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Comparative study on port logistics service capability of China's main ports

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Declaration

I certify that all the material in this research paper 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

As a hub of the maritime transport network system and a window for foreign exchanges, port plays an increasingly important role in promoting international trade and regional economic development. At present, the competition in ports along the China's coasts has become increasingly fierce. With the continuous development of China's international trade and its high dependence on maritime transport, the "B & R" strategy has also promoted China's continuous participation in overseas port projects. Not only the study of the port's overall competitiveness has become increasingly important as a port's competitiveness, but also the study of the port logistics service capability, which is one of the important indicators of port competitiveness, has become increasingly important. The purpose of studying the port's logistics service capability is to discover the strengths and shortcomings of port logistics service in development, and to use this strength as a dominant factor to focus on development, create and maintain competitive advantages, and improve short boards to obtain stable competitive benefits.

This article first elaborates the research background. Secondly, it elaborates the theoretical basis, and at the same time combs and makes a brief review on the research status of port competitiveness and the research status of port logistics service capability at home and abroad. Then, build an evaluation index system for port logistics service capabilities, and summarizes the current status of logistics service capability in China's major ports. In Chapter 4, select the factor analysis method to conduct empirical research on the ten major ports, based on the 2016 data, to obtain the score and ranking of logistics service capability. In Chapter 5, based on the analysis results, the author will give the related suggestions.

KEYWORDS: logistics service capability, evaluation index system, factor analysis

Content

1 Introduction

1.1 Research proposal

1.1.1 Research background

The world economy has entered a new stage of development. The global economic rules are continuously adjusted. The development process of various countries is even more uneven. The Chinese economy has long been highly connected with the world economy. Under the new economic situation, China’s overall ability to respond to the external environment is not enough. In response to China’s problems of overcapacity, high external dependence on energy resources, and excessive concentration of resources in coastal areas, President Xi Jinping has proposed the "B & R" strategy in 2013. In response to the new economic situation, the focus should be on building the "21st Century Maritime Silk Road". This strategy runs through the Eurasian continent and links the East Asian economic circle at the eastern and western end of Europe and Asia, including 26 countries and regions. While China’s international trade continues to grow, it is highly dependent on maritime transport, which is an integral part of the 21st Century Maritime Silk Road. As a link between land and sea, the centre of maritime trade activities, and the node of maritime silk roads, the port plays an significant role in the “B & R” strategy.

It has been pointed out that the key development directions of the 21st Century Maritime Silk Road, which emphasizes the key ports as the key points to jointly create a smoother, safer and more efficient transport corridor. At the same time, it explicitly mentioned that the construction of 15 coastal ports (in Shanghai, Tianjin, Ningbo-Zhoushan, Guangzhou, Shenzhen, Zhanjiang, Shantou, Qingdao, Rizhao, Dalian, Fuzhou, Xiamen, Quanzhou, Yingkou and Lianyungang) must be strengthen.

At present, the external environment for the development of the port economy has undergone major changes. The economic globalization has been deepening. A new round of scientific and technological revolutions and industrial revolutions are gestating. Under the backdrop of the continuous improvement of China’s international status and continuous improvement of its overall strength. The "Belt and Road" strategy has provided China with a good idea for actively participating in international competition and has also brought about development opportunities for China's major ports. However, at present, most of China’s ports are in a mode of extensive development, and there are few comprehensive large-scale ports with strong competitiveness, and the right to speak in the global market is not enough. With the rapid development of internationalized economy and trade, the importance of shipping has become more prominent, and the port will become the most important fulcrum in this system. Its logistics service capabilities, even the comprehensive competitiveness, will inevitably affect the state of economic development of the region and even the entire country. In this dissertation, the author selects 10 major ports from the 15 ports that are focused on the development of the “B & R” carrying out evaluation and research on logistics service capability to have an objective understanding of the logistics service capability and find a force point to continuously improve its own capability, and while continuously improving its own capacity, it provides reference for other ports in China, making it possible for Chinese ports to better integrate the “B & R” strategy and enhance their capabilities. Based on the above background, this article focuses on the evaluation of China's major port logistics service capability and hopes to have an objective and clear understanding of the current strengths and weaknesses of China's major ports.

1.1.2 Research significance

Under the ever-changing global economic changes, China has continuously proposed an active contingency strategy. Under the "B & R" strategic pattern, especially under the Maritime Silk Road Plan, the development of the port economy can drive the economic development of the entire region and even the entire country. It is of great significance to evaluate the logistics service capability of major ports in China:

First of all, from the perspective of the “One Belt and One Road” strategic plan, the port is the most important support point along the “Maritime Silk Road”. It bears the important mission of linking the key areas of the Belt and Road and also carries the important task of the development of China’s foreign trade. As an important support point in the 21st century Maritime Silk Road, the improvement of the logistics service capability of China’s major ports will inevitably make the foreign trade between China and the countries along the Maritime Silk Road smoother and better connect with the “B & R” strategy. While stimulating development opportunities and stimulating regional economic development, we will also increase our overall economic and trade level.

Secondly, to make an objective assessment of the logistics service capability of the major ports along the Maritime Silk Road, China’s major ports can be continuously developed, constantly adjust their development strategies according to their own situation, maintain advantages and improve disadvantages to find a force point for major ports in China improving logistics service, making the promotion of port benefit more efficient, changing the status of extensive development, and enhancing the sustainability of its logistics service capability.

Finally, the conclusions and recommendations of the research on the evaluation of China's major port logistics service capability can also serve as a reference for other ports that have developed more slowly.

1.1.3 Research purpose

The purpose of this article is to evaluate the logistics service capabilities of major ports in China's key construction areas along the “B & R”, not to make a ranking of the port's logistics service capability, but rather to have an objective understanding of the capability of China's major ports, understanding the performance of the port in terms of various influencing factors, of which the purpose is to find out the force point for the port develop in the future, so as to make the promotion of the logistics service capabilities of China's major ports more efficient.

1.1.4 Research content

This article first elaborates the research background. Secondly, it elaborates the theoretical basis, and at the same time combs and makes a brief review on the research status of port competitiveness and the research status of port logistics service capability at home and abroad. Then, build an evaluation index system for port logistics service capabilities, and summarizes the current status of logistics service capability in China's major ports. In Chapter 4, select the factor analysis method to conduct empirical research on the ten major ports, based on the 2016 data, to obtain the score and ranking of logistics service capability. In Chapter 5, based on the analysis results, the author will give the related suggestions.

1.1.5 Research method

The combination of quantitative analysis and qualitative analysis. In the process of analyzing port logistics service capabilities, the analysis was conducted from both qualitative and quantitative perspectives. The two methods were combined to make the study more persuasive.

Diagram illustrating method. In the process of explaining the selected major port logistics service capabilities, the full use of charts to demonstrate the results of a more intuitive display.

Empirical analysis. Establish an evaluation system and use multi-level factor analysis to conduct empirical research on the logistics capabilities of major ports along the Belt and Road in China and evaluate the results.

2 Literature review

2.1 Port competitiveness

In 2001, Malchow and Kanafani proposed in their study that the distance between foreland and hinterland is one of the significant factors which affect the port competitiveness. Foster (1978) found that when shipping companies choosing the ports, they will consider the ability of the port to provide the service to the customers and the distance between the ports and the shipping companies, of which the service ability of the ports has more influences on the decision of the shipping company. Van de Voorde (2002) thought that routes are also important factors considered by the shippers while choosing the ports. Moreover, Haynes (1997) and Jose (2001) considered the port efficiency as another important factor affecting the port competitiveness. Also, with the increasing competition among the ports, the scope of the influence factors for port competitiveness is expanding. Haezendonck and Notteboom (2002) thought that productivity, hinterland accessibility, product quality, cargo generation, port reputation and reliability are vital factors affecting the port's competitiveness. Xu, C.X. (2001) put forward and summarized six main factors of the port competitiveness, including: geographical location, inland transport, port services and efficiency, service prices, socio-economic stability and telecommunication system. In 2005, John R. M. Gordon proposed that a port will have a continuous competitive advantage, relying on resource integration, including government support policies, adequate investment, good port operations, information technology and the port's geographic location and natural deep-water port, and he also expounded the impacts of information technology and port operations on port competitiveness.

On the other hand, various evaluation methods are introduced to the study on port competitiveness. Brian Slack and James J. Wang (2002) analyzed the competition situation among some ports in Asia through the competitiveness model of North American and European ports to verify the differences between the actual competition factors and the theoretical assumptions of the port, providing some advice for the development of the port in the future. Khalid Bicho and Richard Gray (2004) constructed an effective evaluation framework to study the port system based on the logistics and supply chain management. Gi-Tae Yeo and Dong-Wook Song (2006) used AHP and fuzzy mathematical analysis to analyze the competitiveness of port logistics, applied to evaluating the ports in Southeast Asia.

