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Analysis of Shanghai Port's competitiveness after the operation of Yangshan Deep-water Port

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ANALYSIS OF SHANGHAI PORT'S COMPETITIVENESS AFTER THE OPERATION OF YANGSHAN DEEP-WATER PORT

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me,

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **Analysis of Shanghai Port's Competitiveness after the Operation of Yangshan Deep-water Port**

Degree: **Mater of Science in International Transport and Logistics**

It is well-known that China is a significant player in global shipping and trade. As a result of rapid growth of the country's foreign trade, China's transportation infrastructure is not sufficient for the scale of current shipping operations.

As the largest seaport in China, Shanghai Port has 16 international lines connecting with 500 foreign ports in more than 200 countries. The Port of Shanghai is experiencing explosive growth rates, averaging 29% per year in the last three years. This growth is driven by accelerated export demand, stemming from increasing world trade in general. In spite of these impressive numbers, Shanghai's port development remains constrained by problems, say the water depth of the Huangpu River and Yangtze River estuary is 7-8 meters, which definitely can not meet the requirements of the third and fourth generation container ships. Fortunately, Shanghai found the solver – Yangshan Island, where water depths average at least 15 meters, and as a result, fifth and sixth generation container ships can come and go freely.

In this dissertation, firstly I will build an evaluation model by Structural Equation Modeling (SEM) in order to evaluate Shanghai port's competitiveness, comparing with other competitors, say, Hongkong port and Pusan port. After that, I will analyze the results of evaluation further, and try to give some suggestions and solutions to improve Shanghai port's competitiveness.

KEYWORDS: Shanghai port, Port competitiveness, Yangshan deep-water port, Development strategy, Structural Equation Modeling (SEM)

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LIST OF ABBREVIATIONS

CO	Corporation
TEU	Twenty-Feet Equivalent Units
DWT	Dead Weight Tonnage
GDP	Gross Domestic Product
US	United States
WTO	World Trade Organization
EU	European Union
S&P	Sales and purchases

1. Introduction

1.1 Background of research

It is well-known that, at present, China plays a significant role in global trade. The latest report from WTO on April 12th, 2007, *'Risks lie ahead following stronger trade in 2006'*, shows that China is the third largest exporter of the world, with the total value of US $969 billion, accounting for 8% of the world total. At the same time, its total value of imports reached US $792 billion, which makes china a central player in managing global trade flows. The above recent rapid growth of China's foreign trade has resulted in a parallel development of its domestic shipping industry.

As the largest seaport in China, Shanghai Port has 16 international lines connecting with 500 foreign ports in more than 200 countries. Chinese government have already decided a national strategy for Shanghai in early 90's, that is to build Shanghai into an "International Economic, Financial, Trade and International Shipping Center" in the coming decades. However, to achieve these national targets especially the international shipping center part, Shanghai port, compared to other mega-ports in the world, still has a long way to go, according to its natural limitation.

On September 25th, 2005, the first phase of Shanghai international shipping center Yangshan deep-water port was finally put into operation, which includes a port proper, an over-sea bridge and a supplementary operation area at the Luchao Port. It is designed to handle an annual 2.2 million TEUs (20-equivalent-feet) with its five berths and 1600-meter-long dock.

Subsequently, On December 10th, 2006, construction of the second phase of Shanghai's Yangshan Deep-Water Port is completed and put into use. The 1400-meter-long dock, installed with 16 container bridge cranes, provides an annual handling capacity of over 2.5 million TEUs.

1.2 Subject description

1.2.1 What to research

In this dissertation, I will briefly introduce the project of Yangshan deep-water port, evaluate Shanghai port's competitiveness after the operation of Yangshan deep-water port, comparing with other two ports- Hangkong and Pusan, and try to give some suggestions and solutions to improve Shanghai port's competitiveness.

There are two main points I will discuss in detail:

1. The influence of the project on Shanghai port's competitiveness

There is no doubt that Shanghai port has significantly increased its competitiveness in the shipping market after the opening of Yangshan deep-water port. However, as the rapid growth of China's economy has brought millions of cargo waiting to be handled and transported, other ports in this region are also trying their best to get them. Therefore, the competition during the north-east Asia region will definitely be extraordinary fierce.

Under this situation, from my point of view, we should focus our attentions on the question that if Shanghai port can gain a competitive advantage compared to the other mega-ports, especially its main competitors in the north-east Asia. Therefore, I will pick up three main ports in north-east Asia, say Hongkong port, Pusan port, Shanghai port (With Yangshan port), and evaluate their port competitiveness respectively in this dissertation. At the same time, in order to reflect the influence of this project, I will also evaluate the situation of Shanghai port before the operation of Yangshan deep-water port. Thus finally I will choose four ports as evaluation targets, i.e. Hongkong port, Pusan port, Shanghai port (With Yangshan port) and Shanghai port (Without Yangshan port), build an evaluation model of port competitiveness and evaluate these port's competitiveness by using the SEM(Structural Equation Modeling) method.

2. How to improve Shanghai port's competitiveness

After the evaluation of Shanghai port's competitiveness, we will find Shanghai port's competitive advantages and disadvantages in the competition of north-east Asia. According to the results of this evaluation, I will analyze further, and try to find some suggestions and solutions to improve Shanghai port's competitiveness.

1.2.2 Why to research

Yangshan port project in Shanghai is one of the largest port projects currently in the world. In other words, it is a very hot topic in the world. As the third big ports in the world, how Shanghai port performs in the new stage with its brand-new deep-water port has been concerned by lots of people. Meanwhile, as I said before, can Shanghai port gain a competitive advantage compared to the other mega-ports, especially its main competitors in the north-east Asia becomes a significant problem. Its port competitiveness, as a result, must be evaluated carefully.

After the analysis of Shanghai port's competitiveness, how to use and analyze the results of the evaluation becomes the second question. I will try to find the main advantages and disadvantages of Shanghai port after the operation of Yangshan deep-water port and find some suggestions and solutions to improve Shanghai port's competitiveness.

1.2.3 How to research

See Figure 1: 'Paper structure' on page 9.

1.3 Literature review

Research on port competitiveness was mainly started from early 60's of the last century. Before that, there were just some unsystematical researches conducted by several economists and just focused on the relationship between seaborne transportation and ports mostly.

The first research model of port development was founded by an English geographer Bird (1963). He created the 'Any port model' which described how port infrastructures evolve in time and space. Based on his research into the evolution of British ports, Bird proposed a five stage model to demonstrate how facilities in a typical port develop. Starting from the initial port site with small lateral quays adjacent to the town center, the elaboration of wharfs is the product of evolving maritime technologies and improvements in cargo handling. This is also marked by changing spatial relationships between the port and the urban core, as docks are built further away from the central business district. In the final stages, increased specialization of cargo handling, growing sizes of ships, and ever increasing demands for space, for cargo-handling and storage results in port activity being concentrated at sites far removed from the oldest facilities. Port infrastructures are thus constructed over several decades and in some case over several centuries.

Numerous researchers have discussed the development of the port system, with particular focus on load-centers. Ports designated load-centers are similar, for carriers, to hub airports for airlines. Carriers would focus larger vessels at the load-center to minimize the calls made by these vessels. Feeder vessels or inland modes would then distribute traffic between the load center and either feeder ports or inland locations. Ports could compete to be designated as a carrier's load-center.

In addressing the competition between ports, Kenyon (1970) focused on the Port of New York's advantage. He argued that demand from the population of New York resulted in more vessel calls. The increased traffic led to increased port development, which then led to more traffic, and so on. He suggested that the cycle would continue to increase a port's attractiveness until potential capacity was exceeded. Thus external characteristics are advantageous, particularly in seeking load-center status; local (at that time captive) population is one characteristic.

Al-Kazily (1979) compared a feeder system, in which only the hub port's facilities could accommodate larger vessels, to a traditional port system. In a study of the Arabian Gulf, she combined a vessel cost function with traffic projections to determine the efficiency of a feeder system, in which the feeder vessels represent spokes from the hub. This system may be different in the United States, where surface transportation represents the spokes, but the proposed hierarchical relationship between ports is important.

Foggin et al. (1985) explained the development of load-centers as an effect of deregulation. With the development of load centers, ports' hinterlands disappeared. Shippers focused on the door-to-door package, and carriers concentrated services along particular routes to exploit economies-of-scale and density. Hayut (1981; 1991) and Foggin each describe qualitatively characteristics that allow one port to become a region's load-center. These characteristics mirror results from stated-preference surveys, with one obvious characteristic a large population.

Slack (1996) discussed carriers' roles in the development of load-centers. He emphasized the vulnerability of smaller ports in the era of larger vessels. He suggested that smaller ports could be hindered more by the need for intense technological investment for containerization.

Helmick (1994) examined whether voyages had become more concentrated as the load-center concept projected. Using data from the US Census, he examined three hypotheses:

i) that traffic was becoming concentrated along routes,

ii) that traffic was becoming concentrated among ports, and

iii) that network connectivity was decreasing as carriers called at fewer ports

Not one hypothesis was consistently accepted. To explain this, Helmick suggested that three types of carriers existed. The first possessed modernized equipment and followed the hypothesized patterns. The second type was less modern but still followed the patterns of the first carrier. The third type of carrier, however, was represented by tramp lines and filled the lanes vacated by other carriers. He suggested that researchers address the differing behavior of carriers.

In China, researches on port competitiveness started later. In 1980, Chinese domestic economist began to treat port economics as a separated subject, and have published some books and researches then. Ma zongwu's 'Port Economics', Huang daming and Chen fuxing's 'Port Economics' and Zong peihua's 'Port Strategy' are very famous.

In 1990, Shanghai Maritime University summarized 6 main factors in relation to the port competitiveness:

Geographic factor

Inland transport factor

Port service and efficiency factor

Price factor

Social economy factor

Information system factor

The ministry of communications of china had published a research on port development. It introduced a new system: Integrated Port Development Factor System (IPDFS), which included several factors that would influence the development of ports. They are port layout and design, port management, Container throughput, port infrastructures, port logistics, port economy index, maintenance system, port security, information system, and customer service.

From the above literature review, we can find that port competitiveness is still a new and important problem. Nowadays, due to its complicated influencing factors, researches on that field are not very completed. Therefore this dissertation will conduct a deeper research on port competitiveness and try to evaluate Shanghai port's competitiveness and find some solutions to increase Shanghai port's competitiveness.

1.4 Paper structure

Figure 1 shows the framework of my dissertation and the basic methodologies I used in it.

