushan**	**4.73**	**Shang hai**	**5.08**	**Shang hai**	**4.95**	**Shang hai**
3	Guangzhou	2.51	Guangzhou	3.03	Guangzhou	3.43	Tianjin	3.56	Guangzhou	3.83	Tianjin
4	Tianjin	2.41	Tianjin	2.58	Tianjin	3.09	Guangzhou	3.47	Tianjin	3.81	Guangzhou
5	Qingdao	1.87	Qingdao	2.24	Qingdao	2.65	Qingdao	3.00	Qingdao	3.15	Qingdao
6	Dalian	1.71	Qinhuangdao	2.05	Qinhuangdao	2.49	Qinhuangdao	2.52	Dalian	2.72	Dalian
7	Qinhuangdao	1.69	Dalian	2.00	Dalian	2.23	Dalian	2.46	Qinhuangdao	2.49	Qinhuangdao
8	Shenzhen	1.54	Shenzhen	1.76	Shenzhen	2.00	Shenzhen	2.11	Hongkong	2.43	Tangshan
9	Rizhao	0.80	Suzhou	1.51	Suzhou	1.84	Suzhou	2.03	Suzhou	2.22	Yinkou
10	**Zhoushan**	0.80	Rizhao	1.10	Rizhao	1.31	Rizhao	1.51	Shenzhen	1.94	Rizhao

Source: Ministry of Transport of P.R.C <Shipping Industry Development Statistics> (Unit: hundred million tons)

FIGURE 3-6: TOP 10 PORTS CARGO THROUGHPUT IN 2009



Source: Ministry of Transport of P.R.C, Research in China

THE PRESENT SCALES AND TRADE ACHIEVEMENTS OF TWO PORTS.

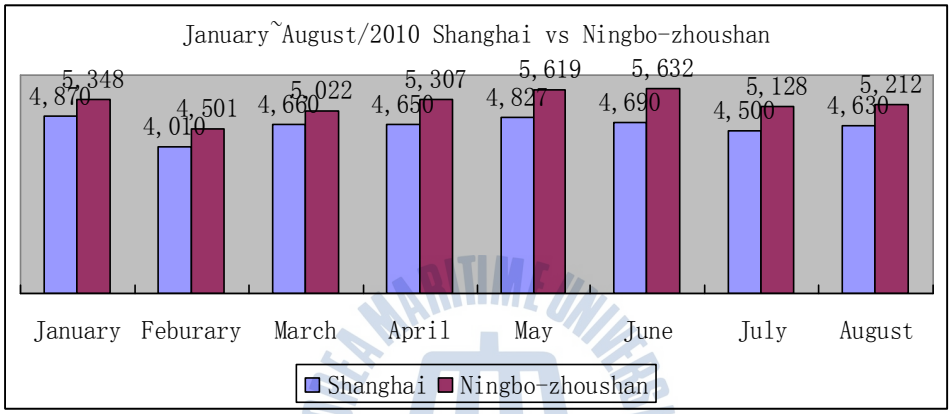
Table 3-8: Cargo Throughput of Shanghai and Ningbo Port from Jan to Aug of 2010

Month	Shanghai		Ningbo-zhoushan	
	Throughput	% of last same period	Throughput	% of last same period
January	4,870	145.0	5,348	150.5
Feburary	4,010	139.1	4,501	149.5
March	4,660	127.9	5,022	134.4
April	4,650	124.9	5,307	126.9
May	4,827	121.6	5,619	122.0
June	4,690	120.4	5,632	120.0
July	4,500	117.7	5,128	115.5
August	4,630	117.0	5,212	112.8
Total	36,837	118.9	41,769	115.2

Source: Ministry of Transport of P.R.C, Research in China (Unit: 10,000 tons)

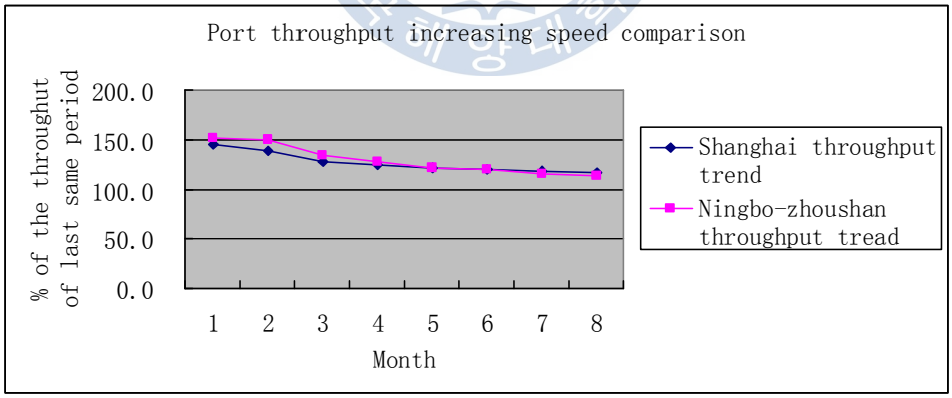
We can see from Table 3-8, Ningbo-zhoushan port has definitely surpassed Shanghai in every month from January 2010, which has a cargo throughput of 4.17 hundred million metric tons until August, 2010. It keeps the No.1 in China nationwide.

FIGURE 3-7: SHANGHAI NINGBO CARGO THROUGHPUT FROM JAN TO AUG IN 2010



Source: Ministry of Transport of P.R.C, Research in China

FIGURE 3-8: CARGO THROUGHPUT INCREASE COMPARISON



Source: Ministry of Transport of P.R.C, Research in China

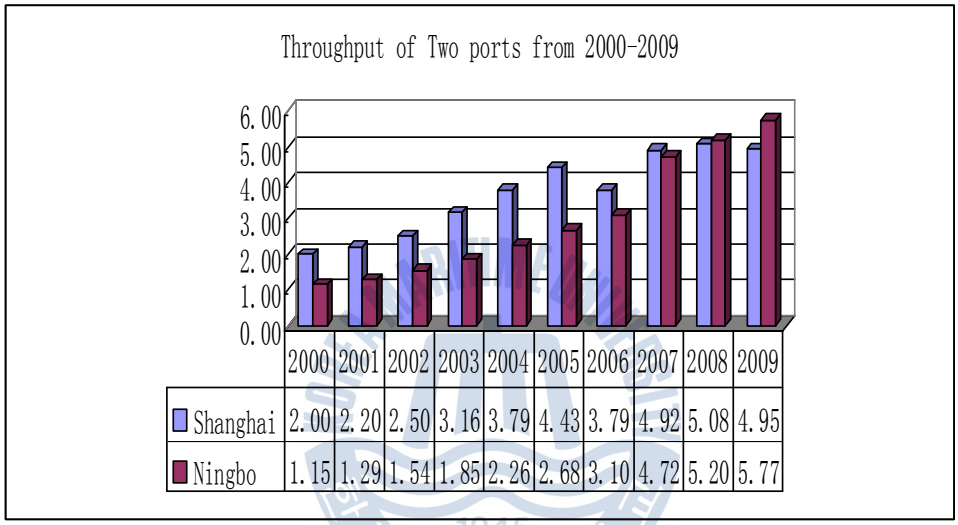
Figure 3-7 shows the cargo port throughput of Ningbo-zhoushan is higher than Shanghai port in every month of 2010. Figure 3-8 shows the increasing speed of the port throughput of Ningbo-zhoushan is developing faster than

Shanghai port in each month.

We can see the fast development of the throughput of Ningbo port in the last 10 years from Figure 3-9:

FIGURE 3-9: THROUGHPUT OF TWO PORTS FROM 2000-2009

(UNIT: HUNDRED MILLION TONS)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shanghai	2.00	2.20	2.50	3.16	3.79	4.43	3.79	4.92	5.08	4.95
Ningbo	1.15	1.29	1.54	1.85	2.26	2.68	3.10	4.72	5.20	5.77

Source: Ministry of Transport of P.R.C, Research in China

In the year of 2009, Ningbo-Zhoushan port's cargo throughput was 5.77 YIK tons, which was the world's No.1. Therein, Ningbo port's throughput was 3.84 YIK tons.

In the year of 2000, Ningbo-Zhoushan port's cargo throughput was Shanghai's 56%. Until 2007, it went up to 96%. From the year of 2008, it has exceeded Shanghai port and became the No.1 among Chinese ports.