In addition, there are also a lot of researches about port competitiveness in Chinese academia. He, X. (2006) established the evaluation index system of port competitiveness based on the eight major ports in China, using principal component analysis and cluster analysis, and evaluated the competitiveness of eight major ports. Ma, Y.G. (2007) built the FCE - AHP evaluation model to compare the competitiveness of port logistics between Shanghai port and Busan port and he found out that concluded that Shanghai international logistics competitiveness was a bit stronger than Busan port. Kuang, H.B. and Chen, S.W. (2007) built TOPSIS model of port comprehensive competitiveness based on port throughput and other three scientific indicators, as they thought the previous researches lacked of a systematic theoretical study, to analyze seven major ports in China. Xiao, H.B. & Xiong, L.Y. & Chen, W.Y. (2008) combined AHP with fuzzy analysis to analyze the influencing factors of the typical ports all over the world and proposed measures to enhance the overall competitiveness of the ports.

2.2 The definition of Port logistics service capability

According to the study of logistics capability, Daughery (1995) believed that an enterprise's logistics capability was a part of enterprise resources and a strategy to enable an enterprise to conceive and improve its efficiency and effect. Bowersox (1996) believed that logistics capacity reflects a manufacturer's ability whether he can provide the competitive customer service at the lowest possible cost. Professor Ma Shi Hua (2004) proposed the supply chain logistics capability theory systematically with the characteristics of supply chain operation as the breakthrough point. Professor Tan Qing Mei (2003) pointed out from the perspective of economics that logistics capability refers to the ability of the logistics supply entity to provide logistics services.

The concept of port logistics service capability can be derived from the logistics capability and defined: that is, the port companies that carry out the logistics activities provide the internal and external customers with the required logistics service capabilities through the effective and reasonable organization and use of various resources of their logistics systems for a certain period of time.

In terms of the constituent elements of port logistics service, the service capability of the port logistics is mainly composed of the factor capability and the operation capability. From the perspective of evaluability, the factor capability mainly refers to the service capability of logistics machinery equipment and logistics facilities area. The operation capability refers to the ability of the port managers to optimize the allocation of logistics resources, and to provide port with high-efficiency, low-cost and low-pollution logistics services through planning, organization and control. At the same time, it also includes the ability of the port to contribute to the sustainable development of the port economy. The factor capability is a static capability, and the operation capability is a dynamic improvement on this static basis, and it is a dynamic capability. (Wu R.C. 2008)

2.2.1 Port logistics service static capability

The main factors affecting the static capability of port logistics service include the port's geographical environment, natural environment, and port infrastructure facilities. (Wang Q.S. 2009)

1) Geographical environment and natural environment

   The geographical environment and natural environment of the port include the geographical location of the port and the natural conditions of the port. The geographical location of the port (natural geography, economic geography, traffic geography, political and military positions, etc.) often determines the port’s status in the country’s political, military, and national economy, and has a lasting and continuous impact on the port; the geographical location mentioned here is mainly refers to the objective geographical location of the port. As the main body to enhance its competitiveness, the port cannot independently choose and change its geographical position, which is an objective factor influencing the logistics capacity of the port.

2) Port infrastructure facilities

The port infrastructure determines the development level and potential of the port. The high level of infrastructure conditions and rich resources are the foundation of the port's healthy development. Good port infrastructure is the basis for realizing the connectivity of the maritime silk road, which also affects its port operation capacity and efficiency. It is an important support for the development of the maritime silk road. Port infrastructure and equipment conditions including the port of anchorage, harbour basins, breakwater, revetment, channels, navigation facilities, berth length, tonnage and number, the storage space, handling and transport machinery, power equipment, communications equipment, etc. Perfect port facilities can quickly handle cargoes and improve the efficiency of port operations. The extent of its perfection affects the scale of port development, determines the position of the port in the surrounding port system and the scope of the economic hinterland, and determines the future direction of port development. It is also an important basis for becoming an international port.

Port infrastructures can be classified into three categories: logistics infrastructure, operational infrastructure and port facilities. The logistics infrastructure of a port mainly includes the shipping channels, anchorage, berth and so on. The port fairways are designed to ensure safe and convenient access of the ship to and from the port. The port must have sufficient water depth and a certain width of the waterway which can be natural or artificially developed. The breakwater is located at the outer edge of the port water area to keep it below the wind and waves and to ensure a smooth water level within the harbour. It is mainly used to meet the requirements of safe and convenient navigation of ships in and out of the harbour when berthing and loading and unloading operations are carried out. Anchorage refers to the water area in the port where the ship is berthed, sheltered, checked by customs, quarantined, and loaded and unloaded. The water area as an anchorage requires proper water depth and sufficient area so as not to interfere with the normal navigation of other ships. The length of the berth generally includes the length of the berth and the necessary safety distance “d” between the two ships. The value of “d” varies depending on the size of the ship, for instance, a 10,000-ton berth is 15-20 meters. The use of berths is exclusively for loading and unloading. The number and size of berths are important indicators of the scale of a port.

The port operational facilities refer to the facilities provided by the port terminal for cargo handling, storage, and related services, and are mainly divided into loading and unloading production facilities and cargo storage facilities. According to international practice, this part of the facilities is usually undertaken by port operators to purchase and operate, mainly including loading and unloading facilities and port storage yards. Among them, port handling machinery and equipment is an important part of the port system. The port storage area is a port facility that provides short-term storage for cargo before loading or after unloading. It is composed of two parts: warehouse and yard. The port storage yard is the main distribution site for cargo, and it plays a role of reserve, adjustment, sorting, and buffering in the process of cargo handling. The freight yard is mainly used to store goods that are influenced by the effects of shower, sun exposure and temperature changes, such as coal, ore, sand and stone tiles and other building materials.

The port facilities mainly include hardware facilities such as lifting machinery, loading and unloading and transportation machinery. The more sophisticated and advanced the port facilities, the higher the operating efficiency of the port and the stronger the logistics service capability it shows.

2.2.2 Port logistics service dynamic capability

The factors which influence the port logistics service dynamic capability mainly includes port throughput, container handling efficiency and so on. (Wang Q.S. 2009)

1) Port throughput

   Port throughput includes cargo throughput, container throughput and passenger throughput. Containers are one of the fastest growing and widely used forms of transportation in the world. The throughput of the port reflects the comprehensive strength of the port. The size of the port throughput indicates the size of the port and its importance in material exchanges.

2) Container handling efficiency

For the those container ports, the container handling efficiency is the important indicator of port logistics service. Container handling efficiency includes TEU per ship-hour, output per bridge crane-hour, the number of ship to port and average time per container on site. TEU per ship-hour refers to the standard volume of containers that can be loaded and unloaded per hour per vessel. Output per bridge crane-hour refers to the average standard volume of container that each bridge crane completes per hour of operation. Average time per container on site refers to the average time of each container staying at the port. These four indicators which can reflect the container handling efficiency all have the significant influence on the quality of logistics service of a port.

3 The construction of the evaluation index system

This chapter is based on related theories and review of relevant literature. It begins with the definition of the port logistics service capability, analysing the factors that affect China's port logistics capacity, and at the same time, complies with the principle of index system construction, so as to construct an ideal evaluation index system of port logistics service capability.

3.1 The construction of evaluation index system

There are many factors influencing the port logistics service capability. The indicators selected in this paper are mainly determined by summarizing and combing the relevant literature on port logistics capacity and competitiveness. This paper selects 14 indicators to establish an index system to evaluate port logistics service capability, mainly focusing on its static capability and dynamic capability.

The static capability of port logistics service includes various port infrastructures, which determines the development level and potential of port logistics service. High-level infrastructure conditions and abundant shoreline and the other resources are the basis for the healthy development of the port. This paper selects the length of the berth, the number of berth, the number of 10,000-ton berth, and the cargo and container annual passing capacity, container yard area and the number of the bridge crane to reflect the level of port infrastructure.

The dynamic capability of port logistics service includes cargo throughput, container throughput and the foreign trade throughput and so on. Containers are one of the fastest growing and widely used forms of transportation in the world. The throughput of the port reflects the capacity of the port and the size of the port throughput indicates the size of the port and its importance in material exchanges. Furthermore, the dynamic capability also includes the efficiency of the port which can reflect the quality of the port logistics service. Thus, this dissertation will select cargo throughput, container throughput, the foreign trade throughput, TEU per ship-hour, output per bridge crane-hour, the number of ship arriving at the port and the average time per container staying on the yard.