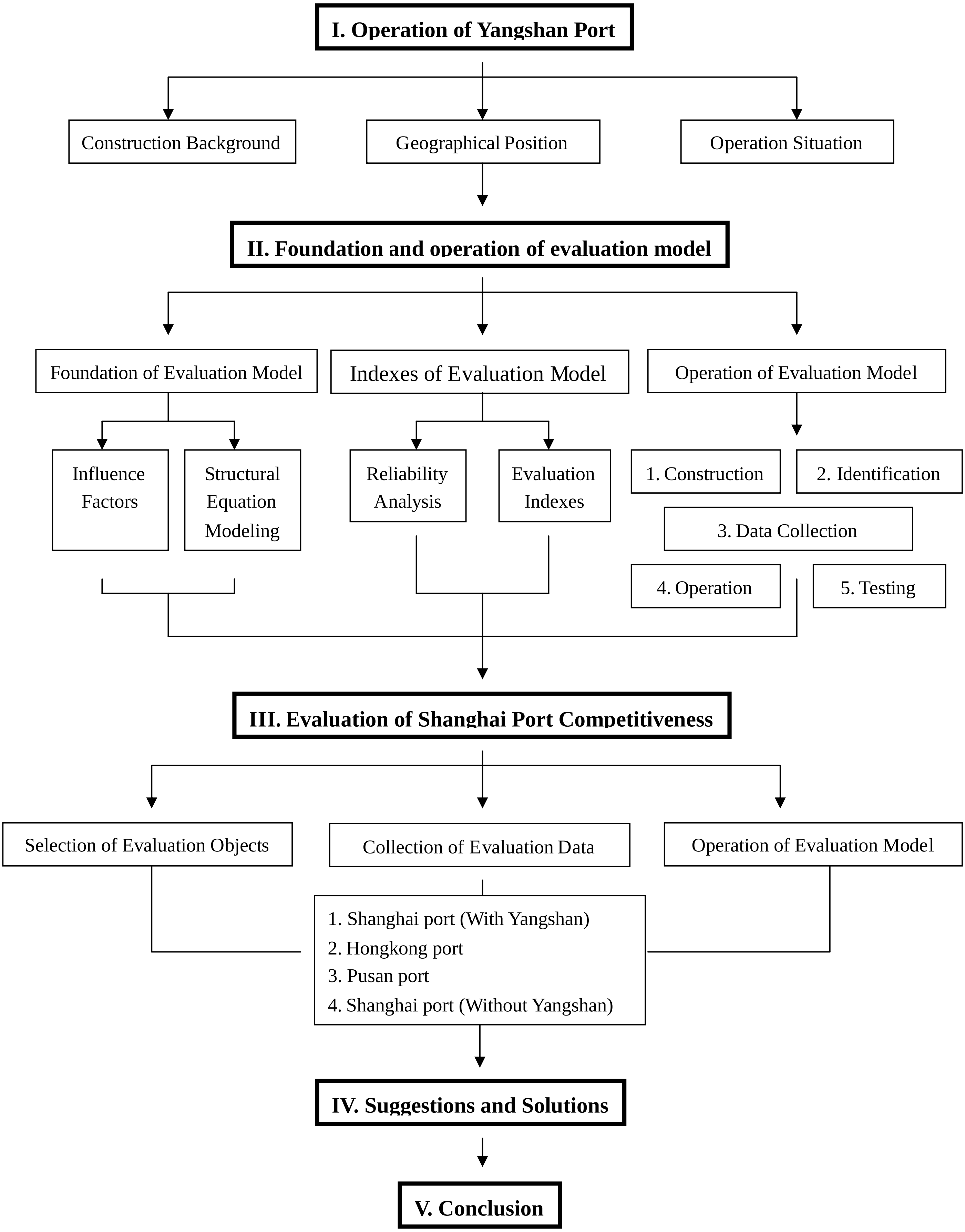

Figure 1 - Paper structure

2. Operation of Yangshan deep-water port

2.1 Construction background of Yangshan port

As the largest seaport in China, Shanghai Port has 16 international lines connecting with 500 foreign ports in more than 200 countries. Chinese government have already decided a national strategy for Shanghai in early 90's, that is to build Shanghai into an "International Economic, Financial, Trade and International Shipping Center" in the coming decades. At present, Shanghai has a strong hinterland economy, a strategic geographical position, large flows of cargo and container transportation, and a high density of international shipping lines, all of which imply a bright future economic growth. However, in spite of these impressive factors, to achieve the national target especially the international shipping center part, Shanghai port, compared to other mega-ports in the world, still has a long way to go. Nowadays, Shanghai's port development remains constrained by two significant problems:

1. The water depth of the Yangtze River estuary (entrance to sea) is 7 meters, which means the third and fourth generation container ships only have access at high tide.

2. The water depth of the Huangpu River in Shanghai is 7-8 meters and the river is too narrow for larger ships. As a result, container ships cannot maneuver freely.

Fortunately, Shanghai Municipal Government (SMG) has measured that at Yangshan Island in the East China Sea water depths average at least 15 meters, and as a result, fifth and sixth generation container ships can come and go freely. The topography of the area provides natural shelter from the typhoon belt. With these findings and the support of China's central government, it was decided to build a new deep water port at Yangshan Island.

On September 25th, 2005, the first phase of Shanghai international shipping center Yangshan deep-water port was finally put into operation, which includes a port proper, an over-sea bridge and a supplementary operation area at the Luchao Port. It is designed to handle an annual 2.2 million TEUs (20-equivalent-feet) with its five berths and 1600-meter-long dock.

Subsequently, On December 10th, 2006, construction of the second phase of Shanghai's Yangshan Deep-Water Port is completed and put into use. The 1400-meter-long dock, installed with 16 container bridge cranes, provides an annual handling capacity of over 2.5 million TEUs.

2.2 Geographical position of Yangshan port

Yangshan deep-water port is near the mouth of the Yangtze River and at the very mouth of the Hangzhou Bay. It is about 27.5 kilometers southeast to the Luochao Port and 104 kilometers from the international shipping route. The sketch of Yangshan port is shown in Figure 2.

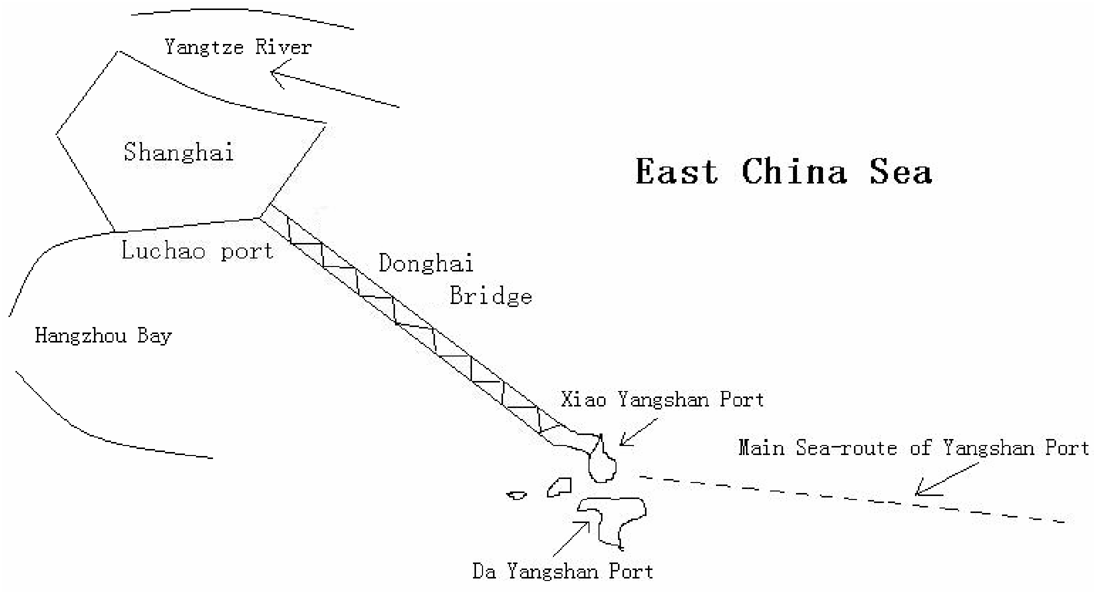

Figure 2 - The sketch of Yangshan port

In addition to completing the five shipping berths, Phase 1 of the project also includes the Donghai Over-sea Bridge which is 32.5 km long and connects the Port Operation Area with the shore. It was designed in accordance with international standards on two-way, six-lane expressways and spans 31.5m. There is a maximum posted driving speed of reach 80 km/ per hour. Besides, there are also supplementary projects which include Luchao Port Supporting Area and other projects related to the overall planning of the Yangshan Deepwater Port Operation Area.

2.3 Operation situation of Yangshan port

The Yangshan port project was commenced in 2002. It is a unique port as it is built on an isolated island over 30 km from the mainland. By December of 2005, the first phase of the project had already been completed. Five, seventy to one hundred thousand tonnage berths have come into operation, and the world newest generation of super-Panamax containerships are able to anchor in the new facilities. The dock is

1600 meters long, and 18 container bridge cranes have been installed, with an annual handling capacity of over 2 million TEUs and a total land area of 21.53 km. These dimensions and the location of the port mean that the world's biggest container ships may be received under any climatic conditions for anchorage and loading operations

The first phase of Yangshan deep-water port operated smoothly and efficiently till now. In 2006, Yangshan deep-water port handled over 3 million TEUs, which is 37.3% more than the designed capacity and had 3,775 vessels berthed in the dock.

Subsequently, On December 10th, 2006, construction of the second phase of Shanghai's Yangshan deep-water port is completed and put into operation. The 1400-meter-long dock, installed with 16 container bridge cranes, provides an annual handling capacity of over 2.1 million TEUs. As reported, the third phase of Yangshan deep-water port will be finished in 2010, with 2650-meter dock and 7 berths.

Nowadays, Yangshan deep-water port, with its 3000-meter dock and 9 berths, provides over 500 million TEUs for Shanghai, which will definitely help Shanghai to achieve its national strategy, to build Shanghai into an 'International Economic, Financial, Trade and International Shipping Center' in the coming decades.

3. Foundation of evaluation model of port competitiveness and its operation process

There is no doubt that Shanghai port has significantly increased its competitiveness in the shipping market after the opening of Yangshan deep-water port. However, as the rapid growth of China's economy has brought millions of cargo waiting to be handled and transported, other ports in this region are also trying their best to get them. Therefore, the competition during the north-east Asia region will definitely be extraordinary fierce.

Under this situation, our attentions should be focused on the question that if Shanghai port can gain a competitive advantage compared to the other mega-ports, especially its main competitors in the north-east Asia. Therefore, in order to evaluate Shanghai port's competitiveness after the operation of Yangshan deep-water port, in this chapter, a port competitiveness evaluation model will be founded. Weight of each evaluation index, which will be used in chapter 4 in order to compare competitiveness of Shanghai port and its main competitors in the north-east Asia, will also be determined in this chapter through using SEM (Structural Equation Modeling) method.

3.1 Foundation of evaluation model of port competitiveness

3.1.1 What is Structural Equation Modeling (SEM)

As David Garson said in 'Structural Equation Modeling', '*Structural equation modeling, or SEM, is a very general, chiefly linear, chiefly cross-sectional statistical* *modeling technique. The goal of SEM is to determine to what extent the theoretical model is supported by sample data.'*

SEM has a language all its own. Independent variables, which are assumed to be measured without error, are called exogenous or upstream variables; dependent or mediating variables are called endogenous or downstream variables. Manifest or observed variables are directly measured by researchers, while latent or unobserved variables are not directly measured but are inferred by the relationships or correlations among measured variables in the analysis.

SEM uses multiple regression and factor analysis models to describe relationships among observed and unobserved variables. It is a combination of path analysis and confirmatory factor analysis. Path analysis is an extension of the regression analysis. A path model allows for multiple independent observed variables and multiple dependent observed variables and tests more complex models than regression models. Confirmatory factor models consist of observed variables that are hypothesized to measure one or more latent variables.

In SEM, interest usually focuses on latent constructs - abstract psychological variables like "intelligence" or "attitude toward the brand" - rather than on the manifest variables used to measure these constructs. A structural equation model implies a structure of the covariance matrix of the measures (hence an alternative name for this field, "analysis of covariance structures"). Once the model's parameters have been estimated, the resulting model-implied covariance matrix can then be compared to an empirical or data-based covariance matrix. If the two matrices are consistent with one another, then the structural equation model can be considered a plausible explanation for relations between the measures.