3.3 Port's Characteristics

3.3.1 Ningbo-zhoushan Port

Ningbo port (2929°52'N, 121°33'E) is situated in the middle of China's coastline. It is at the T-shaped joining point of China's coastline and the Yangtze River. It's a famous deep-water port of mainland China. It enjoys unique natural conditions with convenient traffic reaching in all directions. Outwardly the port links East Asia and the whole round-the-Pacific region. I t's within 1000 sea miles to Hongkong, Kaoshiung, Pusan, Osaka and Kobe. It connects inwardly China's coastal ports and covers directly the whole East China and the economically developed Yangtze River Valley by river-sea through transport via the Yangtze River. It's therefore an ideal place for developing ocean-going transport to the ports of America, Europe, Middle East and Oceania.

It consists of 5 port areas of Belun, Zhenhai, Ningbo old port, Daxie and Chuanshan. It is a modern comprehensive multifunctional deep-water port, combining inland, estuary and coastal harbors with characteristics as following. 1. Deep Depth Channel With deep water and smooth current, the port area of Ningbo is free from strong winds and waves. The entry channel is normally over 18.2m's depth. Large ships of 250,000 to 300,000mts can come and leave by tide. With an exploitable deep-water coastline of over 120km, Ningbo port has broad developing and construction prospects. On the north of Beilun port area, Zhoushan islands serve as its natural defense, so there is no need to build breakwater when construct berths at Beilun. Less investment can produce more benefits. Besides, there is a wide and plain dockland behind the deep-water coastline, which is

extremely good for developing port storage, warehouse and littoral industry.

Ningbo-Zhoushan port, famous for its deep-water, smooth current, a calm sea, vast dockland, no freeze and no silt, have obvious advantages in depth of water which was the most important factor of port nature factor. It's also the only one to receive ships of 300,000 tons.

The channel lead to Beilun area is normally 30 to 100 meters deep, even the shallowest section of 4 km long is over 21meters deep at high tide. So ships of 200,000 to 300,000 tons may enter and leave the port freely. In 1995, Grand Phoenix of 300,000 tons was successfully piloted into the port for operation. In 2000, the damaged foreign ship Weiser with 270,000 DWT and 20.5 meters draft was piloted into the port for help once more. They are the largest ships that have ever been piloted in China. The deep water factor is one of the comparative advantages of Ningbo-Zhoushan port.

1. Large Berth

There are 17 berths which are over 50,000 tonnages including the 50,000-tonnage berth for liquid chemicals, the ore transshipment berth for 200,000-300,000 tonnage vessels and the 250,000-tonnage terminal for crude oil. All these berths are the largest berths in China at present.

2. Great Developing Potential

Ningbo-zhoushan port, consisting of inland, estuary and coastal harbors, enjoys unique natural conditions: Zhoushan Islands serve as the natural defense in the front, there is no need to build any breakwater. There are complete facilities at the rear of the port area and the surroundings of the

port are nice. Fewer investments, shorter period and quicker in providing results feature the building of wharves at the port.

An all-positioned, stereoscopic transport network of collection and distributi on has taken an initial shape at Ningbo Port with expressways(Shanghai-Ha ngzhou-Ningbo Expressway, Hangzhou-Nanjing Expressway, Ningbo-Taizh ou-Wenzhou Expressway and Ningbo-Jinhua Expressway have all been ope ned), railways, airway, river-sea through transport and water-to-water transf er.(cargoes may reach directly Wuhan and Chongqing by river-sea through t ransport.)

3.3.2 Shanghai Port

Shanghai port (31° 23' N 121° 30' E) is situated at the middle of the 18,000km-long Chinese coastline, with the East China Sea to the east and Hangzhou Bay to the south. It includes the heads of the Yangtze River, which is known as “the Golden Waterway” and flows into the East China Sea, Huangpu River, which enters into the Yangtze River, and Qiantang River. It is the leading port in the T-shaped waterway network composed by the Yangtze River and the Chinese coastline.

Therefore, the Port enjoys an advantageous geographical location, favorable natural conditions, vast economically developed hinterlands, and complete inland distribution infrastructure and facilities. It is China’s largest comprehensive port and one of the country’s most important gateways for foreign trade. But there’re also some negative problems.

According to the index of International Shipping Center, the depth of water should be more than -14 meters. The average water depth is about 11 meters in Shanghai port.

Shanghai has been the center in Yangtze River Delta, which leads Shanghai government always puts Shanghai onto the No.1 position, and consider Ningbo-zhoushan and all other ports around this area at the assistant position and should serve Shanghai. However, cooperation in the new times should be balanced, which hasn't been realized by Shanghai government and caused many other cities abandoned service to Shanghai.[7] Industries don't choose Shanghai because of the abnormal behavior and egotistic nature. They prefer to choose Ningbo due to the kind and great nature showed toward the industries.

[7] http://zhidao.baidu.com/question/198270142.html

Chapter 4 AHP Methodology and Analysis Result

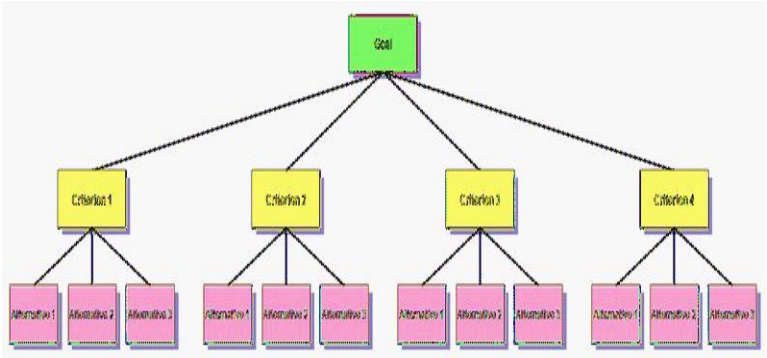
4.1 Analytic Hierarchy Process

4.1.1 AHP Conception

The Analytic Hierarchy Process (AHP) is a structured technique for dealing with complex decisions. Rather than prescribing a "correct" decision, the AHP helps the decision makers find the one that best suits their needs and their understanding of the problem.

Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. The AHP provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. It is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education.

FIGURE 4-1: AHP STANDARD STRUCTURE



Source: http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process

4.1.2 AHP Procedures

1. Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem tangible or intangible, carefully measured or roughly estimated, well or poorly understood anything at all that applies to the decision at hand.

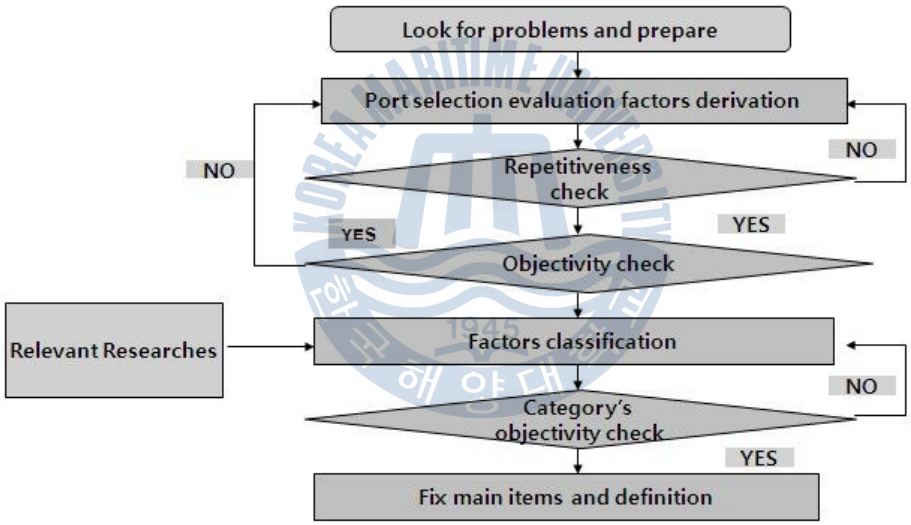
2. Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time. In making the comparisons, the decision makers can use concrete data about the elements, or they can use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations

3. The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing

diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.

4. In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action.

FIGURE 4-2: AHP EVALUATION FACTORS DERIVATION PROCEDURE



4.1.3 AHP Methodology

1. Purpose of Questionnaire

Ship owners are always asked by such questions: What do you care about when you know your vessel will call at some port? The answers are very different.