3.1.1 The evaluation system of port logistics capacity

The evaluation index system of port logistics service capability constructed in this paper is as follows:

Table 1 – The evaluation system of port logistics service capability

The first-level indicator	The second-level indicator	The third-level indicator
Port logistics service capability	The static capability of port logistics service	The length of the berth
		The number of the berth
		The number of 10,000-ton berth
		The annual cargo passing capacity
		The annual container passing capacity
		The container yard area
		The number of the bridge crane
	The dynamic capability of port logistics service	The cargo throughput
		The container throughput
		The foreign trade cargo throughput
		TEU per ship-hour
		Output per bridge crane-hour
		The number of ship arriving at the port
		The average time per container staying on the yard

3.2 Selection of evaluation methods

In this paper, a multi-level factor analysis method is used to evaluate the port logistics service capability evaluation index system to obtain the port logistics service capability scores and rankings. At the same time, the scores and rankings of each port in each influencing factor can be obtained.

The multi-level factor analysis method corrects the shortcomings of the factor analysis method. Factor analysis is a kind of statistical method. It starts from the internal correlation of variables and integrates the variables with complex relationships into several comprehensive factors. Then the weight is determined according to the variance contribution rate of each comprehensive factor. However, the factor analysis method has one disadvantage, that is, it does not consider the importance of each index itself when synthesizing the comprehensive factors. The results obtained are greatly influenced by the correlation between the original indicators. The multi-level factor analysis method deepens the factor analysis method and solves the problem of comprehensive evaluation of multi-level indicators. Take the three-level index system as an example. First, the multi-level factor analysis method uses factor analysis on each of the three-level indicators in the indicator system separately, and differentiates the advantages of the second-level indicators according to the ranking of factor scores. Afterwards, the second-level indicators are weighted using the factor analysis method to get the information of each first-level index and to obtain a comprehensive evaluation. The advantage of selecting a multi-level factor analysis method is that it excludes the influence of factor analysis on the balance of the correlation of the original indicators. It can not only make judgments on port logistics capacity in general, but also can be used to determine the advantages and disadvantages of each aspect of the port. The advantage of choosing a multi-level factor analysis method is that it excludes the influence of factor analysis on the balance of the correlation of the original indicators. It can not only judge the overall port logistics capacity, but also compare the advantages and disadvantages of each aspect of the port. It is beneficial to proceed from various factors affecting the comprehensive competitiveness of ports and evaluate the advantages and disadvantages of various ports so as to have a directional effect on port logistics capabilities.

The multi-level factor analysis analysis model is as follows:

The first is the collection and standardization of data. According to the port under study, a number of index data of the port are collected according to the “port logistics capacity evaluation index system”. In order to eliminate the effects of the differences in the observables and magnitudes, the sample data should be standardized and the formula is:

$$X_{jk} = \frac{y_{jk} - \overline{y_j}}{\sqrt{\frac{1}{s}\sum_{1}^{s}(y_{jk} - \overline{y_j})^2}} \tag{4.1}$$

In the formula, s – the number of the port

y_{jk} - the raw sample data of the k-th index of the j-th port

$\overline{y_j}$ - the average of the k-th index in all ports

X_{jk} - the dimensionless data of the k-th index of the j-th port.

Second-level factor analysis: If there are i indicators at the first level in the indicator system, there are p resolutions for each indicator. Let there be a total of m standardized common factor variables, marked as F_{i1}, F_{i2}, F_{i3}, …, F_{im}, (m < p)

If, (1): $X_i = (x_{i1}, x_{i2}, x_{i3}, ..., x_{ip})'$ is observable random vector, and the mean vector $E(x) = 0$, the covariance matrix $\text{cov}(x) = \Sigma$, and the covariance matrix is equal to the correlation matrix R.

(2): F_{i1}, F_{i2}, F_{i3}, …, F_{im}, (m < p) is the unpredictable vector, and the mean vector $E(F) = 0$, the covariance matrix $\text{cov}(F) = I$, the components of the vector are independent of each other.

(3): $\varepsilon_i = (\varepsilon_1, \varepsilon_2, \varepsilon_3, ..., \varepsilon_i)'$ and F are independent of each other, and E(ε)=0, the covariance matrix Σε is a diagonal matrix.

The second level factor analysis equation is as follows:

$$\left\{ \begin{array}{c} x_{i1} = a_{11}F_{i1} + a_{12}F_{i2} + ... + a_{1m}F_{im} + \varepsilon_1 \\ x_{i2} = a_{21}F_{i1} + a_{22}F_{i2} + ... + a_{2m}F_{im} + \varepsilon_2 \\ ... \\ x_{ip} = a_{p1}F_{i1} + a_{p2}F_{i2} + ... + a_{pm}F_{im} + \varepsilon_i \end{array} \right\} \tag{4.2}$$

A = (a_{pm}) is the component matrix, to construct a factor score function:

$$F_i = \beta_1 F_{i1} + \beta_2 F_{i2} + ... + \beta_m F_{im} \tag{4.3}$$

In the formula, β_m is the proportion of the variance contribution of the common factor F_{im}, that is, the weight; F_i is the comprehensive score of the first layer index i, F_i can reflect the characteristics of the port in a certain aspect, the higher the F_i score, the greater advantage the port has in this aspect.

The first level factor analysis: for the first-level index factor scores obtained, and then do factor analysis, and finally get a comprehensive score of the target layer. In order to distinguish factor scores, when making factor analysis, make the common factor variable U_1, U_2, U_3, …, U_n.

To meet the condition that,

(1): $F_i = (F_1, F_2, F_3, ..., F_i)'$ is observable random vector, and the mean vector $E(F) = 0$, the covariance matrix $\text{cov}(F) = \Sigma$, and the covariance matrix is equal to the correlation matrix R.

(2): $U = (U_1, U_2, U_3, ..., U_n)'$, (n < i) is the unpredictable vector, and the mean vector $E(U) = 0$, the covariance matrix $\text{cov}(U) = I$, the components of the vector are independent of each other.

(3): $\varepsilon_i = (\varepsilon_1, \varepsilon_2, \varepsilon_3, ..., \varepsilon_i)'$ and U are independent of each other, and E(ε)=0, the covariance matrix $\Sigma\varepsilon$ is a diagonal matrix.

The first level factor analysis equation is as follows:

$$\left\{ \begin{array}{c} F_1 = a_{11}U_1 + a_{12}U_{i2} + ... + a_{1n}U_n + \varepsilon_1 \\ F_2 = a_{21}U_1 + a_{22}U_{i2} + ... + a_{2n}U_n + \varepsilon_2 \\ ... \\ F_i = a_{i1}U_1 + a_{i2}U_2 + ... + a_{in}U_n + \varepsilon_i \end{array} \right\} \tag{4.4}$$

To construct a factor score function:

$$U = \beta_1 U_1 + \beta_2 U_2 + ... + \beta_n U_n \tag{4.5}$$

In the formula, β_n is the proportion of the variance contribution of the common factor U_n, that is, the weight; U is the final composite score, and the higher the composite score, the stronger the logistics capacity of the port.

4 The empirical analysis of port logistics service capability of China's main ports

This chapter first analyzes the current status of major ports along the Belt and Road in China from the aspects of the static capability and the dynamic capability of port logistics service. Then using multi-level factor analysis method, from the two aspects selected in this paper, make an empirical analysis of the logistics service capability of the major ports in China.

4.1 The static capability of port logistics service

In this section, the author will first analyse the static capability of port logistics service, which includes the length of berth, the number of berth and the number of 10,000-ton berth, port annual cargo and container passing throughput, the container yard area and the number of the bridge cranes for handling the container.