3.1.2 Why use SEM to evaluate port competitiveness

1. More sophisticated models of relationships are needed

Basic statistical methods only utilize a limited number of variables, which are not capable of dealing with the sophisticated theories being developed in behavioral science. The use of a small number of variables to understand complex phenomena is limiting. SEM permits complex phenomena in behavioral science to be statistically modeled and tested. SEM techniques are therefore becoming the preferred method for confirming (or disconfirming) theoretical models in a quantitative fashion.

2. Models that take into account measurement errors are needed

Researchers are becoming more aware of the need to use multiple observed variables to better understand their area of scientific inquiry and the study of some abstract phenomena (constructs) and they recognize more the importance of validity and reliability of observed scores obtained from measurement instruments. Measurement error has become a major issue in many disciplines, but measurement error and statistical analysis of data have been treated separately. SEM techniques explicitly take measurement error into account when statistically analyzing data.

Nowadays, lots of researches about port competitiveness are based on subjective evaluation. Even in some measurable data analysis, the evaluation of port competitiveness is still affected by many subjective factors because the weight of every evaluation indexes is determined by the survey from experts subjectively.

In this dissertation, SEM evaluation model will be used to evaluate the port competitiveness especially to determine the weight of every evaluation indexes based on objective data in recent years. It will effectively avoid the subjective factors affecting the research.

3.1.3 SEM evaluation model of port competitiveness

SEM expressions of evaluation of port competitiveness are listed as follows:

$$\begin{cases} \eta = \mathrm{B}\eta + \Gamma\xi + \zeta \\ y = \Lambda_y \eta + \varepsilon \\ x = \Lambda_x \xi + \delta \end{cases}$$

Meanings of each letter in the SEM expressions are listed in Table 1

Table 1 - Meanings of each letter in the SEM expressions

Letter	Meanings
η	Vector $m*l$, endogenous variable
ξ	Vector $n*l$, exogenous variable
y	Vector $p*l$, observed variable of η
x	Vector $q*l$, observed variable of ξ
ζ	Vector $m*l$, random error
ε	Vector $p*l$, error of y
δ	Vector $q*l$, error of x
B	Vector $m*l$, coefficient of η
Γ	Vector $m*l$, coefficient of ξ

Λx	Vector $p*l$, regression coefficient of x in η
Λy	Vector $q*l$, regression coefficient of y in ξ

Exogenous variables are assumed to be measured without error, dependent or mediating variables are called endogenous variables.

Observed variables are directly measured by researchers. Unobserved variables are not directly measured but are inferred by the relationships or correlations among measured variables in the analysis.

In the port competitiveness evaluation model:

Endogenous variable 'η' means some unmeasurable indexes;

Exogenous variable 'ξ' means port competitiveness;

'y', observed variable of η, means observed indexes of some unmeasurable indexes;

'x', observed variable of ξ, means observed indexes that most related to port competitiveness.

Till now, foundation of evaluation model of port competitiveness has been basically done. The next step is to determine the evaluation indexes and operate the model following underlying processes:

1. List influence factors of port competitiveness
2. Analyze reliability of above evaluation indexes
3. Determine final indexes of port competitiveness evaluation model
4. Model Construction
5. Model Identification
6. Model Operation
7. Model Testing

8. Model Modification.

3.2 Indexes of evaluation model of port competitiveness

3.2.1 Influence factors of port competitiveness

In this dissertation, the main evaluation object is Shanghai port. Therefore, the factors related to port competitiveness of mega container port will be focused on.

The influence factors of port competitiveness include:

1. Natural Condition

Natural condition factor includes the deep-water berth condition and the depth of waterway, and the influence on the port from weather, say, tide, frost and so on.

Nowadays, the tendency of vessel-enlargement makes the situation of international container transportation changed dramatically. The fifth and sixth generation container ships are now sailing on the main sea-routes all over the world. At the same time, smaller ships are more and more used in feeder lines or unpopular main lines. Due to this above situation, the depth of waterway and the deep-water berth condition in a port seems increasingly important for shipping. Therefore, lots of mega-ports in the world recently has built many deep-water berths and waterways over 14 or 15 meters and broad port area and anchor ground in order to provide service for the fifth and sixth generation container ships and to compete for becoming a pivot port. Possessing of excellent natural conditions will make a port extremely competitive in the fierce competition.

Besides, the daily operation of a port will also be affected by weather of this area.

For instance, some ports in north of China sometimes stopped working because of frost, and some ports in south sometimes attacked by typhoon. Fog and tide are also influence factors. The influence on the port from weather can be reflected directly from the operating days of a port per year.

2. Port Operating Environment

Port Operating Environment factor includes hinterland economy (GDP), hinterland foreign trade value, shipping market conditions, and situation of intermodal transportation.

The main function of a port is always to provide services for customers who need to transport cargo. Accordingly, economy situation of a port's hinterland is decisive to some extend. In other words, the better hinterland economy is, the more cargo throughput of a port will be, and vice versa. The situation of a port's hinterland economy will be evaluated by the gross domestic product (GDP) of this area.

International port provides service for foreign trade, thus, only the number of hinterland's GDP can not reflect the cargo throughput situation of a port completely. In China, more than 80% of foreign trade cargoes are transported by sea. Therefore, foreign trade value is very closely connected with shipping as well, and hinterland foreign trade value of a port is also an important factor of port competitiveness.

In this dissertation, shipping market conditions consists of new building market, second-hand sale and purchase market, chartering market, freight forward market, shipping agent market and shipping insurance and financial market. In fact, a cargo owner often considers shipping market of a port as a significant factor when he chooses export port. For example, he will check if there are convenient freight forwarder companies, in-time liners, insurance companies and so forth. Meanwhile, a shipping company will consider these factors seriously before they choose ports of call as well. Therefore, shipping market condition is a significant factor to port competitiveness.

Good condition of intermodal transportation of a port will definitely help to cut the cost of every single round of transportation, which means a port with convenient intermodal transportation condition will be more attractive and competitive than others. Situation of intermodal transportation of a port, therefore, should be considered when evaluating port competitiveness.

3. Port Management

Port management condition consists of efficiency of loading and discharging, port convenience level and port service level.

Normally, the efficiency of loading and discharging determines berthing time directly. After the development of large vessel, cost per time unit of a huge container ship is increasingly high. Accordingly, a large vessel always try to choose ports of call with high efficiency of loading and discharging, which will lead to less berthing time, more operating time and high availability of a vessel.

Port convenience level reflects the level of port management directly. It is related to the port policies. It can be evaluated by three aspects: free port policy for international transshipment, policy for domestic transshipment, and local export and import policy.

Port, as a service unit, needs to achieve a high level of customer satisfactory.

Apparently, the service level of a port is also concerned by both ship owner and cargo owner. Thus, it should be involved in the port management evaluation factor.

4. Port Infrastructure

In this dissertation, I choose designed throughput capacity of a port and its proportion of deep-water berth to reflect the situation of port infrastructure.

Physically, port infrastructure includes the number of container berths, designed throughput capacity of each berth, loading and discharging facilities, container yard facilities and so on. However, all these above infrastructures can be reflected by the number of designed throughput capacity per year finally. Thus, designed throughput capacity of a port is the first part of port infrastructure evaluation.

When there is not so much difference between two ports, the proportion of deep-water berth can affect the port efficiency largely. A port with higher proportion of deep-water berth is definitely operating with lower loading and discharging cost and management cost.

5. Shipping Condition

Shipping condition here mainly contains liner service frequency per month and sea route coverage.

Basically the more frequent liner service is and the more area its sea routes cover, the more attractive and competitive a port will be.

According to the above analysis, the indexes of port competitiveness evaluation model are basically determined showed in Table 2. It will be further discussed in the next paragraph.

Table 2 - Evaluation Indexes of Port Competitiveness

	B	C
Port Competitiveness	Natural Condition	Depth of waterway
		Operating days per year
	Port Operating Environment	Hinterland economy (GDP)
		Hinterland foreign trade value
		Shipping market condition
		Intermodal transportation
	Port Management	Cargo handling efficiency
		Port convenience level
		Port service level
	Port Infrastructure	Designed throughput capacity
		Proportion of deep-water berth
	Shipping Condition	Liner service frequency
		Sea route coverage

3.2.2 Reliability Analysis of evaluation indexes of port competitiveness

As UT Austin said in ‘Structural Equation Modeling using AMOS’, *‘reliability is the correlation of an item, scale, or instrument with a hypothetical one which truly* *measures what it is supposed to.'* There are many ways to analysis reliability, in this dissertation, I will choose the most typical way, say, internal consistency: estimation (Cronbach's alpha), which is based on the correlation among the variables comprising the set.

3.2.2.1 Experts survey

Table 3 - Importance of different factors to port competitiveness

Num.	Factors	Importance
C1	Depth of waterway	
C2	Operating days per year	
C3	Hinterland economy (GDP)	
C4	Hinterland foreign trade value	
C5	Shipping market condition	
C6	Intermodal transportation	
C7	Cargo handling efficiency	
C8	Port convenience level	
C9	Port service level	
C10	Designed throughput capacity	
C11	Proportion of deep-water berth	
C12	Liner service frequency	
C13	Sea route coverage	

Note: Please use '1, 2, 3, 4, 5, 6, 7' to evaluate the importance of different factors to port competitiveness. '1' means it has nothing to do with port competitiveness, '3' means there is a little connection between, '5' means they are connected to some extend, '7' means it is closely related to port competitiveness. '2, 4, 6' are in between of them respectively.

25 Survey sheets were sent to different experts, and 20 effective answer sheets were received. Thus, the rate of effective answer sheet is 80%. The 20 experts include 8 experts from Shanghai Shipping Exchange who have focused on researching shipping for years, 5 from Shanghai International Port (Group) Co., Ltd. who are very familiar with Shanghai port and other ports' situation. The other 7 from different shipping companies respectively: COSCO, China Shipping, Far East Shipping, and Hua Mao Freight Forward Company. Here is the result of the survey in table 4.

Table 4 - Result of 'factors' importance' survey

C1	***C2***	***C3***	***C4***	***C5***	***C6***	***C7***	***C8***	***C9***	***C10***	***C11***	***C12***	***C13***
7	5	7	6	7	6	6	7	3	6	6	6	6
7	4	7	6	6	6	4	6	4	6	5	5	6
7	4	7	5	6	5	5	6	5	5	5	5	5
7	4	7	5	6	6	5	5	3	5	6	5	5
7	5	7	6	7	6	6	7	3	6	6	6	6
6	4	6	6	6	6	4	6	4	6	5	5	6
6	4	7	5	6	5	5	6	5	5	5	5	5
7	4	7	6	6	6	5	5	3	5	6	5	5
7	5	7	6	7	6	6	7	3	6	6	6	6
6	4	6	6	6	6	4	6	4	6	5	5	6
6	5	6	4	5	4	5	5	3	4	4	5	6
7	4	6	6	6	4	4	6	4	6	5	5	6
7	6	7	6	6	5	5	6	5	5	5	5	5
7	4	7	6	6	6	5	5	3	5	6	5	5

6	4	7	4	5	5	5	6	5	4	5	5	5
7	5	7	6	6	6	5	5	3	5	6	5	5
7	3	7	6	7	5	6	7	3	6	6	6	6
6	3	6	6	6	6	4	6	4	6	5	4	5
7	4	7	6	6	5	5	6	5	5	5	5	5
6	4	6	5	6	5	4	5	6	5	4	4	4

3.2.2.2 Result of Reliability Analysis

Cronbach's alpha is the most common form of internal consistency reliability coefficient. Alpha equals zero when the true score is not measured at all and there is only an error component. Alpha equals 1.0 when all items measure only the true score and there is no error component.