Generally, there're 4 main factors which are: Cost, Service, Safety and Efficiency. The relationship among these four factors are hard to fix, because some ship owners care about the cost most while some cares about the safety most, especially European ship owners. Of course every owner all over the world cares about the safety of the vessel, because without safety, they will get nothing. Thus we need to use AHP analysis to check which one indeed is the most important.

2. Scale of Intensity of Importance

AHP Procedure is very similar to hierarchical value structure, and in the model, there're 1-9 scales of the intensity of importance which will be used like ruler for measuring each factor. The scales are showing as Table 4-1.

Table 4-1: 1-9 Fundamental Scale of Importance Degree

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

Source: http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process

3. Speculation Process of Weighted Value

After pairwise comparison, we should speculate the relative weighted value of evaluation standard of each hierarchy's comparison targets. That is, use a_{ij} price which obtained though pairwise comparison in foregoing steps, to speculate the numerical value $W_1, W_2, \cdots, W_n$ which contains evaluation standard $C_1, C_2, \cdots, C_n$'s weighted value and intensity of importance. There are two such speculation methods of weighted value: Eigen Value Method and Logarithmic Least Square Method.

(1) Eigen Value Method

First, from the special situation of weighted value's speculation, in case it can be objectively and precisely speculated like an object's quality and or size between a_{ij} and W_1, W_2 establish as following.

$$a_{ij} = W_i / W_j \ (ij = 1,2,3,\cdots,n) \quad \text{---------- ①}$$

And, in this situation

$$a_{ik} \cdot a_{kj} = (W_i / W_k) \cdot (W_k / W_j) = W_i / W_j = a_{ij}$$

The established judge's consistency is perfect. The perfect judge's consistency is to the evaluation standard of C_1, C_2, C_3, if evaluate $C_1 : C_2$ as 2:1 and $C_1 : C_3$ as 4:1, then $C_1 : C_2 : C_3 = 4 : 2 : 1$ should be right.

From ①

$$a_{ji} \cdot W_i = W_j$$

$$\sum_{j=1}^{n} a_{ji} \cdot W_j = n W_j, \ i = 1,2,\cdots,n$$

Then the matrix will be like below.

$$\begin{vmatrix} w_1/w_2 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ & \vdots & \vdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{vmatrix}$$

That is, below form has been established.

$$Aw = nw \text{----------②}$$

Here $W = (w_1, w_2, \cdots, w_n)^T$ is real relative weighted value's vector, "n" is the number. But, ② is and equation showing relationship between Eigen value and Eigen vector.

$$Aw = \lambda w \text{----------③}$$

It is called a special form.

A is n × n matrix, in "n" dimension space R^n 's vector W (not 0), if Aw is w's scalar multiple, that is some scalar λ is A's Eigen Value, then w is λ's corresponding Eigen value.

To write equation ③ again:

$Aw = \lambda Iw$ (I: unit matrix)

And

$$(A - \lambda I)w = 0 \text{----------④}$$

If λ is common value, the equation's solution should not be 0 but exist, then ④' s necessary requirement is

$$det(A - \lambda I) = 0.$$

This is called Matrix A's special equation, the scalar λ to meet with this equation is Matrix A's Eigen Value.

Generally, A is n times' matrix, n λprice $\lambda_1, \lambda_2, \cdots, \lambda_n$ exists, if $a_{ii} = 1$, then $\sum_{i=0}^{n} \lambda_i = n$

And in n λprice, the biggest λprice $\lambda_{max} = n$, the left $\lambda_i$prices all is 0.

Follow this, ② can be established only when pairwise comparison's matrix A's consistency is perfect. But, because most has decision making problems a_{ij} is not accurate physical speculation, so price was decided according to the assessor's subjective judge, a_{ij} will be out of strange ratio w_i / w_j. Thus, as the judge's consistency cannot be assured, ② will not be established more.

In this case, pairwise comparison matrix A's element a_{ij} price λ_{max}'s consistency will not be big and it will match with a near price to n, through this characteristic and equation of $Aw = \lambda_{max} w$, weighted value w can be speculated.

If vector w is solved, we allot w's respective element though $a = \sum w_j$, then normalized weighted value will be obtained.

(2) Consistency Speculation

AHP uses hierarchical analysis method. One of the useful information is speculation of consistency. The Consistency Index provides information concerned to weighted value or size and order of contribution level.

When λ_{max}'s price approaches to n, pairwise comparison's Matrix A can be explained to be consistency, such feature and λ_{max}'s price always bigger than n, through such features, we build below method to speculate consistency.

(CR：Consistency Ratio)=CI/RI

Here the price is calculated according to $CI=(\lambda_{max}-n)/(n-1)$, RI (Random Index) is according to evaluation standard's number n's size. RI 's prices are gotten through a flow that choose number from 1 to 9 randomly, make hundreds of matrix, then start to calculate CI price and make average.

There's limitation of human's judgment in complicated and fastidious decision of method, thus CR>0.

In hierarchy analysis decision-making, considering of such point, perfect judge's consistency is not required. But if CR price is too big, we can see the judge's consistency is not good, it will be not easy to use the weighted value which obtained from such judge in decision-making. Only as $CR\leq 0.1$, the judge's consistency exists. If CR>0.1, pairwise comparison should be done again, or questionnaire should be amended. But, when do group decision-making, if CR>0.1, the method that the questionnaire is exempted can be used.

(3) Comprehensive weighted value

AHP's last step is a process as to the lowest hierarchy's alternative, to get relative weight and priority order, put the calculated evaluation standards' relative weighted value in each hierarchy together. It is a step for settling the highest hierarchy's decision-making problem, to solve the alternative's comprehensive weighted value so as to get the intensity if importance or influence to the alternatives in the lowest hierarchy.

Here when every standard is not separated because of quantitative, qualitative factors, alternative comprehensive weighted value can be solved through below.

$$TW_j(1) = \sum_{j=1}^{n} w_1 \cdot x_{ji},\ j = 1, 2, \cdots, m. \quad \text{----------⑧}$$

Here $TW_j(1)$: j time's alternative's comprehensive weighted value

w_j : evaluation standard i's relative weighted value

x_{ji}: to evaluation standard i, j time's alternative's weighted value is

$$\sum_{j=1}^{n} w_j = 1 \quad \text{----------⑨}$$

$$\sum_{i=1}^{n} x_{ji} = 1 \quad \text{----------⑩}.$$

But to quantitative factors or qualitative factors, relative weight or alternative's importance are separated, to express by general equation as following.

$$TW_j(2) = \sum_{j=1}^{n} Ws_j \cdot Xs_{ji} + \sum_{j=1}^{n} Wo_j \cdot Xo_{ji},\ j = 1, 2, \cdots, m. \quad \text{---⑪}$$

$$\sum_{j=1}^{n}(Ws_j + Wo_j) = 1 \quad \text{----------⑫}$$

$$\sum_{i=1}^{n} Xs_{ji} = 1,\ i = 1,2,\cdots,n \quad \text{----------⑬}$$

$$\sum_{i=1}^{n} Xo_{ji} = 1,\ i = 1,2,\cdots,n \quad \text{----------⑭}$$

The alternative's comprehensive weighted value TW_i is each alternative's relative weight and an important standard to choose alternative when there is priority.

4.2 Selection of Evaluation Factors

4.2.1 Model Establishment

1. Deduction of Specific Evaluations

(1) 1st research on specific evaluations

This study is designed to compare the competitiveness between Shanghai and Ningbo-zhoushan port. To figure out the importance and priority in port competitiveness, this study refers to Lee Jia Bin's research on Competition and Cooperation among ports. [2009], analysing from the side of evaluation standard and conceptual define which includes port equipment, port service, port environment, restrictions to vessel's entrance and sailing, economic scale behind, social political condition, port work system and so on. We get below 44 evaluations.