4.1.1 The length of berth

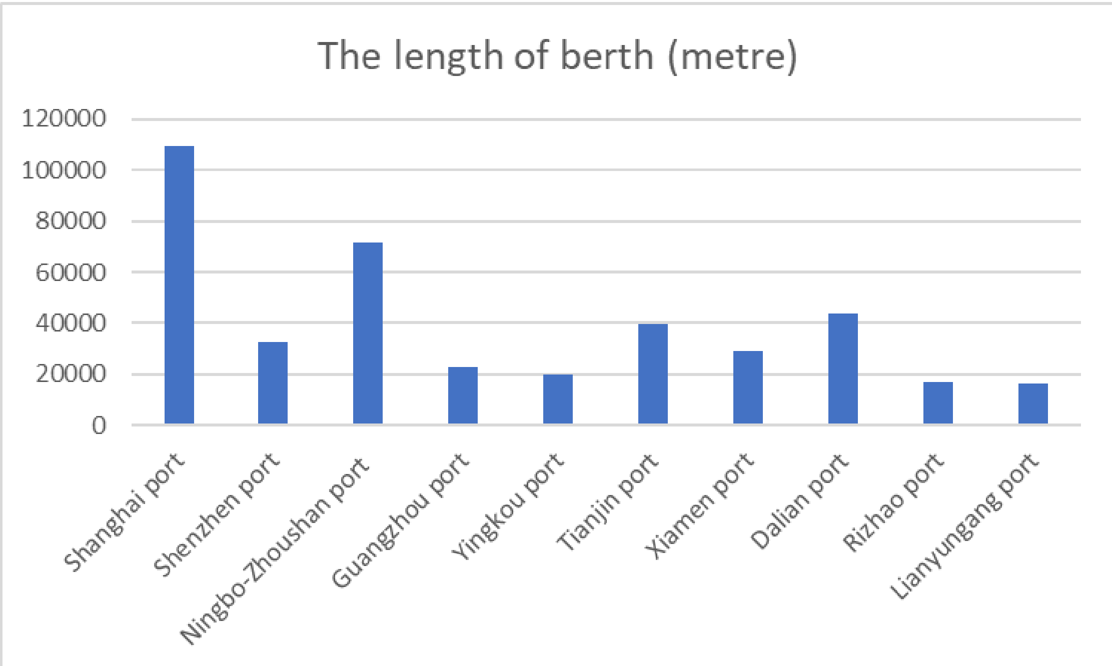

Figure 1 – The length of berth of the ten ports in China
Source: YEARBOOK PORTS OF CHINA 2017

The figure below shows the berth length of the ten main ports along the maritime silk road in China (Shanghai port, Shenzhen port, Ningbo-Zhoushan port, Guangzhou port, Yingkou port, Tianjin port, Xiamen port, Dalian port, Rizhao port and Lianyungang port), and the unit of this indicator is metre.

By the end of 2016, the berth length of Shanghai port was 109,200 metres, which was far ahead of the other ports. The second longest berth length among these ten ports belonged to Ningbo-Zhoushan port, which was nearly two-thirds of the berth length of Shanghai port (71,500). Another berth length over 40,000 metres long was owned by Dalian port which was 43,956 metres. The berth length of the other four ports are between 20,000 ~ 40,000 metres with 32,448m of Shenzhen port, 22,849m of Guangzhou port, 39,389m of Tianjin port and 29,236m of Xiamen port. The berth length under 20,000 metres were Lianyungang port (16,450m), Yingkou port (19709m) and Rizhao port (17289m) with Lianyungang port the shortest one among the ten ports.

4.1.2 The number of berth and the number of 10,000-ton berth

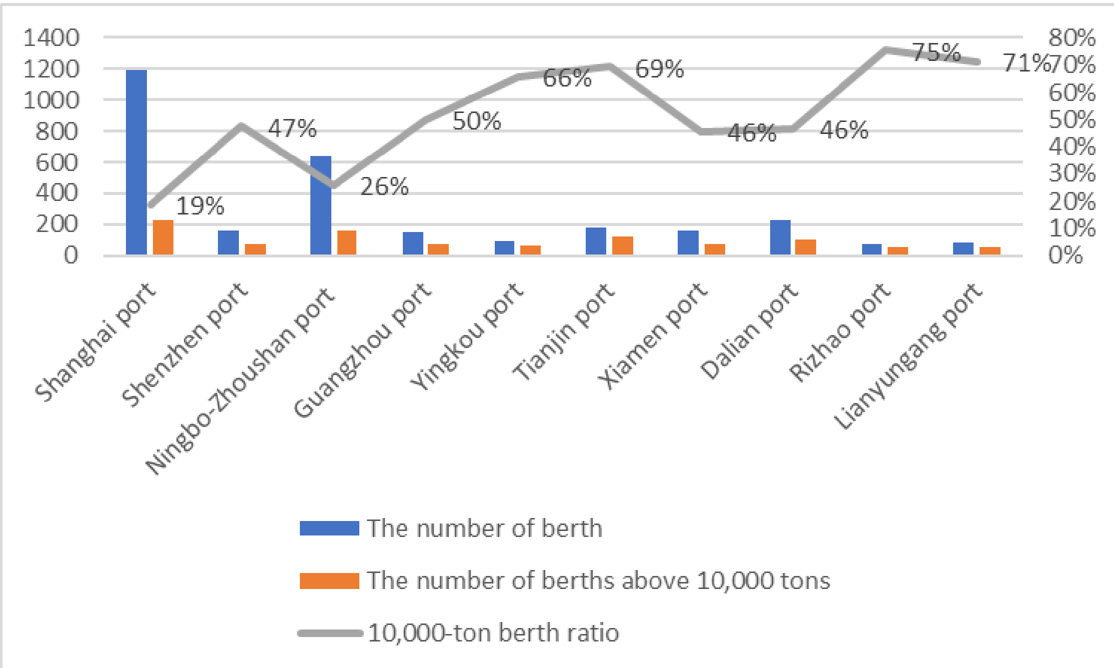

Figure 2 – The number of berth and the number of 10,000-ton berth
Source: YEARBOOK PORTS OF CHINA 2017

Figure 3.2 demonstrates the number of the berth and the 10,000-ton berth of the ten ports. The blue bar represents the number of berth, the orange bar represents the 10,000-ton berth of the ten ports and the grey line shows the ratio of the number of the berth above 10,000 tons.

The two ports with the largest number of berths were Shanghai Port and Ningbo-Zhoushan Port, 1195 and 639 respectively, which were also far ahead of the other eight ports, and among the other eight ports, only Dalian ports owned more than 200 berth, which was 222. The numbers of berth of the other four ports were distributed between 100 ~ 200 that Shenzhen port had 156 berths, Guangzhou port had 152 berths, Tianjin port had 176 berths and Xiamen port had 164 berths. Under 100, there were Yingkou port (93), Rizhao port (69) and Lianyungang port (80), of which the berth numbers are a little bit behind the other seven ports.

As for the number of the berth over 10,000, Shanghai port (224) and Ningbo-Zhoushan port (164) still took the first position and second position respectively among these ten ports. In addition to Shanghai port and Ningbo-Zhoushan port, only Tianjin port and Dalian port owned more than 100 berths over 10,000 tons with Tianjin port 122 and Dalian port 103. The other four ports, Shenzhen port, Guangzhou port and Xiamen port, had the similar number of 10,000-ton berth, which was 74, 76 and 75 respectively. The remaining ports, Yingkou port, Rizhao port and Lianyungang port, had the relatively less berths than the other ports that Yingkou port owned 61 berths, Rizhao port owned 52 berths and Lianyungang port owned 57 berths.

From the aspect of 10,000-ton berth, it is interesting to be noticed that those had the relatively less total berth number had the relatively higher ratio of 10,000-ton berth. At the first level, there were four ports of which the ratios were between 60 percent and 75 percent. Among them, Rizhao port owned the biggest ratio which was 75%, then was Lianyungang port 71%, Tianjin port 69% and Yingkou port 66%. At the second level, they were Shenzhen port, Guangzhou port, Xiamen port and Dalian port, of which the ratios are 47%, 50%, 46% and 46% respectively. In these ports, nearly half of the berths of each port were 10,000-ton berths. At the third level, they were

Shanghai port (19%) and Ningbo-Zhoushan port (26%) and their 10,000-ton berth ratio is the lowest of the ten ports.

In general, those with a relatively low proportion of 10,000-ton berths are mostly the ports which had the advantage on the number of the berth. Therefore, these ports still have huge room for development in the construction of 10,000-ton berths, and there is still room for improvement in port infrastructure.

4.1.3 Port annual passing capacity

In Figure 3.3, it illustrates the annual cargo passing capacity and the annual container passing capacity of the ten ports in 2016. The blue line represents the annual cargo passing capacity and the orange line represents the annual container passing capacity, of which the units are 10,000 tons and 10,000 TEU respectively. The left-hand figure shows the amount of the annual cargo passing capacity and the right-hand figure shows the amount of the annual container passing capacity.