By convention, a lenient cut-off of 0.60 is common in exploratory research; alpha should be at least 0.70 or higher to retain an item in an ‘adequate’ scale; and many researchers require a cut-off of 0.80 for a ‘good scale’.

After that, I will try to delete each item respectively to see if delete one of them can improve the alpha level and according to that to decide the final indexes of evaluation model.

After running the computer software SPSS V.13.0[1], I got the results of reliability analysis in Table 5 and Table 6.

[1] SPSS is a statistical analysis software from SPSS co., Ltd.

Table 5 - Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.749	0.812	13

Table 6 - Item Total Statistics

Num.	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
C1	63.95	16.050	0.581	0.718
C2	66.35	17.187	0.146	0.760
C3	63.90	16.516	0.479	0.727
C4	65.00	15.158	0.556	0.712
C5	64.50	14.684	0.845	0.688
C6	65.15	16.239	0.336	0.738
C7	65.70	15.063	0.536	0.714
C8	64.70	14.432	0.664	0.697
C9	***66.70***	***22.958***	***0.574***	***0.863***
C10	65.25	15.355	0.526	0.716
C11	65.30	14.853	0.649	0.702
C12	65.50	15.000	0.762	0.697
C13	65.20	16.484	0.355	0.736

In table 5 and 6, it is clear that the present Cronbach's alpha is 0.749, which means the indexes of port competitiveness are basically reliable. However, I also noticed that if the ninth item, say, 'port service level' is deleted from the table, the

Cronbach’s alpha will be increased sharply to 0.863, which is a very good scale of reliability analysis.

It happens possibly because that, ‘port service level’ is a broader index, which contains the other indexes listed in the table, e.g., the ‘port convenience level’, ‘cargo handling efficiency’, ‘operating days per year’ and ‘intermodal transportation’. That may cause overlap of evaluation and thus different experts have different opinions on that issue.

According to the reliability analysis, I decided to delete the ninth index ‘port service level’, and run the software again. Results are shown in Table 7 and 8.

Table 7 - Reliability Statistics after deleting ‘port service level’ item

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.863	0.872	12

Table 8 - Item Total Statistics after deleting ‘port service level’ item

Num.	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
C1	60.05	20.050	0.609	0.850
C2	62.45	21.418	0.155	0.880
C3	60.00	20.737	0.467	0.858
C4	61.10	19.147	0.562	0.851
C5	60.60	18.674	0.833	0.836

C6	61.25	20.092	0.389	0.864
C7	61.80	18.800	0.585	0.850
C8	60.80	18.695	0.603	0.849
C10	61.35	19.397	0.526	0.854
C11	61.40	18.358	0.740	0.839
C12	61.60	18.779	0.809	0.837
C13	61.30	20.221	0.442	0.859

3.2.3 Final evaluation indexes of port competitiveness

After all these above analysis, now the final evaluation indexes of port competitiveness are determined as shown in Table 9.

Table 9 - Final Evaluation Indexes of Port Competitiveness

Port Competitiveness	B	C
	Natural Condition	Depth of waterway
		Operating days per year
	Port Operating Environment	Hinterland economy (GDP)
		Hinterland foreign trade value
		Shipping market condition
		Intermodal transportation
	Port Management	Cargo handling efficiency
		Port convenience level

	Port Infrastructure	Designed throughput capacity
		Proportion of deep-water berth
	Shipping Condition	Liner service frequency
		Sea route coverage

3.3 Operation of evaluation model

3.3.1 Model Construction

After the foundation of port competitiveness modal in above paragraphs, I will run the computer software named AMOS V6.0[2] to depict this model by path diagram and then calculate evaluation result by the software.

The path diagram is shown as Figure 3.

[2] AMOS is also a statistical analysis software used for SEM from SPSS Co., Ltd.

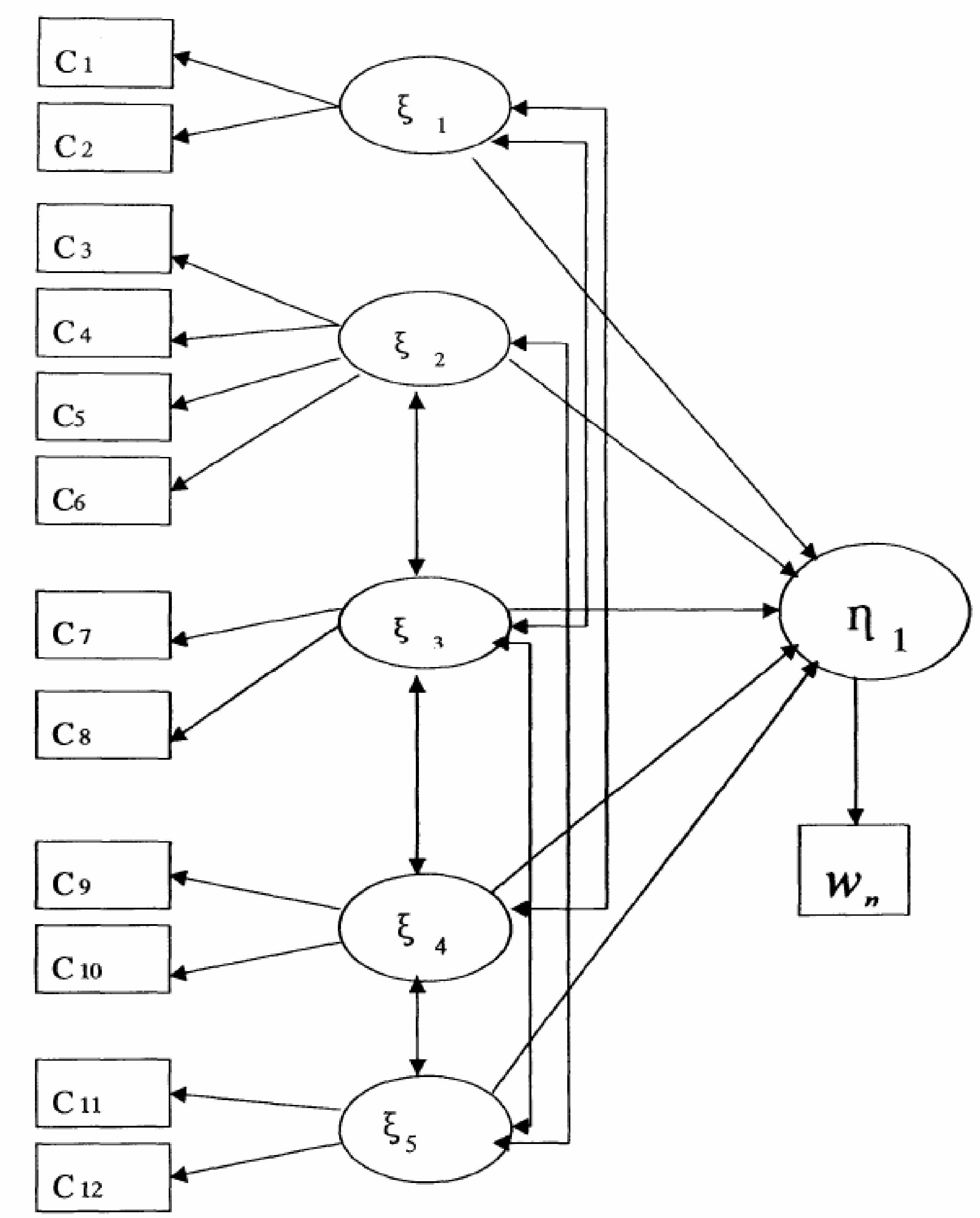

Figure 3 - AMOS Graphics of port competitiveness evaluation model

In the above graphics, rectangles stand for observed variables and ellipses are unobserved variables. If there is no line between two variables, it means these two variables are totally irrelated. A line with single arrow, like ‘ξ1’ to ‘C1’ and ‘C2’, represents ‘ξ1’ causes the scores observed on the measured variables C1 and C2. Bidirectional arrow represents relationships without an explicitly defined causal direction. For instance, ξ2 and ξ3 are related or associated, but no claim is made about ξ2 causing ξ3, or vice versa.

Table 10 - Meanings of each variable in Fig.3

	Exogenous	**Endogenous**
Observed Variables	C1: Depth of waterway C2: Operating days per year C3: Hinterland economy (GDP) C4: Hinterland foreign trade value C5: Shipping market condition C6: Intermodal transportation C7: Cargo handling efficiency C8: Port convenience level C9: Designed throughput capacity C10: Proportion of deep-water berth C11: Liner service frequency C12: Sea route coverage	Wn: Throughput of Port
Unobserved Variables	ξ1: Natural Condition ξ2: Port Operating Environment ξ3: Port Management ξ4: Port Infrastructure ξ5: Shipping Condition	η1: Port Competitiveness

3.3.2 Model Identification

Firstly, assume T means the number parameters estimated in this model. In this evaluation model, there are 14 error variances, 6 factor variances, 12 path coefficients (covariances between exogenous unobserved variables), and 12 factor loadings. Therefore T = 44.

Then assume P means the number of exogenous observed variables and Q equals the number of endogenous observed variables. Thus, P = 12, Q= 1. Consequently, there are [(P+Q) (P+Q+1)]/2 = 91 degrees of freedom.

Due to:

91	–	44	=	47>0
(Degrees of freedom)		(Parameters estimated)		(Available degrees of freedom)

Therefore, this model is structurally identified. In fact, it is over-identified because there are 47 positive degrees of freedom present.

3.3.3 Data Collection

In order to operate the evaluation model and determine the weight of each indexes in this model, the data from 1995-2005 of three main ports in China, say, Shanghai, Qingdao and Ningbo port, have been collected.

3.3.3.1 Measurable data collection

All the measurable data have been collected in number:

Wn. Throughput of Port (million TEU per year);

C1. Depth of waterway (meter);

C2. Operating days per year (days per year);

C3. Hinterland economy (GDP) (billion USD);

C4. Hinterland foreign trade value (billion USD);

C7. Cargo handling efficiency (TEU per ship * hour);

C8: Port convenience level;

C9. Designed throughput capacity (million TEU per year);

C10. Proportion of deep-water berth;

C11. Liner service frequency (times per week)

3.3.3.2 Unmeasurable data collection

All the unmeasurable data have been evaluated by the survey answer sheets received from 20 experts who joined the survey.

In view of each expert's different level of authority in different areas, I gave every expert a different weight and calculated the final score of each index according to the following equation:

$$n = \frac{\sum_{i=1}^{23}(w_i * n_i)}{\sum_{i=1}^{23} w_i}$$

'n': Score got from an expert

'w': Weight of an expert

Survey sheets are shown as follows in Table 11.

Table 11 - Port competitiveness survey 1

C5. Shipping market condition

Year / Port	1995	1996	…	2005
Shanghai				
Qingdao				
Ningbo				

C6. Intermodal transportation condition

Year / Port	1995	1996	…	2005
Shanghai				
Qingdao				
Ningbo				

C8. Port convenience level

Year / Port	1995	1996	…	2005
Shanghai				
Qingdao				
Ningbo				

C12.Sea route coverage

Year / Port	1995	1996	…	2005

Shanghai				
Qingdao				
Ningbo				

Note: Please use '1, 2, 3, 4, 5, 6, 7' to evaluate the situation of each factor of each port. '1' means bad, '3' means common, '5' means good, '7' means excellent. '2, 4, 6' are in between of them respectively.