1. Pilot/ Tug/ Night Navigation restriction	2. DWT/ LOA/ BM Limitation
3. Channel/Draft/ Air Draft Limitation	4. Water density
5. Flag Discrimination & old age vessel related	6. Tide range
7. Bunker charge, bunkering possibility	8. Lightening charge
9. Agency fee, Agency service	10. Cargo handling charge
11. Lashing charge	12. Transshipment cost
13. Holiday/ Night Additional Charges	14. Berth Number/Length
15. Shifting availability between berths	16. Lightening berth availability
17. Loading/ Discharging method	18. Loading/ Discharging rate
19. Berthing time from pilot station to berth	20. Watchman Compulsory or not
21. Distance from the berth frontier to warehouse	22. Work shift enough or not
23. Weather factor/ Swell/rainy season	24. Berth priority (First come/serve)
25. Feasibility of Partial discharging	26. Space of warehouse
27. Numbers of Trucks for transporting cargo	28. Limitation of yard Storage
29. Cargo handling speed in warehouse	30. Port charge
31. Work facility - Capacity & Numbers	32. Work gangs /shift numbers
33. Working hour	34. Distance from factory to the port
35. Cargo delivery & turn around time	36. Traffic Congestion outside Port
37. Lashing Material Tariff Rate	38. Quarantine time
39. All relative documents required	40. Port authority's cooperation
41. Tax-free zone availability	42. Free storing days/charge
43. Normal waiting Time	44. QDA availability

(2) Repeatability

It is not easy to use all of the 44 factors to do AHP analysis, in the 1st stage of factors selection, not all of the factors are necessary to the research itself. Such as the Holiday/ Night Additional Charges, Watchman Compulsory or Not, Tariff and so on. Since Shanghai and Ningbo-zhoushan port is so close and they both perform Chinese marine law, most parts of the evaluation factors are the same. Considering this, we delete the same evaluation standards and keep 18 factors.

(3) Classification of evaluation factors

According to the precursors' researches and vessel operators' working experience, we got the main factors which influence the ship owner's decision when choosing the port, which are mostly separated into 5 blocks: Terminal condition, cost, speed, environment and service, with the specific evaluation factors, the basic AHP structure is showed as Table 4-2:

Table 4-2: 2nd Stage of Factors Selection

Items	
1.Terminal condition	Port restriction to vessel
	Restriction to cargo
	Congestion
	Berth condition
	Port Facility
2.Cost	Port charge
	Lightening charge
	Cargo causing charge
3. Speed	Berth/ De-berth time
	QDA
	Cargo turn around speed
	Load/ Discharge rate
4.Outer environment	Space of Storage Yard
	Free storing days
	Port position
5. Service	Agency service
	C.I.Q
	Port authority's cooperation

(4) Objectivity

In the 2nd stage of classification and selection, we got 5 items and 18

specific factors, but all of them were selected according to the previous research. Also, author contacted with many people who are working in shipping companies, through different kinds of interviews such as telephone, e-mail, face to face chatting and even msn chatting, finally, 12 most important factors in 4 items were fixed. The 4 items are: Port cost, Port service, Port facility and Port environment, showing as table 4-3.

Table 4-3: Final Factors Selection

Main items	Specific factors	Contents
Port Cost	Port charge	Port dues, pilotage, tuggage, line handling charge, dockage, quarantine, agency fee and so on
	Cargo operation charge	Cargo loading/discharging/lashing/warehouse storing charge
	Lightening charge	Vessel with draft over 12m needs to lighten part cargo at Lvhuashan anchorage
Port Service	Port productivity	Loading/discharging/cargo turn around speed of different cargo
	Agent service	Including port congestion(take berth speed), Night navigation available or not
	Port authority's support	PSC inspection/ Cooperation attitude/ Informatization level
Port Facility	Water depth	Draft restriction to vessel's DWT
	Berth condition	Includes berth length and berth numbers.
	Cargo handling equipment	Shore crane/Floating crane/Grab/Convey belt/fork lift-Capacity & Numbers/work shifts
Port Environment	Cargo availability	Cargo resources from factories, brokers, backhaul cargo availability
	Inland transport connectivity	Highway, railway, bridge connects to the cargo factories from the port.
	Weather condition	Rainy season/Typhoon

4.2.2 Factors Specification

1. Port Cost

Cost is a very important factor in the process of deciding the port of call. Many companies put it as the first important to be considered, especially small companies. It can be divided it into three parts: port charge, cargo operation charge; lightening charge.

1) Port Charge

Port charge includes: port dues, pilotage, tuggage, line handling, tally fee, dockage, mooring, quarantine, tonnage dues, agency fee, bunker charge, holiday/night surcharge and so on, the specific of the port charge has been explained in Chapter 3, including lightening charge.

2) Cargo Operation Charge

It is the cargo handling charge including loading & discharging, as well as lashing charge, cargo's free storing days in the warehouse (normally the first 7 days is free. Some ports are 5 days while some are 12 days) and the storing charge after the free storing period.

Cargo transportation charge from the berth frontier to the warehouse also is contained sometimes. In most situations it is separated from the port charge because not all of this charge should be paid by the Owner. It depends on the transportation contract between owner and the shipper. If FI/FO (Free in and Free out) terms, owner will not pay for this charge; and if BT terms, owner should pay. It is important to check the terms before checking the port charge, because charge caused by cargo are always expensive, compared to the basic port charge.

2. Port Service

1) Port Productivity

It doesn't only mean the loading/discharging speed but also the time to be used to take berth from the pilot embarkation of vessel to the berth, the distance and trucks to be used for transporting from the berth frontier to the warehouse, and the cargo load and or discharge time in the warehouse as well. But among these, the most important one is the cargo operating speed, which depends on the stevedores and facilities.

2) Agent Service

People always misunderstand it as the serve attitude of operators in local agent's office. Actually, the most important is how to make vessel take berth first under port congestion[8] conditions. It should depend on the relationship between the local agent and port authority.

When vessel meets with the congestion situation, they have to wait because almost all the ports are performing first come first berth rule, but some ports can accept QDA (quick dispatch agreement) with the owner. Owners also prefer to pay for the QDA though it is expensive. It is much better than making vessel wait at anchorage.

Storage yard condition also can cause port congestion because if not enough

[8] Congestion means when there are too many vessels in the port, all of the berths are occupied, no any free berth available for forthcoming vessels. All forthcoming vessels should wait for the berth at anchorage. And even sometimes under bad weather conditions, the anchorage is full of vessels and no space for more vessels.

space for storing cargo, new coming vessels will have no place to store the cargo, thus the cargo can not be discharged and vessel have to wait on the berth for storage yard to be cleared, which is as the same as letting vessel wait at the anchorage.

3) Port Authority's Support

Port authority's support includes C.I.Q (Customs, Immigration, Quarantine Inspection), PSC (Port state control) and terminal administrators. The world is changing. Nowadays officers working in the government do not think they are the leaders who should be served well but try to serve people, because of the drastic competition between ports.

Competition between ports requires the port authorities should show their best co-operations to the ship owner. In ancient times, there were not so many ports and people's awareness of competition was not grown. the port authorities were the biggest, owner or agent should do whatever they asked. But now, situations are changed too much. Officers in every port are trying to support the owner thus to get more calling vessels.

Generally, their support includes: the feasibility of using container terminal to discharge or stow general bulk cargo; how to solve the problem when receivers are unable to complete customs formalities and late submission; possibility of hiring or arranging stowage yard and or transportation by ship owners for quick dispatch if receivers fail to arrange yard and or trucking; if it is possible that vessel is arrested because of cargo shortage; possibility of hiring stowage yard by ship owner; feasibility of partial discharging; is there any special zone available for Transshipment to other area or country and so on. All of above mentioned questions are the most sensitive problems cared

by ship owners. If port side always trying their best to help and support owners to settle such kinds of problems, it would give a good impression and become a big attraction to owners.

3. Port Facility

1) Water Depth

In Shanghai port, there are two channels: one is South channel with basic depth of 5.2 meters while the other one North channel with basic depth 10.0meters. Vessel's enter of port not just decided but the basic depth of the water but also consider the tide range in Most of Chinese ports are tidal ports. In Shanghai port, tide range is around 0~4m. All vessels must take the favorable tide to enter and leave.

There is a formula to calculate the limitation of channel depth:

- South Channel : 5.5M + Available Tide – Ukc 0.7m - S(t)
- North Channel :10.0M + Available Tide - Ukc 1.0m - S(t)

[9]UKC = Under-Keel Clearance (1)
S (t) = SQUAT = 10% x draft, or Speed/100; (2)

The channel limitation doesn't not only include the draft, but also the air draft. Take Shanghai port as example, there are 5 bridges on Huangpu River, always vessel should be limited by 3 of them: Yangpu Bridge - 48M; Nanpu Bridge - 46M; Xupu Bridge - 46 M.