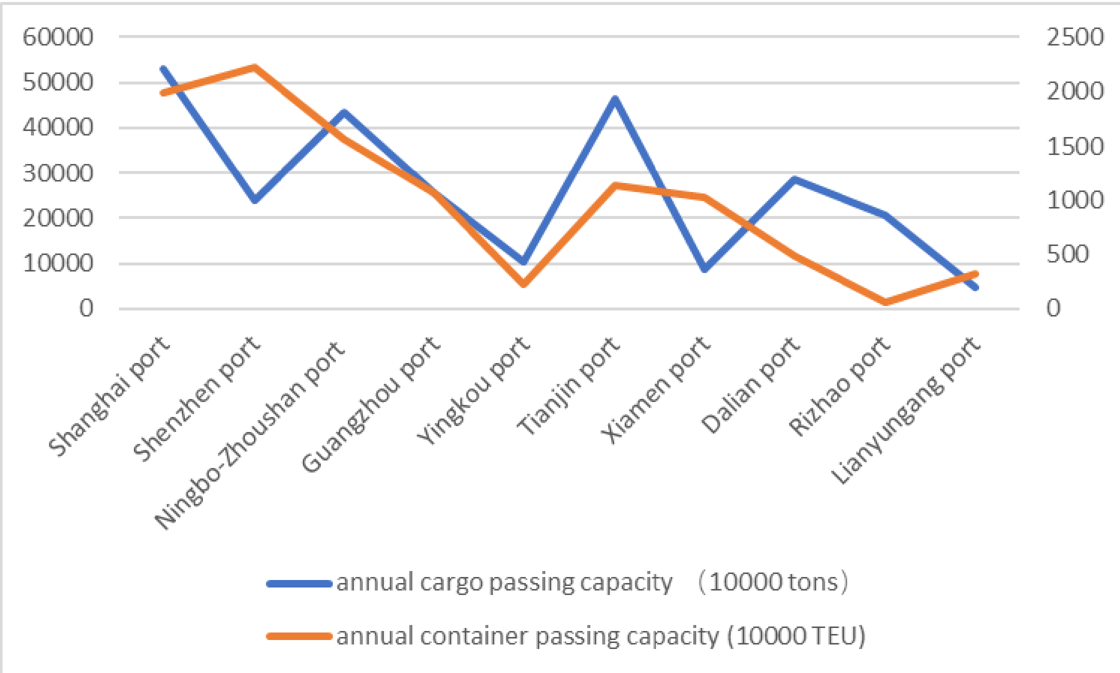

Figure 3 – Annual cargo passing capacity and annual container passing capacity
Source: YEARBOOK PORTS OF CHINA 2017

In 2016, three ports were estimated that their annual cargo passing capacity were over 400 million tons, and they were Shanghai port (530 million tons), Ningbo-Zhoushan port (435 million tons) and Tianjin port (464 million tons) with Shanghai port being at the leading position. However, there were also three ports' cargo capacity under 200 million tons, Yingkou port, Xiamen port and Lianyungang port, and the passing capacity of each port was 104.4 million tons, 86.73 million tons and 47.7 million tons respectively. The cargo capacity of the remaining ports was Shenzhen port 239 million tons, Guangzhou port 256.31 million tons, Dalian port 287 million tons and Rizhao port 204.67 million tons.

As for the annual container passing capacity, its trend is not the same as the trend of annual cargo passing capacity. From the aspect of the container, the passing capacity of Shenzhen port was at the leading position, ahead of the other ports (22.22 million TEU), while Rizhao port had the weakest container capacity which was 0.65 million TEU. The capacities of Dalian port, Yingkou port and Lianyungang port were a little better than that of Rizhao port, which were 4.9 million, 2.2 million and 3.2 million TEU respectively. The other ports' capacities stayed between 10 ~ 20 million that Shanghai port 19.83 million t, Ningbo-Zhoushan 15.65 million t, Guangzhou port 10.67 million t, Tianjin port 11.31 million t and Xiamen port 10.31 million t.

4.1.4 Container yard area

The Figure 3.4 shows the container yard area of the ten ports in 2016, and the unit of the indicator is 10,000 square metres.

Among these ten ports, Shanghai port owned the biggest container yard area, 7.71 million m^2, which was nearly 1.5 times larger than Shenzhen port (4.86 million m^2). Both of the two ports' container yard area were far ahead of the other eight ports. There were three ports with the container yard area exceeding 2 million m^2 that Ningbo-Zhoushan port had 2.1 million m^2, Tianjin port had 2.33 million m^2 and Xiamen port had 2.05 million m^2. The other two ports, Dalian port and Guangzhou port, had the container yard areas more than 1 million m^2, for Dalian port 1.19 million m^2 and for Guangzhou port 1.17 million m^2. The scale of container yards of Rizhao port and Yingkou port were 0.68 million m^2 and 0.45 million m^2 respectively. As for Lianyungang port, its owned the smallest scale of container yard among these ten ports, which was 0.196 million m^2.

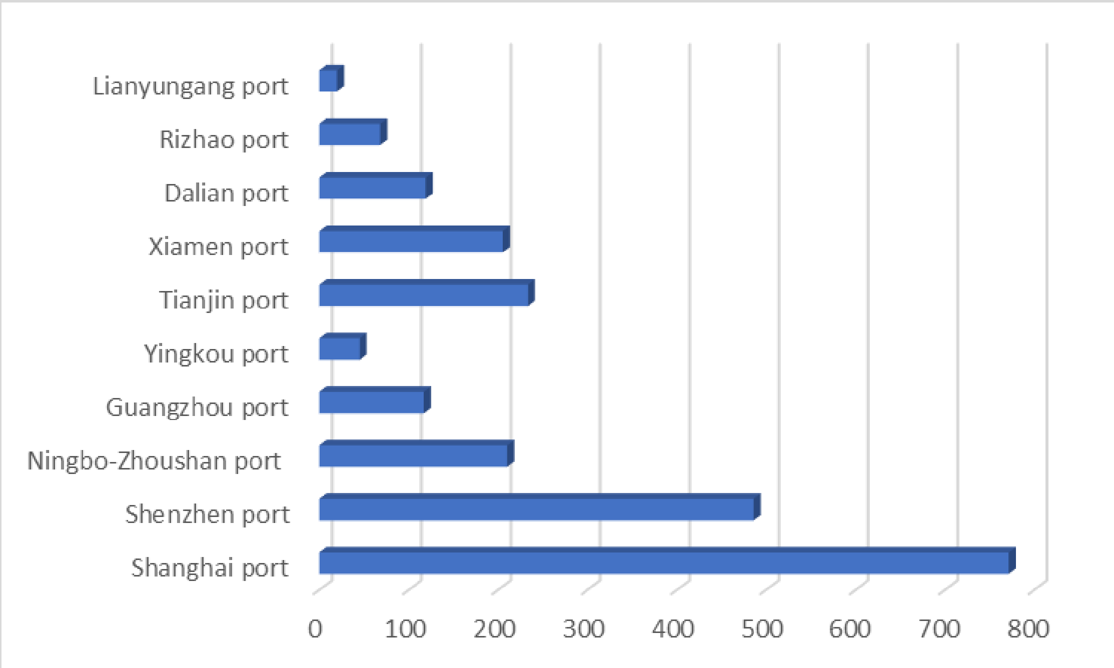

Figure 4 – Container yard area of the ten ports
Source: YEARBOOK PORTS OF CHINA 2017

4.1.5 The number of bridge cranes

The number of bridge cranes for loading and unloading containers in each port are showed in the Figure 3.5.

From the aspect of the number of bridge cranes, Shanghai port (147) and Shenzhen port (128) still held the first and the second position among the ten ports, far more than the others. Those having the cranes more than 40 were Xiamen port and Ningbo-Zhoushan port, which were 55 and 49, and between 10 ~ 40, there were Guangzhou port (33), Tianjin port (37), Dalian port (22) and Rizhao port (15). The remaining ports were Yingkou port and Lianyungang port, of which the number of bridge cranes were less than 10. For Yingkou port, it had 6 cranes, and for Lianyungang port, it had only 2 cranes. Similarly, the ports which owned the larger container yard areas also had more bridge cranes for handling the containers.