3.3.3.3 Data Processing

Put all the mentioned measurable and unmeasurable data together in Table 12, 13 and 14, preparing for the operation of the evaluation model of port competitiveness in next paragraph.

Table 12 - Data of Shanghai port from 1995-2005

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Wn	1.53	1.97	2.53	3.41	4.22	5.61	6.34	8.61	11.28	14.55	18.09
C1	7	7	7	7.6	5	8.5	8.5	9	10	10	15
C2	352	352	352	352	352	352	352	352	352	352	352
C3	127.87	149.49	168.9	181.82	194.59	215.08	236.26	261.29	359.38	451.72	558.78
C4	47.36	54	60	63.49	75.75	110.7	122.5	156.1	281.5	390.2	506.8
C5	3.89	4	4.44	4.56	5	5.11	5.56	5.67	5.83	5.92	6.12
C6	4.33	4.33	4.67	5	5.33	5.33	5.67	5.67	5.82	5.95	6.33
C7	105	123	141	170	190	238	284	300	324	334	350
C8	4.33	4.33	4.67	4.67	5	5.33	5.67	5.67	5.93	6.15	6.33
C9	135	160	195	230	290	315	400	440	515	735	955

C10	0	0.375	0.359	0.348	0.345	0.317	0.375	0.364	0.375	0.383	0.385
C11	249	247	286	339	360	438	470	519	624	827	942
C12	3.2	3.5	4.2	4.6	4.9	5.5	5.8	6	6.1	6.3	6.5

Table 13 - Data of Qingdao port from 1995-2005

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Wn	0.6	0.81	1.03	1.21	1.54	2.12	2.64	3.4	4.24	5.14	6.31
C1	21	21	21	21	21	21	21	21	21	21	21
C2	363	363	363	363	363	363	363	363	363	363	363
C3	86.64	96.17	116.15	124.95	133.41	148.85	164.15	182.33	234.87	301.72	365.6
C4	18.78	20.1	21.97	21.1	22.88	30.83	35.1	40.54	68.4	85.6	100.5
C5	3	3.22	3.56	3.67	4.22	4.33	4.89	5	5.34	5.63	5.91
C6	2.89	3	3.44	3.67	3.89	4	4.22	4.33	4.35	4.73	5.15
C7	70	92	120	148	157	210	243	287	290	293	300
C8	3.11	3.44	3.56	4	4.11	4.56	4.78	4.89	5.12	5.23	5.33
C9	123	135	164	178	182	231	275	300	337	382	419
C10	0	0.23	0.184	0.164	0.144	0.27	0.293	0.279	0.279	0.282	0.293
C11	90	100	125	140	160	185	205	215	250	335	400
C12	2.3	2.6	2.9	2.9	3.1	3.6	4	4.4	4.4	4.7	5.5

Table 14 - Data of Ningbo port from 1995-2005

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Wn	0.16	0.2	0.26	0.17	0.6	0.9	1.21	1.86	2.77	4.01	5.21
C1	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
C2	350	350	350	350	350	350	350	350	350	350	350
C3	53.62	63.71	71.65	76.15	83.1	92.44	102.59	115.94	154.96	183.64	228.54

C4	16.4	18.1	20.8	21	24.2	35.9	41.1	51.4	85.5	103.4	120.3
C5	2.56	2.89	3.11	3.67	3.78	4.22	4.56	4.56	4.87	4.91	5.34
C6	2.67	2.67	3	3.67	3.67	3.67	4.33	4.33	4.63	4.75	5.14
C7	45	45	56	78	82	85	113	135	193	240	300
C8	3.11	3.44	3.44	4.22	4.44	4.89	5.11	5.33	5.33	5.54	5.67
C9	30	35	40	45	60	70	95	105	130	190	250
C10	0.33	0.29	0.63	0.56	0.5	0.43	0.53	0.48	0.52	0.56	0.58
C11	48	53	65	71	82	90	94	106	118	135	153
C12	1.6	2	2.3	2.4	2.8	3.3	3.9	4.3	4.3	4.7	5.5

Source: 1. National Bureau of Statistics of China (2006) *China Statistic Yearbook 1995-2005*

2. Shanghai Shipping Exchange. *http://www.sse.net.cn/*

3. Shanghai International Port (Group) Co., Ltd. *http://www.portshanghai.com.cn/*

4. Qingdao port. *http://www.qdport.com/*

5. Ningbo port Group. *http://www.nbport.com.cn/*

Indexes explanation:

Wn: Throughput of Port (million TEU per year)

C1: Depth of waterway (meter);

C2: Operating days per year (days per year);

C3: Hinterland economy (GDP) (billion USD);

C4: Hinterland foreign trade value (billion USD);

C5: Shipping market condition;

C6: Intermodal transportation condition;

C7: Cargo handling efficiency (TEU per ship * hour);

C8: Port convenience level;

C9: Designed throughput capacity (million TEU per year);

C10: Proportion of deep-water berth;

C11: Liner service frequency (times per week);

C12: Sea route coverage.

3.3.4 Model Operation

After the foundation of port competitiveness modal and data collection in above paragraphs, now it is time to run the computer software AMOS V6.0 and get the result. The results are listed in Figure 4 and Table 15.

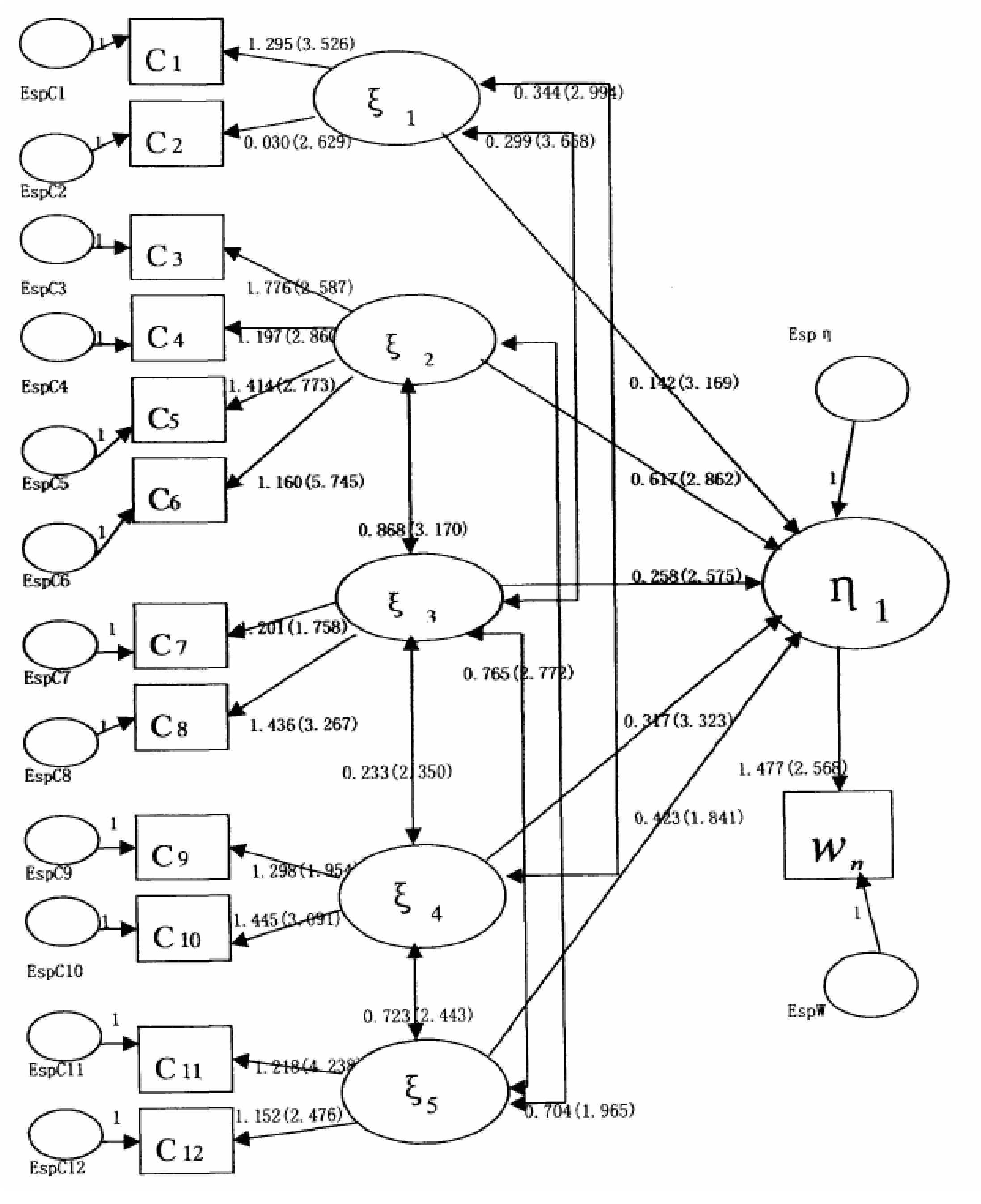

Figure 4 - Output of AMOS graphics

Table 15 - Evaluation and reliability of parameters

Chi-square = 86.823			
Degrees of freedom = 91			
Parameters	P-value	t	**Estimate**
η1 ← ξ1	0.000	3.169	**0.142**
η1 ← ξ2	0.000	2.862	**0.617**
η1 ← ξ3	0.000	2.575	**0.258**
η1 ← ξ4	0.000	3.323	**0.317**
η1 ← ξ5	0.031	1.841	**0.423**
ξ1 ← C1	0.000	3.525	**1.295**
ξ1 ← C2	0.000	2.629	**0.030**
ξ2 ← C3	0.000	2.587	**1.776**
ξ2 ← C4	0.000	2.86	**1.197**
ξ2 ← C5	0.000	2.773	**1.414**
ξ2 ← C6	0.000	5.745	**1.160**
ξ3 ← C7	0.039	2.358	**1.201**
ξ3 ← C8	0.000	3.369	**1.436**
ξ4 ← C9	0.000	3.091	**1.445**
ξ4 ← C10	0.022	2.012	**1.298**
ξ5 ← C11	0.000	4.238	**1.218**
ξ5 ← C12	0.000	2.476	**1.152**

From Table 15, it is obvious that all ‘t’ are over than 2, and ‘p - value’ are close to 0, which proves the significance tests of individual Parameters are pretty good.

3.3.5 Model Testing

So far, none of the output we have seen contains tests of statistical significance. To evaluate global model fit will be the next step. AMOS produces such tests.

3.3.5.1 Tests of Absolute Fit

In order to test absolute fit, we need to check the value of 'λ^2', and 'df' (degree of freedom)

$$\lambda^2 = (n-1)F$$

F = Fit function;

n = Number of samples.

Then check the value of 'a':

$$a = \frac{\lambda^2}{df}$$

If a < 2, it normally means the modal fits the data.

In this case, we have got the results before, say, the chi-square value is 86.823 with 91 degrees of freedom, which means a=0.954 < 2 and the modal fits the data well.

3.3.5.2 Tests of Relative Fit

Because the chi-square test of absolute model fit is sensitive to sample size and non-normality in the underlying distribution of the input variables, investigators often turn to various descriptive fit statistics to assess the overall fit a model to the data.