(1) http://www.shipagt.com, http://www.shipagt.com/thread-1739-1-1.html
(2) http://www.52ship.com/bbs/simple/?t118693.html

Therefore, for large vessels to enter and leave Shanghai port, the draft should below 10.5m, and air draft should below 46m at least. And in this case, vessel can enter or leave the port only twice in a day with the high tide. If the tide is missed, vessels have to wait for another day, which will be a huge lose to the carrier.

2) Berth Condition

Generally, vessel size restriction includes DWT (Dead Weight Tonnage), LOA (Length of all) limitation, which depends on the berth size. E.g. in Shanghai port, if vessel's LOA is more than 275M, harbor master's special arrangement / agreement should be needed.

Length of the berth decides the berthing vessel's LOA limitation while the number of the berth decides the congestion condition. The longer the berth length is, the larger the vessel can be berthed. The more the berth number, the less congested will the port be, supposing the working facilities and stevedores are enough.

3) Cargo handling equipment

Port facility includes shore cranes with grabs for general cargo, conveyor belt for bulk powers, chain bucket unloader which special for bulk cargo like iron ore, fork lift in the warehouse, gantry crane for containers and heavy crane for over length/weight cargo.

Chinese ports always have enough stevedores with 3 working shifts per day, except for the national holiday especially the Spring Festival because labors prefer to go home since it is the Chinese biggest and most important national festival.

4. Port Environment

1) Cargo availability

In modern shipping market, ship owner is not the one with highest position any more, vessel always chase after cargo, thus ship owner should follow the cargo owner to make sure of the move of vessel, as well as the backhaul.

2) Inland Transport Connectivity

Sometimes, cargo needs to be transshipped through train or other traffic vehicles directly after discharging or before loading. If the traffic near the port area is always jammed or the port position is just near the downtown, such as Busan old container port in Korea, the cargo transport speed will be really slow, especially in rush hours. Fortunately, Busan authority has realized this point and changed the main container port to suburb which is called Busan New Port. It advanced the terminal's cargo turning around time, so did the cargo operating speed.

3) Weather Condition

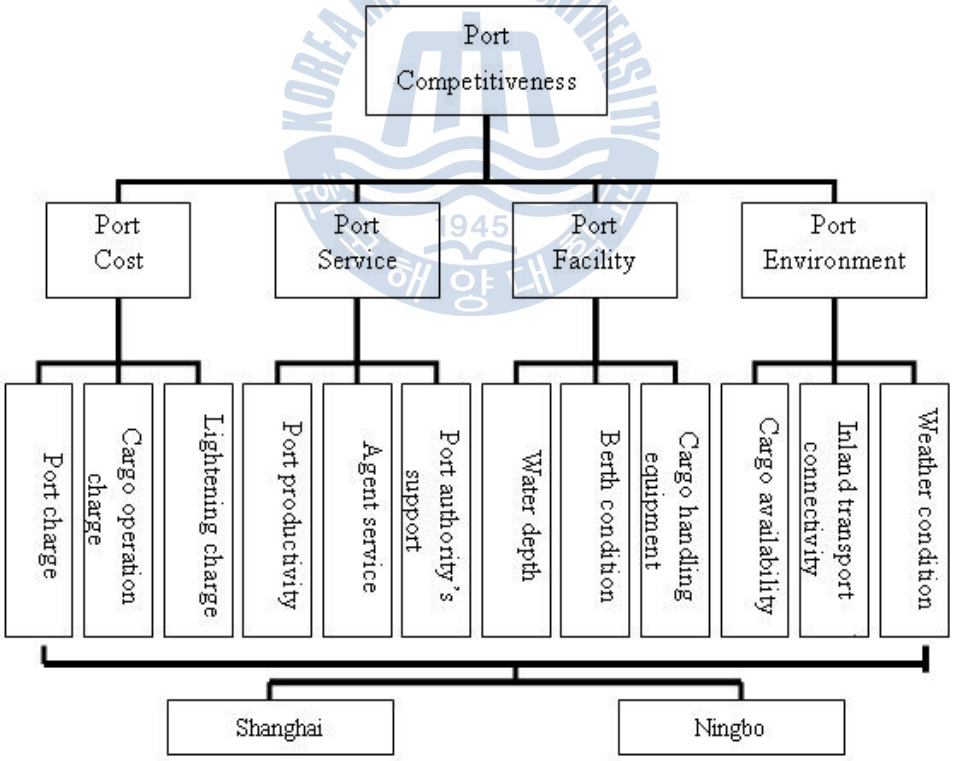
It is important but out of control. Rainy season can be known but the rainy days can only be checked 5-7days before vessel's calling, voyage by voyage. Owners check rainy season and others such as typhoon when decides the port, but have to check rainy or windy days in every shipment.

4.3 Result of AHP Analysis

4.3.1 Hierarchic Structure Model

The most important factor to solve the multifactor decision making problem in accordance with AHP is an analysis of evaluation factors to assess alternatives, and the creation of hierarchic structure. This study illustrated a hierarchic analysis structure in Fig.4-3, which was established after a number of corrections through converge with the opinions of experts in ports and AHP.

FIGURE 4-3: HIERARCHIC ANALYSIS STRUCTURE ON PORT COMPETITIVENESS



4.3.2 Result of AHP Analysis

1. Survey on Respondents

The study employed the geometric average method, which re-generalizes the survey after evaluation. The major reason in employing the geometric average method is that the method is the only procedure that satisfies the characteristic of a reciprocal number of the pairwise comparison. Hence, all comprehensive opinions were gathered, and calculated the weight value via applying each matrix value of the pairwise comparison matrix on the 1,3,5,7 and 9.

The survey was implemented targeting experts in port, and the survey details were prepared to use the pairwise comparison evaluation designed for calculating the significance of AHP analysis.

The Questionnaire was distributed to operators in different shipping companies in Korean and China, as well as operators working in port administration offices, total 53 respondents in 2010. Among them 36 responses returned and all of them was received by E-mail. Among all the responses, 13 ones showed Consistency Ratio > 0.15, which were eliminated from sample selection, and total 23 responses with Consistency Ratio <= 0.15 were used for the survey analysis.

Table 4-4: Survey Details of Respondents

	Distinction	Responses	Ratio
Work place	Korean Ship Owner	13	56.5%
	Chinese Ship Owner	7	30.4%

	Others	3	13.1%
Work Department	Operation Department	12	52.2%
	Business Department	8	34.8%
	Others	3	13.0%
Work Position	Manager	11	47.8%
	Vice Manager	5	21.7%
	Staff	4	17.4%
	Others	3	13.1%
Vessel Size	Mini-bulkers	4	17.4%
	Handysize	5	21.7%
	Handymax	6	26.1%
	Panamax	4	17.4%
	Capesize	1	4.3%
	Others	3	13.1%
Loading/discharging term	FI/FO	19	82.6%
	BTBT	1	4.3%
	Others	3	13.1%
Total	23 (100%)		