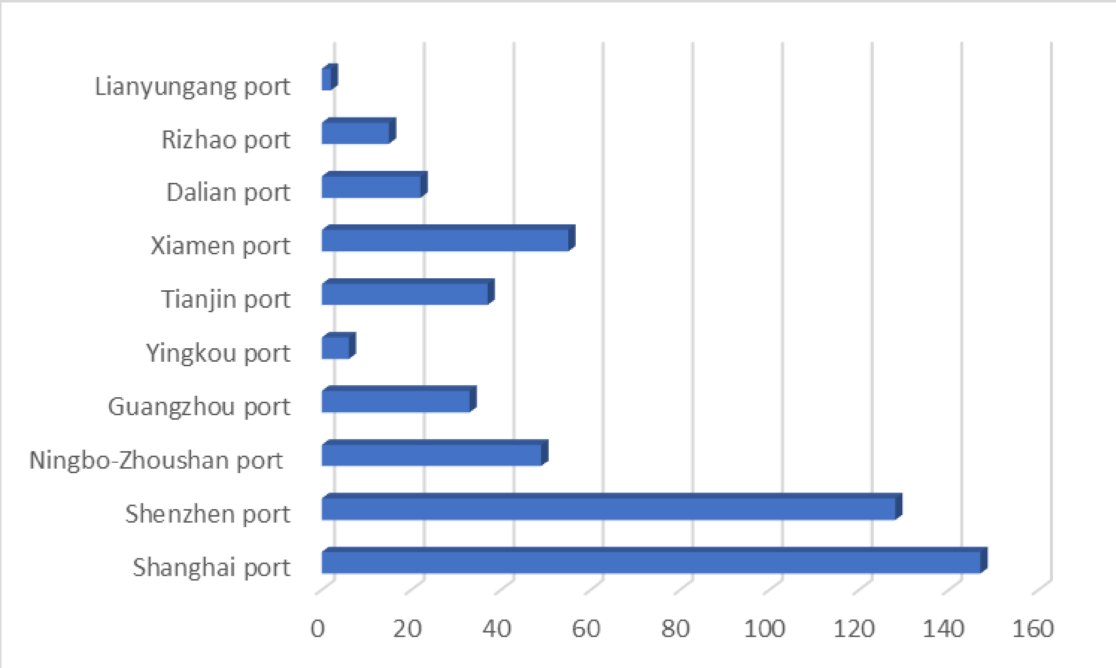

Figure 5 – The number of bridge cranes
Source: YEARBOOK PORTS OF CHINA 2017

4.2 The dynamic capability of port logistics service

Next, the dynamic capability of port logistics service will be analysed in this section. The indicators of the dynamic capability include cargo throughput, foreign trade throughput and container throughput, output per ship-hour, output per bridge crane-hour, the number of ship to port and average time per container staying on the yard.

4.2.1 Cargo throughput

The cargo throughput and the foreign trade throughput of the ten ports in 2016 is demonstrated in Figure 3.6. The blue bar shows the amount of cargo throughput and the orange line shows the amount of the foreign trade throughput with the unit of 10,000 tons.

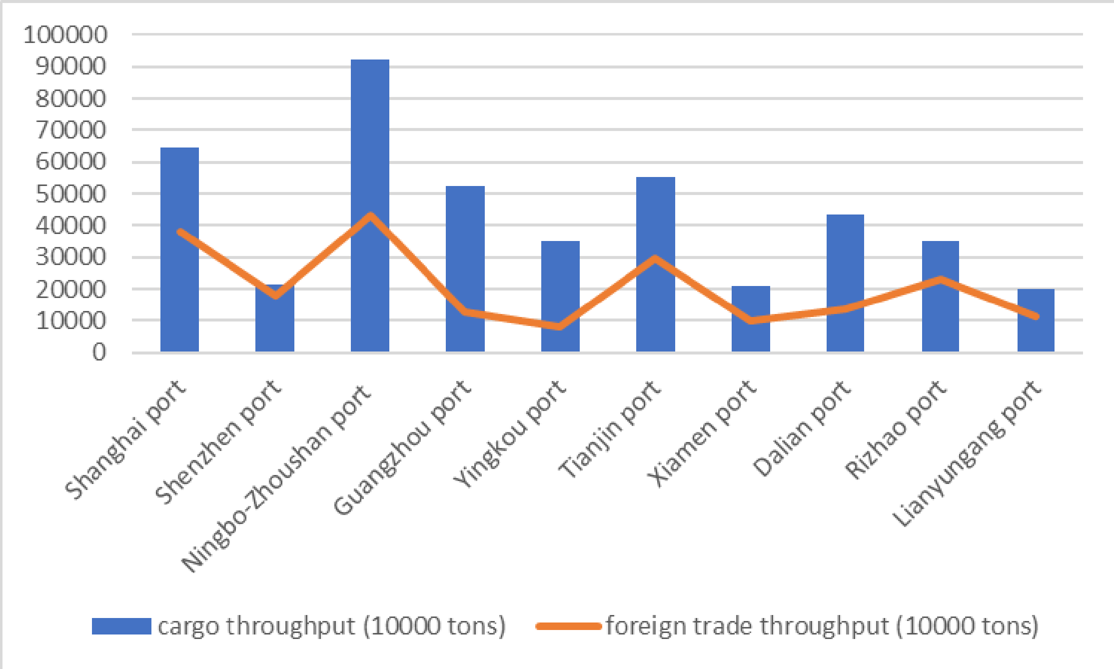

Figure 6 – Cargo throughput and foreign trade throughput of ten ports in 2016
Source: YEARBOOK PORTS OF CHINA 2017

From the aspect of the cargo throughput, Ningbo- Zhoushan port got the leading position among these ten ports, of which the cargo throughput was 922.09 million tons. The second leading position belonged to Shanghai port, of which the cargo throughput was 644.82 million tons. Then were Tianjin port (550.56 million tons) and Guangzhou port (522.54 million tons). Between 300 and 500 million tons, there were Dalian port (436.6 million t), Yingkou port (352.17 million t) and Rizhao port (350.07 million t). The remaining three ports had the similar cargo throughputs that Shenzhen port (214.1 million t), Xiamen port (209.11 million t) and Lianyungang port (200.82 million t).

On the other hand, from the aspect of the foreign trade throughput, the gap between Ningbo-Zhoushan port and Shanghai port was not very large that Ningbo-Zhoushan port had 431.35 million t and Shanghai port had 380.12 million t, however, they were still in a leading position. And only Tianjin port and Rizhao port's foreign trade throughputs were more than 200 million t, which were 296.93 million t and 232.46 million t respectively. Under 200 million t, there were Shenzhen port (180.22 million t), Guangzhou port (125.96 million t), Dalian port (139.1 million t), Lianyungang port (112.33 million t), Xiamen port (97.95 million t) and Yingkou port (79.55 million t).

As for the foreign trade throughput ratio, the Figure 3.7 shows that most of the cargos of Shenzhen port was for foreign trade, of which the ratio was highly up to 84%, and there were six ports at the medium level that Rizhao port accounted for 66%, Shanghai port accounted for 59%, Lianyungang port accounted for 56%, Tianjin port accounted for 54 % and Ningbo-Zhoushan port accounted for 47% as same as Xiamen port. The remaining three ports were at the low level that Dalian port took up to 32%, Guangzhou port took up to 24% and Yingkou port took up to 23%.

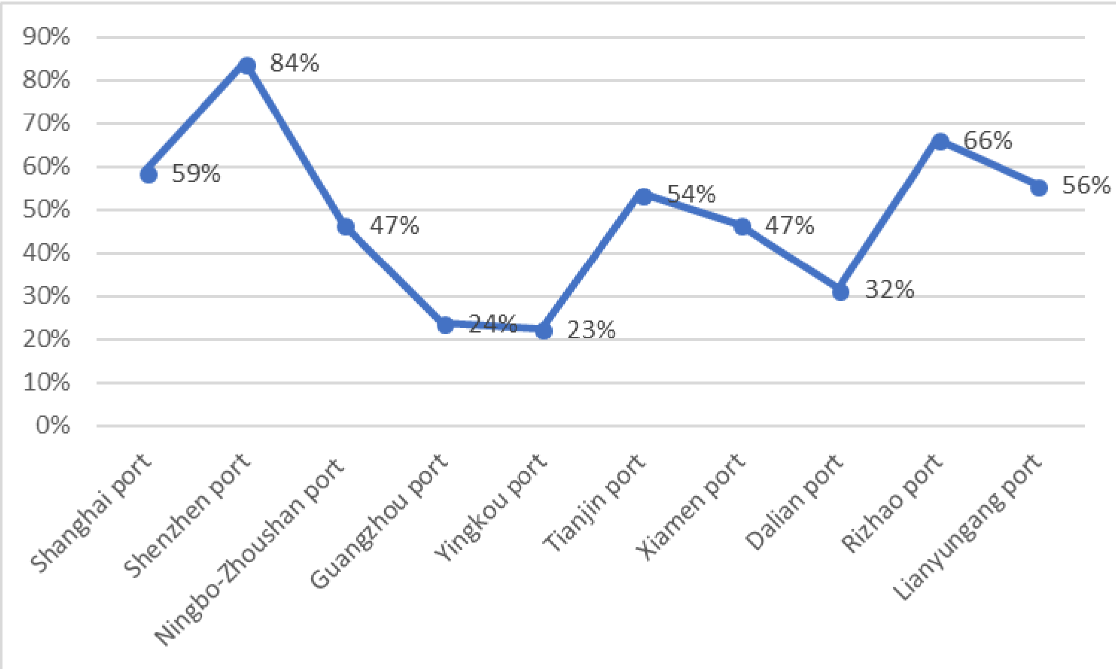

Figure 7 – Foreign trade throughput ratio
Source: YEARBOOK PORTS OF CHINA 2017

4.2.2 Container throughput

Figure 3.8 illustrates the container throughput of the ten ports in China in 2016. The unit of the indicator is 10,000 TEU.