We check ‘GIF’ and ‘AGFI’ to test relative fit.

$$GIF = 1 - \frac{F\left[S, \sum(\hat{\theta})\right]}{F\left[S, \sum(0)\right]}$$

$$AGFI = 1 - \frac{(p+q)(p+q+1)/2}{df}(1-GFI)$$

S = Covariance matrix of observed variables;

∑ = Covariance matrix of model;

P = Number of exogenous observed variables;

Q = Number of endogenous observed variables.

If both GIF and AGFI are in the range of 0.9-1, it usually means that relative fit of this model is great.

In this case,

$$GIF = 1 - \frac{F\left[S, \sum(\hat{\theta})\right]}{F\left[S, \sum(0)\right]} = 0.976$$

$$AGFI = 1 - \frac{(p+q)(p+q+1)/2}{df}(1-GFI) = 0.933$$

According to these tests of both absolute and relative fit, I draw the conclusion that the global model fit is great and there is no need to modify the model.

3.4 Result of operation of port competitiveness evaluation model

3.4.1 Results output

To sum up, after the operation of port competitiveness evaluation model, we can get the estimate weight of each index in this model directly. It is listed in Table 16.

Table 16 - Estimate weight of each index in the port competitiveness modal

B	Estimate	C	Estimate
Natural Condition	0.142	Depth of waterway	1.295
		Operating days per year	0.030
Port Operating Environment	0.617	Hinterland economy (GDP)	1.776
		Hinterland foreign trade value	1.197
		Shipping market condition	1.414
		Intermodal transportation	1.160
Port Management	0.258	Cargo handling efficiency	1.201
		Port convenience level	1.436
Port Infrastructure	0.317	Designed throughput capacity	1.445
		Proportion of deep-water berth	1.298
Shipping Condition	0.423	Liner service frequency	1.218
		Sea route coverage	1.152

3.4.2 Results analysis

1. Port Operating Environment (Estimate weight = 0.617)

It is the most important factor in all these five 'B' indexes due to its highest estimate weight. In its sub-indexes, the 'hinterland economy (GDP)' factor ranks first with the weight of 1.776, following with the 'shipping market condition' factor weighting 1.414, 'hinterland foreign trade value' and 'intermodal transportation' are also significant to port competitiveness.

It shows that, the better hinterland economy is, the more competitive a port will be. Port provides services for its hinterland. That is the reason why hinterland economy plays such an important role in port competitiveness. At the same time, 'shipping market condition', as a basic evaluation factor of a port, its importance to port competitiveness also is reflected in this model.

2. Shipping Condition (Estimate weight = 0.423)

'Shipping condition' factor here has the second large weight of 0.423. It mainly contains 'liner service frequency per month' factor and 'sea route coverage' factor, weighting 1.218 and 1.152 respectively.

Nowadays, providing liner service and sailing in the world are definitely the two basic functions of a port. It is no doubt that condition of these two basic functions of a port seems crucial to its competitiveness evaluation.

3. Port Infrastructure (Estimate weight = 0.317)

'Designed throughput capacity of a port' weights 1.445 and 'proportion of deep-water berth' 1.298.

It is necessary to mention that, I have tried to delete recent 2-3 years' data and calculate then. I found the results of ‘proportion of deep-water berth’ index decreased dramatically. It means the result of this evaluation model can just reflect the situation of a special time period, and the significance of ‘proportion of deep-water berth’ is increasing recently.

4. Port Management (Estimate weight = 0.258)

‘Port management’ factor seems less important than the above three indexes in the evaluation. It consists of efficiency of loading and discharging weighting 1.201 and port convenience level, weighting 1.436.

5. Natural Condition (Estimate weight = 0.142)

‘Natural condition’ factor has the least weight in port competitiveness evaluation. Especially the ‘operating days per year’ factor, which just weight 0.030 in this index.

If we re-check the data collected before, it is not too hard to find that the operating days of every port are all over 350 and do not change frequently. That is why it has such a low weight in evaluation. On the other side, ‘depth of waterway’ factor are the other factor that decreased significantly when I deleted last 2-3 years’ data. Its importance to port competitiveness is increasing accordingly.

4. Evaluation of Shanghai port's competitiveness after the operation of Yangshan port

After the analysis of Chapter 3, the single weight of each index is determined by the model of port competitiveness modal. In this chapter, I will pick up three main ports in north-east Asia, say Hongkong port, Pusan port, Shanghai port (With Yangshan port), and evaluate their port competitiveness respectively. At the same time, in order to reflect the influence of this new project, I will also evaluate the situation of Shanghai port before the operation of Yangshan deep-water port. Thus finally I will choose four ports as evaluation targets, i.e. Hongkong port, Pusan port, Shanghai port (with Yangshan port) and Shanghai port (without Yangshan port).

4.1 Selection of evaluation objects

In north-east Asia, Hongkong is an international shipping center now. Meanwhile, Shanghai and Pusan are both aimed at being an international shipping center in the future. In order to compare Shanghai with its main competitors in north-east Asia, I decide to choose Hongkong port and Pusan port, whose container throughput are now ranking no.2 and no.5 in the world this year, as evaluation targets. We can see the location of each port in Figure 5.

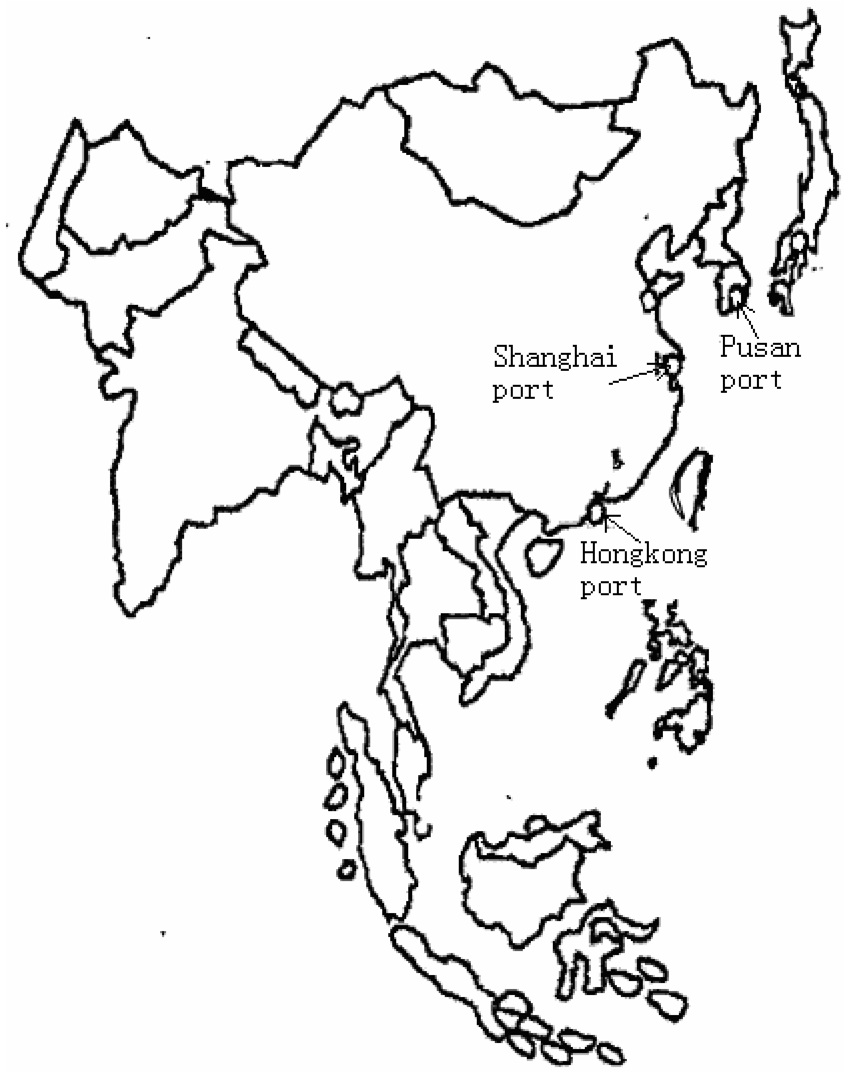

Figure 5 - Location of three main ports in north-east Asia

4.2 Collection of evaluation data

4.2.1 Measurable Data Collection[3]

4.2.1.1 Data Collection

[3] All the data collected in this chapter are the latest data of 2006.

1. Throughput of the port（million TEU per year）

Port	Shanghai	Hongkong	Pusan
Throughput	21.71	23.23	12.03

Source: Shanghai Shipping Exchange. http://www.sse.net.cn/

2. Depth of waterway (meter)

Port	Shanghai	Hongkong	Pusan	Shanghai (without Yangshan port)
Depth	15	15.5	15	10

Source: 1. Shanghai Shipping Exchange. http://www.sse.net.cn/

2. Hongkong Port Development council. http://www.pdc.gov.hk/

3. Busan Port Authority. http://www.busanport.com/

3. Operating days (days per year)

Port	Shanghai	Hongkong	Pusan
Operating days	352	352	352

Source: 1. Shanghai International Port (Group) Co., Ltd. http://www.portshanghai.com.cn/

2. Hongkong Port Development council. http://www.pdc.gov.hk/

3. Busan Port Authority. http://www.busanport.com/

4. Hinterland economy (GDP) (billion USD)[4]

Port	Shanghai	Hongkong	Pusan
GDP	648.3 ①	533.1 ②	664.4 ③

4 Currency exchange rate used in this dissertation is the data on Dec.31st, 2006: 1 USD = 7.8 RMB = 7. 76 Hongkong Dollar = 7.97 Macao Pataca= 939.8 Korea Won

Source: 1. National Bureau of Statistics of China (2006) *China Statistic Yearbook 2006*

2. Korea National Statistical Office. http://www.nso.go.kr/

① Shanghai port's direct hinterland includes:

Shanghai city + Jiangsu province + Zhejiang province + Part of Anhui province

132.0 + 276.3 + 200.6 + 78.7*50% = 648.3

② Hongkong port's direct hinterland includes:

Hongkong + Guangdong province + Macao

188.8 + 330.8 + 13.5 = 533.1

③ Pusan port's direct hinterland includes:

Majority of Korea

820.3 * 81%[5] = 664.4

5. Hinterland foreign trade value (billion USD)

Port	Shanghai	Hongkong	Pusan
Foreign trade	656.8①	1185.8 ②	514.3 ③

Source: 1. National Bureau of Statistics of China (2006) *China Statistic Yearbook 2006*

2. Korea National Statistical Office. http://www.nso.go.kr/

3. WTO. http://www.wto.org/

① Shanghai port's direct hinterland includes:

Shanghai city + Jiangsu province + Zhejiang province + Part of Anhui province

227.5 + 284 + 139.2 + 12.25*50% = 656.8

[5] Pusan, as the biggest port in Korea, handled 81% throughput of Korea.