Source: Analysis of Questionnaire Results

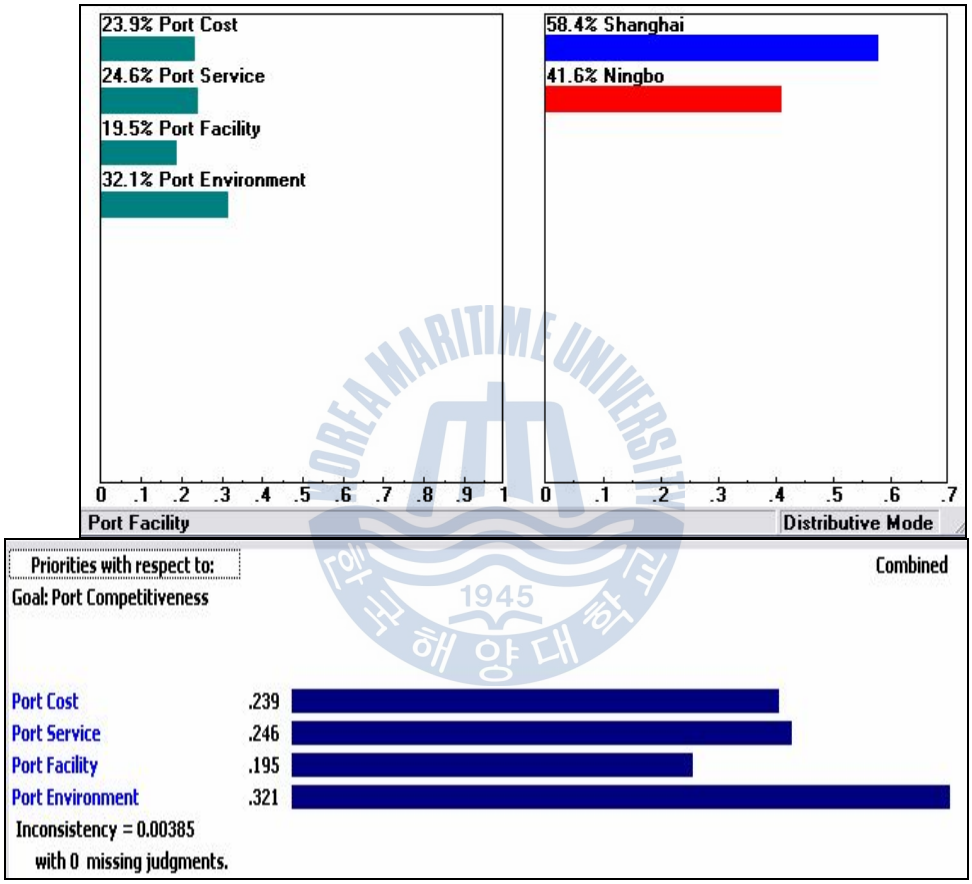
2. Data Analysis

1) Major evaluation factors' Importance Degree

To compare the competition ability between Shanghai and Ningbo-zhoushan port, we made the matrix of relative comparison for decision-making, and use Eigen Value Method to get relative importance among decision-making factors of port selection. The results of the questionnaire of the 4 major evaluation factors are showing as Figure 4-4:

Port Cost (0.239), Port Service (0.246), Port Facility (0.195) and Port Environment (0.321). Also, Shanghai port is 0.584, bigger than Ningbo-zhoushan port 0.416.

FIGURE 4-4: INTENSITY OF IMPORTANCE OF 4 MAIN EVALUATION ITEMS



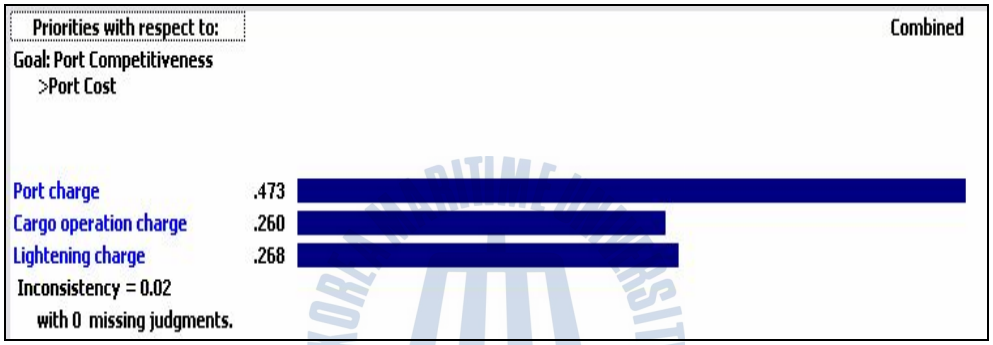
Seen from the analysis of the questionnaire, among the 4 major evaluation factors, port environment was the most important criterion in making the decision, with the significance 0.321, followed by port service and port cost, the factors were weighted 0.246 and 0.239 respectively.

2) Specific Evaluation Factors' Importance Degree

(1) Port Cost

In the port cost item, the 3 factors' importance degrees are showing as Figure 4-5: Port charge (0.473), Cargo operation charge (0.260) and Lightening charge (0.268).

FIGURE 4-5: INTENSITY OF IMPORTANCE OF FACTORS OF PORT COST



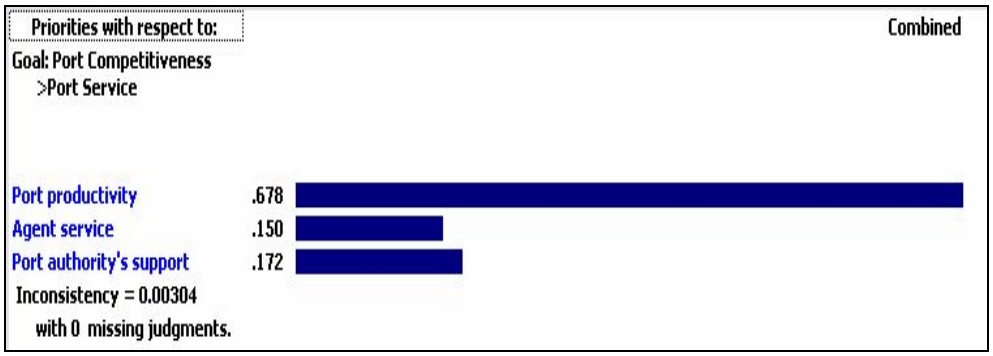
Among 3 factors in port cost, the port charge is with the biggest significance of 0.473, which is almost twice bigger than the other two factors. It perhaps because most of our respondents are operating middle size vessels, the lightening charge only make sense to panamax or capsize even super max vessel, but only 17.4% of the respondents are operating panamax and 4.3% are operating capsize. And the cargo handling charge doesn't make sense to operators who are operating vessels under FI/FO (free in and free out) loading/discharging term, but 82.6% of our respondents are operating vessels under such transport contract.

(2) Port Service

In the port service item, the 3 factors' importance degrees are showing as

Figure 4-6: Port productivity (0.678), Agent service (0.150) and Port authority's support (0.172).

FIGURE 4-6: INTENSITY OF IMPORTANCE OF FACTORS OF PORT SERVICE



Among 3 factors in port service, port productivity is with the biggest significance of 0.678, which is almost 4 time's bigger than the other two factors. It is not hard to understand, because we had explained before, the port productivity stands for the work speed. Speed makes time, and to business man, time is money. If ship owner even doesn't care about the work speed, then what else should they care about? That is, if a business man doesn't care about the money, then why he makes the business?

(3) Port Facility

In the port facility item, the 3 factors' importance degrees are showing as Figure 4-7: Water depth (0.423), Berth condition (0.368) and Cargo handling equipment (0.209).

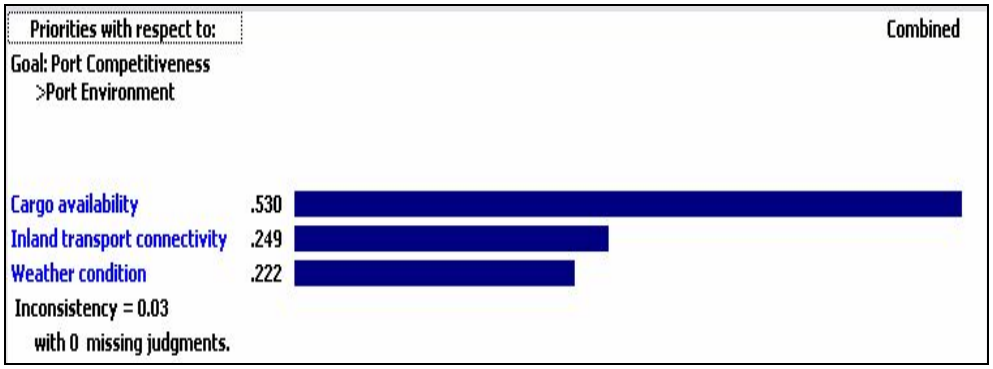
FIGURE 4-7: INTENSITY OF IMPORTANCE OF FACTORS OF PORT FACILITY

Among the 3 factors in port facility, water depth is the No.1 with significance 0.423, but berth condition is also with a high significance of 0.368. Water depth is the basic requirement for vessel to enter the port. Without a satisfying water depth, vessels can not even enter the port, not mention all others. Berth condition is about the port congestion, it is also a good way to save time if vessels can always take berth directly after entering under good berth condition, of course ship owners will prefer such port.