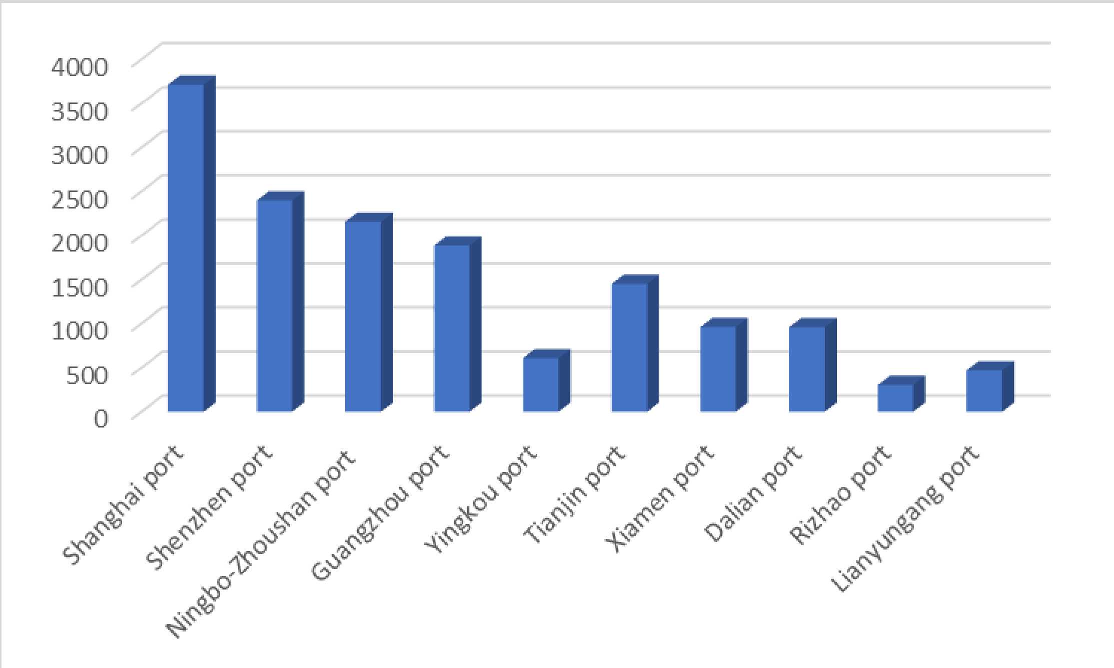

Figure 8 – The container throughput of the ten ports in 2016
Source: YEARBOOK PORTS OF CHINA 2017

With the large scale of container yard and many bridge cranes, Shanghai port has strong ability to handle the containers. Thus, in 2016, Shanghai port handled 37.13 million TEU, which was far more than the other ports. Although the cargos handled by Ningbo-Zhoushan port were more than that of Shenzhen port, the containers handled by Shenzhen port (23.98 million TEU) were more than that of Ningbo-Zhoushan port (21.57 million TEU). The other two ports which handled more than 10 million TEU containers were Guangzhou port (18.85 million TEU) and Tianjin port (14.52 million TEU). Under 10 million TEU, there were Xiamen port (9.61 million TEU), Dalian port (9.58 million TEU), Yingkou port (6.09 million TEU), Lianyungang port (4.7 million TEU) and Rizhao port (3.03 million TEU).

4.2.3 TEU per ship-hour

Figure 3.9 demonstrates the average amount of container loaded and unloaded per ship per hour of the ten ports in 2016, and the unit of this indicator is TEU/hour.

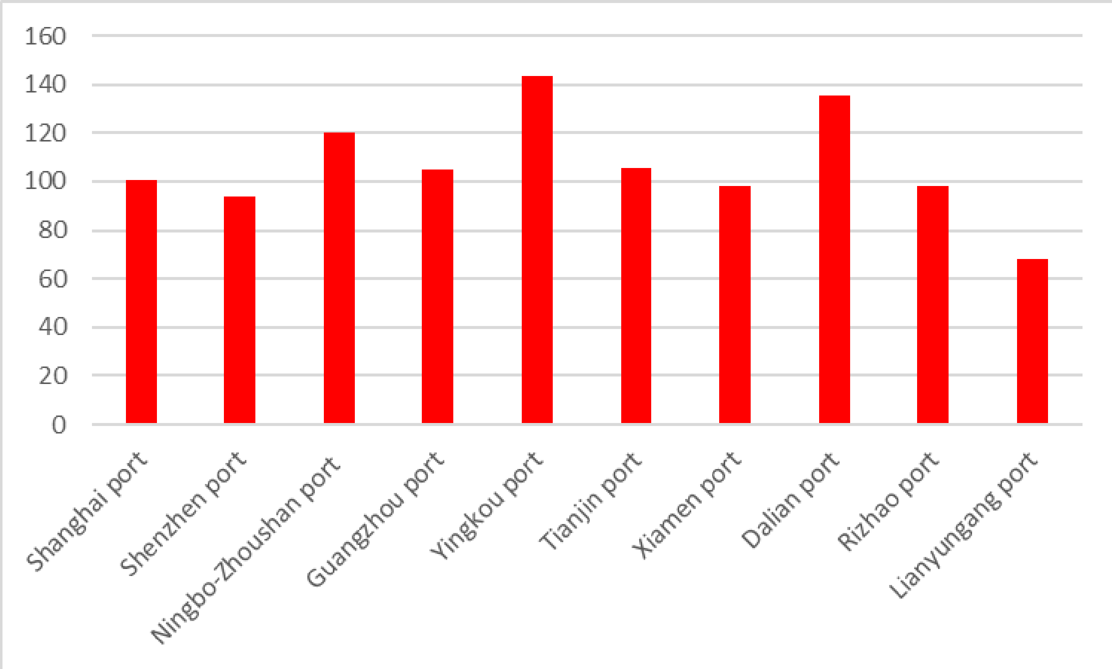

Figure 9 – TEU per ship-hour
Source: YEARBOOK PORTS OF CHINA 2017

The top three of the average amount of container loaded and unloaded per ship per hour among the ten ships were Yingkou port (143.25), Dalian port (135.41) and Ningbo-Zhoushan port (120.44). Between 100 ~ 120 TEU/hour, there were also three ports, which are Shanghai port (100.29), Guangzhou port (104.67) and Tianjin port (105.6). The TEU per ship-hour of the rest of the ports was under 100 TEU/hour that Shenzhen port was with 93.8 TEU/hour, Xiamen port was with 98.27 TEU/hour, Rizhao port was with 98.3 TEU/hour and Lianyungang port was with 68 TEU/hour which owned the lowest efficiency among these ports.

4.2.4 Output per bridge crane-hour

The average amount of container loaded and unloaded per bridge crane per hour of the ten ports in 2016 is demonstrated in the following chart, and the unit is TEU/hour.