② Hongkong port's direct hinterland includes:

Hongkong + Guangdong province + Macao

652.2 + 527.2 + 6.42 = 1185.8

③ Pusan port's direct hinterland includes:

Majority of Korea

634.9 * 81% = 514.3

6. Cargo handling efficiency (TEU per ship * hour)

Port	Shanghai	Hongkong	Pusan
Efficiency	390 ①	480 ②	460 ③

Source: 1. Shanghai International Port (Group) Co., Ltd. http://www.portshanghai.com.cn/

2. Hongkong Port Development council. http://www.pdc.gov.hk/

3. Busan Port Authority. http://www.busanport.com/

7. Designed throughput capacity (million TEU per year)

Port	Shanghai	Hongkong	Pusan	Shanghai (without Yangshan port)
Throughput capacity	12.05 ①	18 ②	4.92 ③	7.35

Source: 1. Shanghai International Port (Group) Co., Ltd. http://www.portshanghai.com.cn/

2. Hongkong Port Development council. http://www.pdc.gov.hk/

3. Busan Port Authority. http://www.busanport.com/

① Shanghai port:

27 berths built before 2005 (7.35 million TEU);

5 berths of the first phase of Yangshan deep-water port (2.2 million TEU);

4 berths of the second phase of Yangshan deep-water port (2.5 million TEU)

② Hongkong port:

24 berths of K-Q dock (18 million TEU)

③ Pusan port:

27 berths before 2006 (4.12 million TEU)

3 berths of the first phase of Pusan new port (0.8 million TEU)

8. Proportion of deep-water berth

Port	Shanghai	Hongkong	Pusan	Shanghai (without Yangshan port)
Proportion	38.9%	80%	36.7%	18.5%

Source: 1. Shanghai International Port (Group) Co., Ltd. http://www.portshanghai.com.cn/

2. Hongkong Port Development council. http://www.pdc.gov.hk/

3. Busan Port Authority. http://www.busanport.com/

9. Liner service frequency (times per mouth)

Port	Shanghai	Hongkong	Pusan
Liner frequency	2173	2000	1960

Source: 1. Shanghai Shipping Exchange. http://www.sse.net.cn/

2. Hongkong Port Development council. http://www.pdc.gov.hk/

3. Busan Port Authority. http://www.busanport.com/

4.2.1.2 Data conversion

In this paragraph, I will change the above measurable data into the number formed as experts' survey sheet, say, to use '1, 2, 3, 4, 5, 6, 7' to evaluate the situation of each factor of each port. '1' means bad, '3' means common, '5' means good, '7' means excellent. '2, 4, 6' are in between of them respectively.

The result of data conversion is shown in Table17.

Table 17 - The result of measurable data conversion

Port	**Shanghai**	**Hongkong**	**Pusan**	**Shanghai (without Yangshan port)**
Throughput	6.54	7.00	3.63	6.54
Hinterland GDP	6.83	5.62	7.00	6.83
Foreign trade value	3.88	7.00	3.04	3.88
Liner frequency	7.00	6.44	5.81	7.00
Depth of waterway	6.77	7.00	6.77	4.52
Throughput capacity	4.69	7.00	1.91	2.86
Operating days	7.00	7.00	7.00	7.00
Handling efficiency	5.69	7.00	6.71	5.69
Deep-water berth	3.40	7.00	3.21	1.62

4.2.2 Unmeasurable Data Collection

All the unmeasurable data have been evaluated by the survey answer sheets received from 20 experts who joined the survey.

In view of each expert's different level of authority in different areas, I gave every expert a different weight and calculated the final score of each index according to the following equation:

$$n = \frac{\sum_{i=1}^{23}(w_i * n_i)}{\sum_{i=1}^{23} w_i}$$

'n': Score got from an expert
'w': Weight of an expert

Survey sheets and results are shown as follows in Table 18.

Table 18 - Port competitiveness survey 2

1. Shipping market condition

Item / Port	New building, second-hand S&P, and chartering market	Freight forward and shipping agent market	Shipping insurance and financial market	**Result**
Shanghai	3.65	5.85	2.7	**4.07**
Hongkong	5.95	5.85	6.65	**6.15**

Pusan	5	4.65	3.75	**4.47**

2. Intermodal transportation condition

Item / Port	Highway	Railway	Seaway	**Result**
Shanghai	4.4	3.3	3.85	**3.85**
Hongkong	5.65	3.7	6.6	**5.32**
Pusan	4.6	3.85	5.35	**4.60**

3. Port convenience level

Item / Port	International transshipment	Domestic transshipment	Local export and import	**Result**
Shanghai	3.6	4.3	4.95	**4.28**
Hongkong	6.65	6.1	6.15	**6.30**
Pusan	5.95	4.95	5.45	**5.45**

4. Sea route coverage

Item / Port	**Result**
Shanghai	**5.95**
Hongkong	**6.55**
Pusan	**5.45**

Note: Please use '1, 2, 3, 4, 5, 6, 7' to evaluate the situation of each factor of each port. '1' means bad, '3' means common, '5' means good, '7' means excellent. '2, 4, 6' are in between of them respectively.

4.2.3 Data Processing

Put the data collected in 4.2.1 and 4.2.2 together, we can get the port competitiveness evaluation data in Table 19.

Table 19 - Data for port competitiveness evaluation

Index \ Port		Shanghai	Hongkong	Pusan	Shanghai (without Yangshan port)
Throughput		6.54	7.00	3.63	6.54
Port Operating Environment	Hinterland economy	6.83	5.62	7.00	6.83
	Foreign trade value	3.88	7.00	3.04	3.88
	Shipping market	4.07	6.15	4.47	4.07
	Intermodal trans.	3.85	5.32	4.60	3.85
Shipping Condition	Liner frequency	7.00	6.44	5.81	7.00
	Sea route coverage	5.95	6.55	5.45	5.95
Port Infrastructure	Throughput capacity	4.69	7.00	1.91	2.86
	Deep-water berth	3.40	7.00	3.21	1.62
Port Management	Handling efficiency	5.69	7.00	6.71	5.69
	Port convenience	4.28	6.30	5.45	4.28

Natural Condition	Depth of waterway	6.77	7.00	6.77	4.52
	Operating days	7.00	7.00	7.00	7.00

4.3 Analysis of the evaluation result

According to Table 16 in Chapter 3 and Table 19, now we get the final result of Shanghai port competitiveness evaluation compared with its competitors in Table 20.

Table 20 - Final result of Shanghai port competitiveness evaluation compared with its competitors

	Weight	Index	*Weight*	Shanghai	Hongkong	Pusan	Shanghai2[6]
Port Operating Environment	*0.617*	Hinterland economy	*1.776*	7.48	6.16	7.67	7.48
		Foreign trade value	*1.197*	2.87	5.17	2.25	2.87
		Shipping market	*1.414*	3.55	5.37	3.90	3.55
		Intermodal trans.	*1.16*	2.76	3.81	3.29	2.76
Shipping Condition	*0.423*	Liner frequency	*1.218*	3.61	3.32	2.99	3.61
		Sea route coverage	*1.152*	2.90	3.19	2.66	2.90
Port Infrastructure	*0.317*	Throughput capacity	*1.445*	2.15	3.21	0.87	1.31
		Deep-water berth	*1.298*	1.40	2.88	1.32	0.67
Port	*0.258*	Handling efficiency	*1.201*	1.76	2.17	2.08	1.76

[6] Shanghai 2 means 'Shanghai (without Yangshan port)'.

Management		Port convenience	*1.436*	1.59	2.33	2.02	1.59
Natural Condition	*0.142*	Depth of waterway	*1.295*	1.24	1.29	1.24	0.83
		Operating days	*0.03*	0.03	0.03	0.03	0.03

Port / Index	Shanghai	Hongkong	Pusan	Shanghai (without Yangshan port)
Operating Environment	16.66	20.50	17.11	16.66
Shipping Condition	6.51	6.51	5.65	6.51
Port Infrastructure	3.55	6.09	2.20	1.98
Port Management	3.35	4.50	4.10	3.35
Natural Condition	1.27	1.32	1.27	0.86
Port Competitiveness	**31.33**	**38.92**	**30.33**	**29.35**

The tables above show the result of port competitiveness clearly. The ranking of four ports is:

1. Hongkong port (38.92);
2. Shanghai port (31.33);
3. Pusan port (30.33);
4. Shanghai port (without Yangshan deep-water port) (29.35)

Hongkong port, mainly due to its excellent port operating environment, gets a considerable competitive advantage over other 3 targets. Shanghai port and Pusan port are very close to each other. Shanghai port, with its new Yangshan deep-water port, performs better in ‘Shipping Condition’ and ‘Port Infrastructure’ items, which leads to a small advantage over Pusan port. However, Pusan port also has very strong hinterland economy and convenient Intermodal transportation, which makes it competitive in the competition of north-east Asia. We can also see from the result that Yangshan deep-water has given Shanghai port a big raise in its port competitiveness, say, changes from 29.35 to 31.33. It is obvious that Yangshan deep-water port plays a significant role in Shanghai port’s development.

In the next chapter, I will analysis the result of this evaluation and try to provide some suggestion and solution to the development of Shanghai port.

5. Suggestions and solutions of improving Shanghai port's competitiveness

5.1 Suggestions on operating environment

We can see it clearly from Table 21, that Shanghai port has an absolute disadvantage in port operating environment compared to Hongkong and Pusan port.

Table 21 - Port operating environment comparison

Index		Shanghai	Hongkong	Pusan
Port Operating Environment	Hinterland economy	7.48	6.16	7.67
	Foreign trade value	2.87	5.17	2.25
	Shipping market	3.55	5.37	3.90
	Intermodal transportation	2.76	3.81	3.29
Total		16.66	20.50	17.11

Although Shanghai port has a very strong hinterland economy which owns a 1.32 points lead to Hongkong, the other indexes of Shanghai, especially 'shipping market' and 'intermodal transportation', are much lower than Hongkong and Pusan port.

5.1.1 Completing and improving shipping market

Shipping market condition

Item / Port	New building, second-hand S&P, and chartering market	Freight forward and shipping agent market	Shipping insurance and financial market
Shanghai	3.65	5.85	2.7
Hongkong	5.95	5.85	6.65
Pusan	5	4.65	3.75

Seen from the result of above evaluation, to solve that problem of operating environment, Shanghai port in the future should keep focusing its attention on completing and improving its shipping market, especially the 'S&P and chartering market' and 'shipping insurance and financial market' which have got relatively low marks in the evaluation. Hongkong, as a port with long shipping history, has a great deal of experience in this filed which is worthy of learning by Shanghai.

5.1.2 Improving the condition of intermodal transportation

Intermodal transportation condition

Item / Port	Highway	Railway	Seaway
Shanghai	4.4	3.3	3.85
Hongkong	5.65	3.7	6.6
Pusan	4.6	3.85	5.35

Good condition of intermodal transportation of a port will definitely help to cut the cost of every single round of transportation. Shanghai port, restricted by its natural limitation, can not perform well in the intermodal transportation. But it is necessary to mention, the new sea-cross bridge – Donghai Bridge which connects Yangshan port with Shanghai, has provided great service for Shanghai and improved the intermodal service dramatically.

It is reported that in 2007, the project aiming at increasing the depth of Yangtze-river entrance will be completed. That will lead to a 10-meter-depth waterway of Shanghai, which will definitely help to improve the current situation of Shanghai port.

5.2 Suggestions on port management

We can see from Table 22, Shanghai port has an absolute disadvantage in port management compared to Hongkong and Pusan port.

Table 22 - Port management comparison

Index		Shanghai	Hongkong	Pusan
Port Management	Handling efficiency	1.76	2.17	2.08
	Port convenience	1.59	2.33	2.02
Total		3.35	4.50	4.10

As collected data shown in Chapter 3, Shanghai port's cargo handling efficiency is increasing quickly these years. It is nearly to catch up with the most efficient port in the world. Therefore, the main problem of Shanghai port in management factor is 'Port convenience'.

5.2.1 Increasing international transshipment

Port convenience level

Item / Port	International transshipment	Domestic transshipment	Local export and import
Shanghai	3.6	4.3	4.95
Hongkong	6.65	6.1	6.15
Pusan	5.95	4.95	5.45

Compared with other two ports, Shanghai port has an extremely low quantity of international transshipment containers. Try to attract more transshipment containers can definitely increase Shanghai port's competitiveness.