(4) Port Environment

In the port environment item, the 3 factors' importance degrees are showing as Figure 4-8: Cargo availability (0.530), Inland transport connectivity (0.249) and Weather condition (0.222).

FIGURE 4-8: INTENSITY OF IMPORTANCE OF FACTORS OF PORT ENVIRONMENT

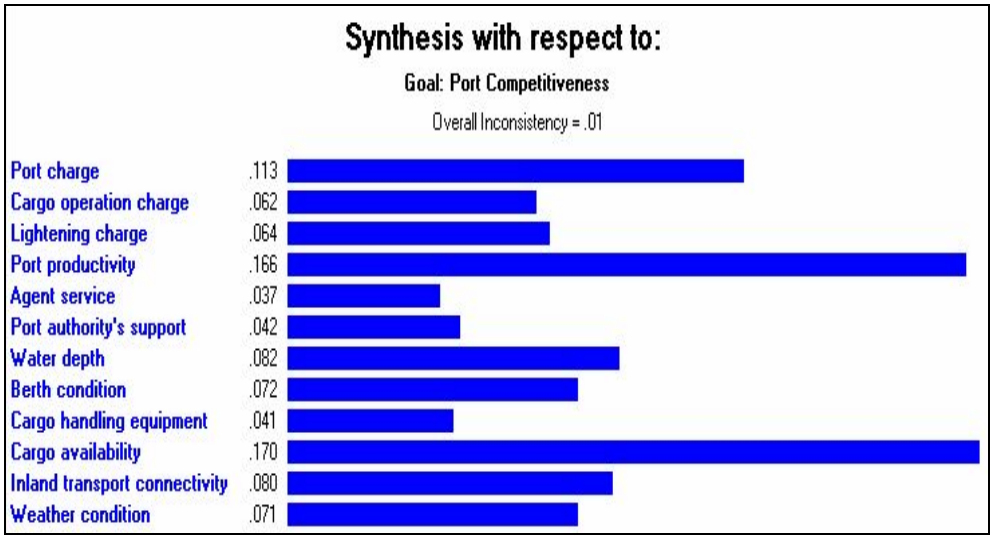


Among the 3 factors in port environment, cargo availability is the most important one with significance of 0.530 which is twice bigger than the other two. As is known to all, in the modern shipping market, ship owner is not the one with highest position any more, vessel always chase after cargo, thus ship owner, they should follow the cargo owner to make sure of the move of vessel, and as well as the backhaul.

(5) Synthesis Importance of all factors

Below Figure 4-9 shows the synthesis importance degree results.

FIGURE 4-9: INTENSITY OF IMPORTANCE OF SYNTHESIS FACTORS



Among all the evaluation factors, cargo availability is the most important criterion in making the decision, with the significance 0.170, followed by port productivity 0.166, and the 3rd one port charge, which is 0.113. Others are more or less the same.

3. Result of AHP analysis

Table 4-5: Synthesis Importance Degree

Type	Detail Items	Significance	Synthesis significance
Port cost	Port charge	S: 0.598	S: 0.576 N: 0.424
		N: 0.402	
	Cargo operation charge	S: 0.547	
		N: 0.453	
	Lightening charge	S: 0.225	
		N: 0.775	
Port service	Port productivity	S: 0.652	
		N: 0.348	
	Agent service	S: 0.623	
		N: 0.377	

	Port authority's support	S: 0.589	
		N: 0.411	
Port facility	Water depth	S: 0.225	
		N: 0.775	
	Berth condition	S: 0.702	
		N: 0.298	
	Cargo handling equipment	S: 0.682	
		N: 0.318	
Port environment	Cargo availability	S: 0.727	
		N: 0.273	
	Inland transport connectivity	S: 0.599	
		N: 0.401	
	Weather condition	S: 0.484	
		N: 0.516	

Through above comparison, we can see that of port charge and cargo handling charge, Shanghai is much cheaper than Ningbo port, but as to the lightening charge, Ningbo is much cheaper. Therefore, to large vessels which need to lighten cargo before entering Shanghai port, Ningbo is a better choice.

For the port service, in general handling is faster and vessels can take berth earlier in Shanghai than Ningbo port, also the port authorities, are more concerned to facilitate the nautical and commercial activities for vessels. For the port facility, Ningbo's water depth is much deeper than Shanghai port, but Shanghai's berth condition and equipments are much better than Ningbo port. For the port environment, Shanghai has more cargo resources and much convenient inland transportation infrastructure. But seeing from

here, we still can not make any decision that which port is better because both of them have their advantages and disadvantages.

Shanghai port is chosen by more owners as a better choice. Among the 4 main categories, port environment is the most important. Cargo availability is the most important among all the specific evaluation factors. It is proved the sentence that in modern shipping industry, ships are not the most important element any more. Ships chase after the cargo, thus ship owner follows the cargo owner.

Another two factors: port productivity and port charge are the 2nd most important ones. Therefore, in ship owner's eyes, the No.1 is cargo, No.2 is speed, and the No.3 is cost.

After the process of comparing Shanghai and Ningbo-zhoushan port in all the specific factors, the final significance of Shanghai port is 0.576, while Ningbo-zhoushan port is 0.424. Most of the ship operators prefer Shanghai port as the first selection for their vessels.

Chapter 5 Conclusion

In Chapter 3, through the theoretical comparison of port condition between Shanghai and Ningbo-zhoushan port, we learnt that Ningbo-zhoushan port's objective condition is much better than the Shanghai port for big bulk vessels. The result analysis of Questionnaire in Chapter 4 revealed that most of the ship owners still prefer Shanghai port to be the better calling port selection. But the question is that how the Ningbo-zhoushan port's cargo throughput could surpass Shanghai port from 2008.

Through the analysis in Chapter 3 and Chapter 4, we assumed that both of the two ports have advantage and disadvantages. Therefore, it is hard to say which port is better easily. But we have analyzed in Chapter 4 that the most important 3 factors influencing the owner's selection of a port are cargo availability, port productivity and port charge. It is understood that the channel depth is the obvious advantage of Ningbo Port. It is a deep water and silt all around year ice-free port, with depth from -4 to -33 meters. But not all of the vessels need so deep water depth. Ningbo benefits from its water depth and thus attracted all the panamax, cape size and even super max to call, following this, the port's cargo throughput raised fast and even surpassed Shanghai port. Due to the restriction of water depth in Shanghai port, it is too difficult to develop bulk cargo industry. Yangshan Port was dug to meet water depth of 15 meters but the problem is "it is only for

Yangshan container." [10]The bulk can only be imported to Shanghai after lightening at Lvhuashan anchorage, which would increase cost as well as transport time.

Now we can get the conclusion as following:
In terms of port charge and cargo handling charge, Shanghai is much cheaper, but as to the lightening charge, Ningbo is much cheaper. Therefore, to normal size vessels, Shanghai is better and to huge vessels which need to lighten cargo before entering Shanghai port, Ningbo is cheaper.

For port service, Shanghai is faster in general handling and vessels can take berth earlier, but Ningbo is faster and professional in bulk cargo's operation. Therefore, to general cargo vessels, Shanghai is better while to big bulk vessels, Ningbo is better.

For port facility, Ningbo's water depth is much deeper than Shanghai port, but Shanghai's berth condition and equipments are much better than Ningbo port. Thus, to normal size vessels, Shanghai is better because Shanghai's water depth is enough for them while Ningbo is better for those who need to navigate in deep waterways.

For port environment, Shanghai has more cargo resources and much convenient inland transportation infrastructure. That's why Shanghai port always attracts ship owners and most of the operators in owner companies choose Shanghai in the questionnaire though Ningbo port also has obvious

[10] http://home.wangjianshuo.com/archives/20060420_visited_yangshan_deep_water_port.htm

advantages. In modern market, ship owner is not the biggest any more, ship owners chase cargo owners, which is to say, ships follow the cargo.

In fact, it can be seen clearly from Shanghai's three ports' planning: Wusong port is for internal trade; Waigaoqiao port to the hinterland and transit cases; Yangshan Port is striving to become an international transit port, there is no bulk planning. It is understood that freight shipping are three main categories: containers, general cargo, bulk, oil and gas (tank) transport, Shanghai basically concentrates in the first two while Ningbo-zhoushan is professionally for the last two, in the import and export, crude oil is the first, at the same time, oil, metal ores, mining and other construction materials and food imports also occupying an important position in China.