Despite other geographic reasons which restrict Shanghai port from earning more transshipment containers, Shanghai port can try to improve its port policy, which is one of the decisive factors in attracting transshipment. Providing a relatively convenient procedure, improving a better service will be very helpful. By the way, Pusan port charges much less than Shanghai and Hongkong. It is one of the most important reasons for their high quantity of transshipment throughput.

5.2.2 Providing better value-added service

As I mentioned before, Shanghai port has a very strong hinterland economy. Depend on this advantage and combined with Chinese relatively low labor cost, try to provide better value-added service in port, like processing trade, logistics service and so on will be helpful to improve Shanghai port's competitiveness. If Shanghai port can provide better value-added service than others, it will gain much more customer satisfactory and become more competitive than before compared to other ports in north-east Asia.

5.3 Suggestions on Yangshan deep-water port

After analysis the current disadvantages of Shanghai port, there are some other suggestions on Yangshan deep-water port project. Yangshan deep-water port project plays a very significant role in Shanghai port's international shipping center strategy. Therefore, how to operate and develop Yangshan deep-water port should also be considered seriously.

5.3.1 Connecting with Shanghai shipping market as soon as possible

Yangshan deep-water port is within a long distance (27.5 km) of Shanghai. There are possibly problems of how to connect Yangshan port with the relatively mature shipping market in Shanghai.

Fortunately, Shanghai government is now building a new district called 'Nanhui portside district', which is between Yangshan port and Shanghai city. It is just like the Pudong development district of Shanghai in 1990, with lots of modern facilities, buildings, and factories. The new district will provide different kinds of services, like modern logistics service, processing trade in port, foreign trade, business service, and living and travelling service.

The building of Shanghai Nanhui portside district will definitely help Yangshan port to connect with Shanghai city as soon as possible.

5.3.2 Increasing intermodal transportation ways

Now, there is just a sea-cross bridge between Shanghai and Yangshan port. Although the bridge is very broad and has modern facilities, it is still not enough for the increasing tons of cargo. Try to take advantage of seaway transfer is the major way I mentioned before to solve this problem.

Besides, it may be possible to build railways connecting Yangshan port with Pudong development district of Shanghai and the new-building portside district which I introduced before. After that, Shanghai port can take full advantage of intermodal transportation, say, seaway-railway transportation model and that would increase Shanghai port's competitiveness dramatically.

5.3.3 Taking full use of natural conditions

The depth of waterway seems to be the major limitation of Shanghai port for years. Finally, Shanghai port has its new deep-water port and berths. After the first and second phase of Yangshan port, Shanghai port should try whatever they can to take full use of the current natural advantage.

Try to provide more comfortable services to the world, attract more liner companies to berth by open policy and convenient procedure, and charge reasonable port fee. All these matters should be considered in the next phases of Yangshan deep-water project.

Conclusion

Yangshan port project in Shanghai is one of the largest port projects currently in the world. In other words, it is a very hot topic in the world. As the third big ports in the world, how Shanghai port performs in the new stage with its brand-new deep-water port has been concerned by lots of people. Meanwhile, can Shanghai port gain a competitive advantage compared to the other mega-ports, especially its main competitors in the north-east Asia becomes a significant problem. Its port competitiveness, as a result, must be evaluated carefully.

In this dissertation, I briefly introduced the project of Yangshan deep-water port, evaluated Shanghai port's competitiveness after the operation of Yangshan deep-water port, comparing with other two ports- Hangkong and Pusan, and tried to give some suggestions and solutions to improve Shanghai port's competitiveness.

The ranking of the four target ports is:

1. Hongkong port (38.92);
2. Shanghai port (31.33);
3. Pusan port (30.33);
4. Shanghai port (without Yangshan deep-water port) (29.35)

According to the port competitiveness evaluation, I found Shanghai port's competitive advantages and disadvantages in the competition of north-east Asia. According to the results of this evaluation, I analyzed deeply, and gave some suggestions and solutions in order to improve Shanghai port's competitiveness.

After the first and second phase of Yangshan port, Shanghai port are now trying whatever they can to take full use of the brand-new deep-water port. However, considering the current situation of Shanghai port and the results of port competitiveness evaluation, I suggested that Shanghai port should:

(1) Try to improve its operating environment by completing shipping market and improving the condition of intermodal transportation;

(2) Try to improve its port management by increasing international transshipment and providing better value-added service;

(3) Continue to improve the performance of Yangshan deep-water port in connecting with Shanghai shipping market as soon as possible, increasing intermodal transportation ways and taking full use of natural conditions.

Reference

1. Arbuckle, J. (1997). *Amos Users' Guide Version 3.6*. Chicago IL: Smallwaters Corporation.

2. Bollen, K.A. (1989). *Structural Equations with Latent Variables*, New York: Wiley.

3. Browne, M.W. (1984). "Asymptotically distribution-free methods for the analysis of covari-ance structures." *British Journal of Mathematical and Statistical Psychology, 37,* 62-83.

4. Browne, M.W. and R. Cudeck (1993), *"Alternative ways of assessing model fit," in Testing Structural Equation Models,* ed. K.A. Bollen and Long. S., Newbury Park CA: Sage, 136-162.

5. Cai Zhengrong. (2005, May). Container transport along Yangtze booming in the ascendant. *Port Review, (5),* 9-13.

6. Cao Zhongxi. (2005, January). The realization of integration and optimization of port resources. *Port Economy, (1),* 7-8.

7. Charles W.L.Hill, Gareth R.Jones. (2004). *Strategic Management —An Integrated Approach(6th ed.).* Houghton Mifflin Company.

8. Chen fuxiang. (2005). Discussion about the cooperation and development of Bohai Rim's ports. *Port Economy, 2,* 22-23.

9. David Garson (1998). *Structural Equation Modeling*, North Carolina State University Republished on 2007 from the World Wide Web: http://www2.chass.ncsu.edu/garson/pa765/index.htm

10. Du Dongling. (1997, June). Developing ports relying on the cities and making use of ports to develop economy. *Shanghai Port Technology, (6)*, 23-25.

11. Du Dongling. (1997, May). The theory discussion concerning the relationship between ports and cities. *Shanghai Port Technology, (5),* 19-23.

12. Ebel, Robert L. (1951). Estimation of the reliability of ratings. *Psychometrika* 16: 407-424.

13. Fleiss, J. L., Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educational and Psychological Measurement, 33*: 613-619.

14. Haggard, E. A. (1958). *Intraclass correlation and the analysis of variance.* NY: Dryden.

15. Landis, J. R., Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics 33*:159-174.

16. Lu Haihu (2004). The establishmert of Yangshan deep-water port and the international container hub port in the Far East. *Maritime China, 08.*

17. Liu Nan, Liu Guoqing (2005). Investigation on the container port system in Shanghai International Ship Center. *Ocean Development and Management, 06,* 22-26.

18. LIU Wei , XU Jianhua (2006). Project of Shanghai International Shipping Center's Yangshan Deep-Water Port and Its Significance of Construction. *Logistics Scitechnol, 03,* 15-19.

19. National Bureau of Statistics of China (2005). *China Statistic Yearbook 1995-2005.* Republished on 2006 from the World Wide Web:
http://www.stats.gov.cn/

20. Song Bai(2001). Strengthen Cooperation and Upgrade Pivot Port of International Container to Logistics Center of Seven Seas Shipping. *Shipping Management, 04,* 17-22.

21. Tang Yiwen , Zhan Shuifang(2006). Yangshan Deep-water Seaport and the Construction of International Shipping Center in Shanghai. *World Regional Studies, 01,* 06-09.

22. TD Heaver. (2002). The evolving roles of shipping lines in international. *Logistics. International Journal of Maritime Economics, 4,* 210-230.

23. Tian Zuochen(2002). Division of Function between Yangshan Deep Water Port of Shanghai International Shipping Center and Other Periphery Ports and Carrying Volume Forecast Balance. *Shipping Management, 02,* 11-14.

24. The Busan Port Authority website gives further information on courses
http://www.busanport.com/

25. The Hongkong Port Development Council website gives further information on courses
http://www.pdc.gov.hk/

26. The Korea National Statistical Office website gives further information on courses
http://www.nso.go.kr/

27. The Ningbo port Group website gives further information on courses
http://www.nbport.com.cn/

28. The Qingdao port website gives further information on courses
http://www.qdport.com/

29. The Shanghai International Port (Group) Co., Ltd. website gives further information on courses
http://www.portshanghai.com.cn/

30. The Shanghai Shipping Exchange website gives further information on courses
http://www.sse.net.cn/

31. Tu Deming. (2001, September). Paying attention to the research of port development strategies to meet the challenges in the new era. *China Ports, (9)*, 9-13.

32. UT Austin (2001). *Structural Equation Modeling using AMOS.* Republished from the World Wide Web:
http://www.utexas.edu/its/rc/tutorials/stat/amos/

33. Wan Zheng, Zhang Renyi(2006). On Coordinated Development of Ports in Shanghai International Shipping Center. *Port & Waterway Engineering , 08,*19-23.

34. WTO Report (2007). *Risks lie ahead following stronger trade in 2006.* Reported on April 12th 2007 from the World Wide Web:
http://www.wto.org/english/news_e/pres07_e/pr472_e.htm

35. Xu jianhua.(2005.8). International container transshipment and its prospects. *Containerization,1005(5339),* 23-24

36. Xu jianhua . Port’s strategy choosing. *Port Economy 2005.4* 39-40

37. Xu Peixing(2004).Port Logistic Development: An Opportunity toEnhance Shanghai Port's International Competitiveness. *Journal of Shanghai Maritime University, 02,* 20-22

38. Xu Shujun, Jiang Zhibin(2004). The Tactics for Upgrading Comprehensive Competitive Ability of Shanghai International Shipping Center. *Industrial Engineering and Management, 05,* 34-37.

39. XU Xing(2001). International competitive strategies among Shanghai Port and surrounding ports. *The Ocean Engineering, 02,* 23-26.

40. Yang zhigang & Wu yongfu. (1998). *International container transportation.* People Transport Publishing Company.

41. Yan zuoren & Zhongrong.(2003).*Transportation Economy.* China Communications Press

42. Yang Jinglei , Liu Binglian , Liu Jun(2005). Study on Evaluation of Port Logistics International Competitiveness. *Logistics Technology, 05,* 12-15

43. Zhang Huimin(2004). The Yangshan Deepwater Harbor: Shanghai's Emerging International Shipping Center. *Journal of Shanghai Polytechnic College of Urban Management, 06,* 31-37.

44. Zhang keyun.(2005). *Regional Economic Policy.* Bussiness Press.

45. Zhang lijuan.(2003). *Water transportation theory and practices.* People Transport Publishing Company.

46. Zhang Yaoguang, Cui Yuge. (2006) Analysis on Regional Space Affect of Shanghai Yangshan Deep-Water Port. *Geography and Geo-Information Science, 22(3),* 85-87.

47. Zhao yan. (2003). *Research on competition and cooperation strategy of Shanghai international pivot port.* Unpublished master’s thesis, Shanghai Maritime University,

Shanghai, China.

48. Zhen Hong. *Production Scheduling Optimization of Terminal.* Shanghai: Shanghai Science and Technology Literature Publishing House. 1999.

49. Zhen hong. China container port's competition current condition and trend. *Containerization(2004), 4,* 20-21.

50. Zong Peihua(2004).Developing Port Logistics and Establishing an International Shanghai Port. *Journal of Shanghai Maritime University, 02,* 13-18.