Bulk cargo throughput of Shanghai Port has become precisely a soft underbelly while Ningbo-zhoushan port has always been strong in oil, coal, iron ore transport, one positive and one negative, with significant contrast. "Ningbo is stronger than Shanghai in bulk cargo because of its location, Shanghai still enjoys an advantage in containers," one reporter said. "Ningbo Port's business is well balanced. Compared with Shanghai, the busiest port in the country, Ningbo is involved more in crude oil trade while Shanghai takes more advantages in the container business," said Zhang Hui, an analyst at Donghai Securities.

But to small vessels, Shanghai should be the better choice, for its faster work speed, and most important, more cargo resources. Though we had mentioned in Chapter 3 that in Ningbo-zhoushan port's advantages, there is an important point is the traffic. For getting more cargo resources, Ningbo-zhoushan port is trying and already tried many ways to develop its

traffic network. Now it is really convenient for cargo owners to transport cargo from factory to Ningbo port. As Shanghai has been famous for many years, also developed many years, it attracts most brokers and many foreign adventures to make branch in Shanghai port. Thus, still, many business and many contracts are signed with companies in Shanghai. Thus, from 2008, cargo throughput of Ningbo-zhoushan port already exceeded Shanghai port.

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【Questionnaire】

<AN ANALYSIS OF PORT COMPETITIVENESS BETWEEN SHANGHAI AND NINGBO USING AHP

-----FOR GENERAL AND BULK CARRIER>

Good day Sirs.

I'm a student studying in shipping management department for master's degree in Korea Maritime University

I'm writing a paper to choose a better port of call between Shanghai and Ningbo for general and bulk vessels, so as to obtain the highest benefit for ship owners.

Shanghai and Ningbo port's geographical position is so close and with many similar natural conditions and manning strategies as well, the differences are not obvious. Therefore, it is not easy to decide which port to call. This paper is to analyze the different factors ship owners should consider when choose a port of call and make a model by using AHP to figure out which port is a better choice.

The answers of this questionnaire will be only used for doing research, without being disclosed to others. Your serious answer will be a great help to this research.

Thanks again for your kind attention.

05th, Oct, 2010

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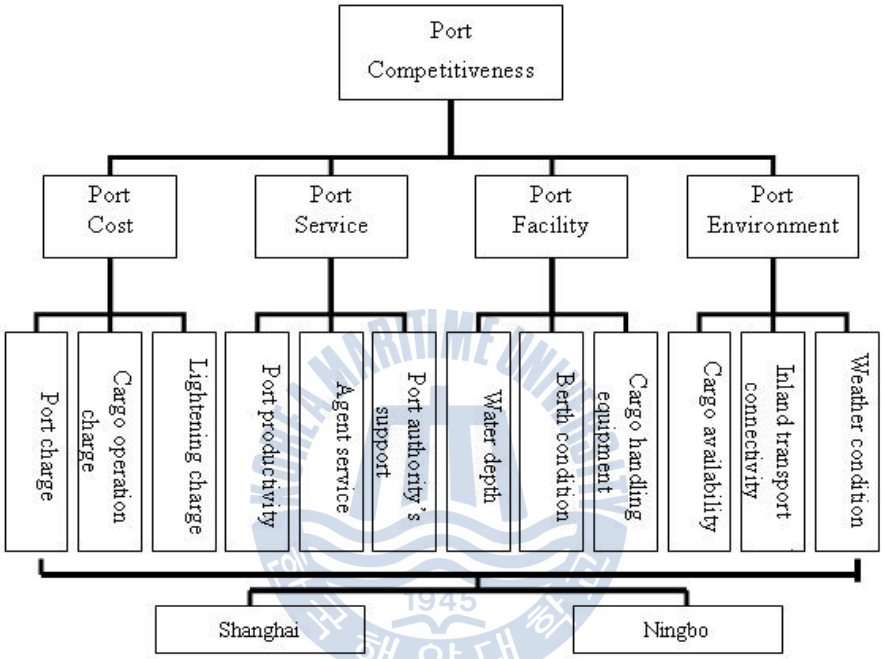
[Terrace structure]



[Specification to the Items]

For evaluating port's competitive ability, we list out 12 specific factors in 4 main items which shows as below chart.

Main items	Specific factors	Contents
Port cost	Port charge	Port due, pilot, tug, line handling, dock, quarantine, agency fee.
	Cargo operation charge	Cargo loading/discharging/lashing/warehouse storing charge
	Lightening charge	Discharge part cargo at anchorage before berthing

Port service	Port productivity	Loading/discharging/cargo turn around speed of different cargo
	Agent service	Port congestion(take berth speed), Night navigation availability
	Port authority's support	PSC inspection/ Cooperation attitude/ Informatization level
Port facility	Water depth	Draft restriction to vessel's DWT
	Berth condition	Includes berth length and berth numbers.
	Cargo handling equipment	Shore crane/Floating crane/Grab/Convey belt/fork lift-Capacity & Numbers/work shifts
Port environment	Cargo availability	Cargo resources from factories, brokers.
	Inland transport connectivity	Highway, railway, bridge connect to cargo factories from port
	Weather condition	Rainy season/Typhoon

[Example]

This research is made to collect advices on the importance intensities of the factors which considered influence the port's competitive ability by using pairwise comparison.

For example, it is considered to be “moderate importance” of "Port cost" between “Port cost” and “Port service”, so make a remark under the corresponding importance degree like below.

Standard	Important←----------Same----------→Important																	Standard
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Port cost							○											Port

[Standard of Importance intensity]

Below are the scales of importance intensity for evaluating.

Importance	Definition
1	equal importance
3	moderate importance
5	strong importance
7	very strong importance
9	absolute importance
2, 4, 6, 8	importance degrees are in the middle of above scales

[Questionnaire]

< Research on answerers >

Work place	a, Korean ship owner b, Chinese ship owner c, Harbor master
Department	a, Operation department b, Business department c, Others
Position	a, Manager b, Vice manager c, Staff
Vessel size	a, Mini-bulkers b, Handysize c, Handymax d, Panamax e, Capesize
Load/disch term	a, FIFO b, FIBT c, BTBT

1. Please make a remark below the corresponding importance intensity in every line based on comparison between every 2 of the 4 items (Port cost, Port service, Port facility, Port environment).

Standard	Important←----------Same----------→Important																Standard
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Port cost																		Port service

Port cost																	Port facility
Port cost																	Port environment
Port service																	Port facility
Port service																	Port environment
Port facility																	Port environment

2. Please make a remark below the corresponding importance intensity in every line based on comparison between every 2 of the three factors “Port charge”, “Cargo operation charge" “Lightening charge” in item ‘‘Port cost’.

Standard	Important←----------Same----------→Important																Standard
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Port charge																		Cargo operation charge
Port charge																		Lightening charge
Cargo operation charge																		Lightening charge

3. Please make a remark below the corresponding importance intensity in every line based on comparison between every 2 of the three factors “Port

productivity", "Agent service" "Port authority's support" in item 'Port service'.

Standard	Important←----------Same----------→Important																	Standard
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Port productivity																		Agent service
Port productivity																		Port authority support
Agent service																		Port authority support

4. Please make a remark below the corresponding importance intensity in every line based on comparison between every 2 of the three factors "Water depth" "Berth condition", "Cargo handling equipment" in item "Port facility".

Standard	Important←----------Same----------→Important																	Standard
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Water depth																		Berth condition
Water depth																		Cargo handling equipment
Berth																		Cargo

condition																	handling equipment

5. Please make a remark below the corresponding importance intensity in every line based on comparison between every 2 of the three factors “Cargo availability”, “Inland transport connectivity” “Weather condition" in item ‘Port environment’.

Standard	Important←----------Same----------→Important																Standard
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Cargo availability																		Inland transport connectivity
Cargo availability																		Weather condition
Inland transport connectivity																		Weather condition

6. Please make a remark below the corresponding importance intensity in every line based on pairwise comparison between every 2 of all the major evaluations and all factors which considered important and influence the competitive ability between Shanghai and Ningbo port.

Standard	Important←----------Same----------→Important	Standard

	t																	
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Shanghai																		Ningbo
Shanghai																		Ningbo
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- Thank you -