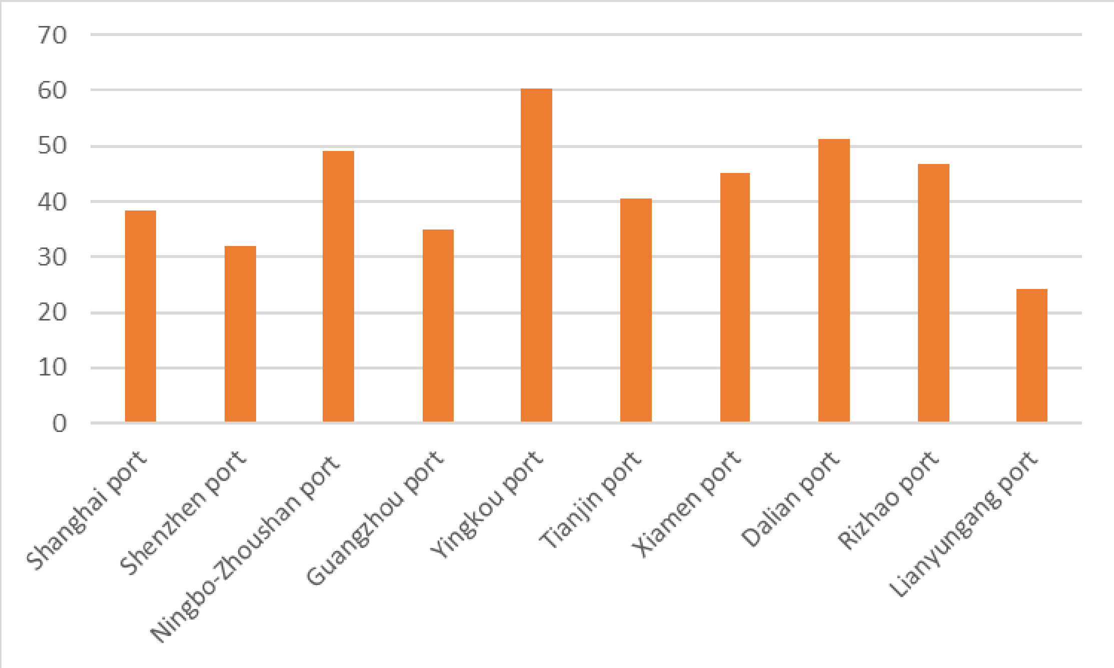

Figure 10 – Output per bridge crane-hour
Source: YEARBOOK PORTS OF CHINA 2017

In Yingkou port, one bridge crane had handled 60.25 TEU in an hour, which was the highest efficiency among the ten ports, while in Lianyungang port, one bridge crane had handled only 24.06 TEU in an hour. Among the other ports, there were Ningbo-Zhoushan port (48.99), Tianjin port (40.55), Xiamen port (45.1), Dalian port (51.31), and Rizhao port (46.8), of which the crane had handled more than 40 TEU in an hour. As for the remaining ports, Shanghai port's efficiency was 38.25 TEU /hour, Shenzhen port's efficiency was 32.04TEU/hour, and Guangzhou port's efficiency was 34.95 TEU/hour.

4.2.5 The number of ships arriving at the port

In Figure 3.11, it is showed that the number of container vessels arriving at each port in 2016.

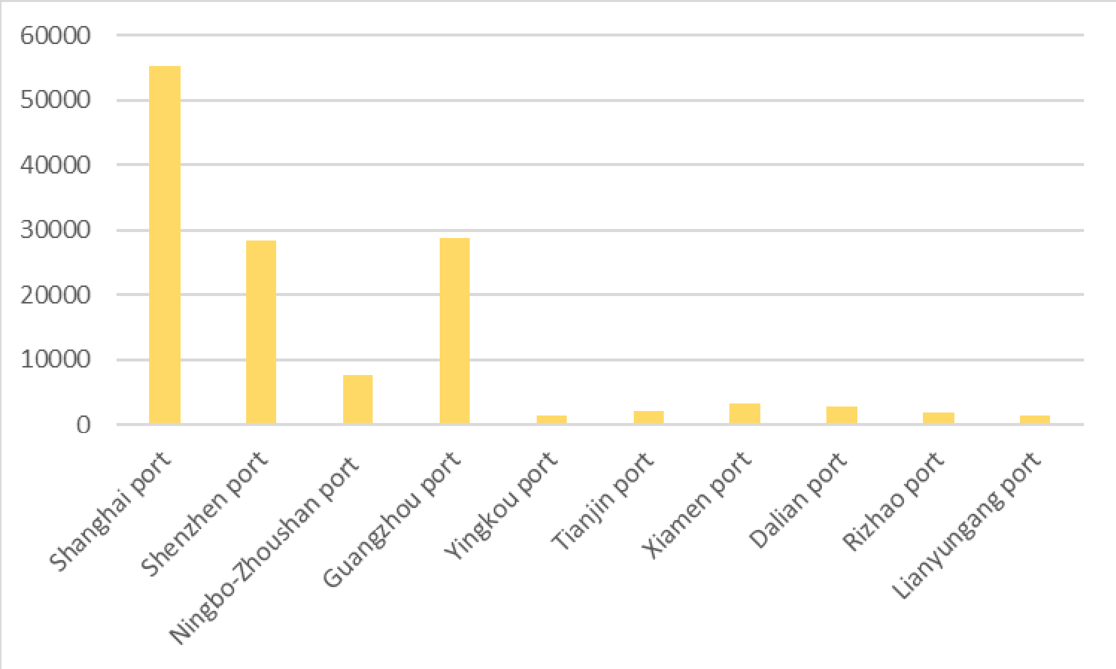

Figure 11 – The number of ships arriving at the port
Source: YEARBOOK PORTS OF CHINA 2017

According to the statistics, in 2016, a large amount of vessels chose to get to Shanghai port, which was 55203. Similarly, the other two ports, of which the numbers of arrivals were more than 10000 ships, were Shenzhen port (28299) and Guangzhou port (28858). As for the other ports, their numbers of container ships arriving at the ports were less than ten thousand. There were 7600 ships arriving at Ningbo-Zhoushan port, 3155 ships arriving at Xiamen port, 2771 ships arriving at Dalian port, 2026 ships arriving at Tianjin port, 1850 ships arriving at Rizhao port, 1481 ships arriving at Yingkou port, 1436 ships arriving at Lianyungang port.

4.2.6 Average time per container staying on the yard

The last indicator of the dynamic capacity of port logistics is the average time of each container staying on the container yard, which is showed in Figure 3.12, and the unit is day.

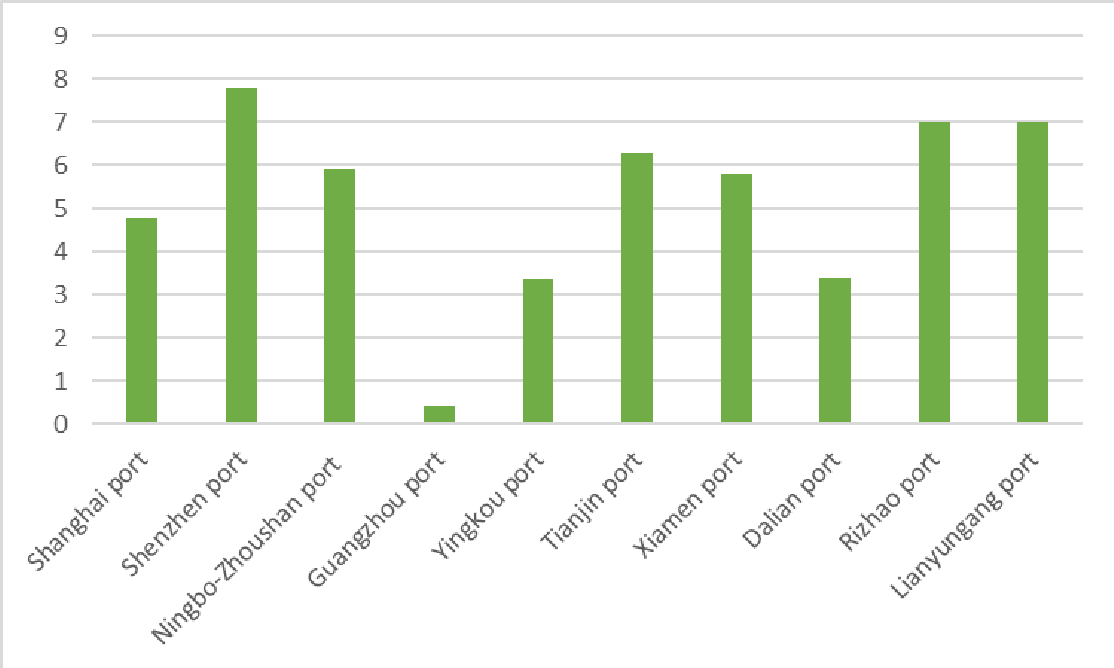

Figure 12 – Average time per container staying on the yard
Source: YEARBOOK PORTS OF CHINA 2017

As is showed in Figure 3.12, the container stayed in the Shenzhen port only for 0.44 days. In addition, those ports with the container staying on the yard for less than five days includes Shanghai port (4.78), Yingkou port (3.35) and Dalian port (3.38). The remaining ports with the average time of the container staying on the yard exceeding for five days were Shenzhen port for 7.82 days, Ningbo-Zhoushan port for 5.9 days, Tianjin port for 6.3 days, Xiamen port for 5.81 days and Rizhao port for 7 days which was as same as Lianyungang port.

4.3 The existing problems

The coastal deep-water shoreline, the number of deep-water berths, and specialized equipment are all important resources for a port to be competitive, which is of great significance for the sustainable development of the port. Scarcity and non-renewability are the most significant features of this resource. Although China has sufficient coastline, the various types of resources which are suitable to be constructed for the large-scale vessels berthing are scarce and distributed unregularly, making port planning more difficult. Judging from the current development trend, for bulk terminals, it must be able to provide berthing services for large vessels with a 30-50-thousand-ton load. The water depth at the foreshore of the terminal and the water depth of the channel should be below -15 metres to meet the current requirements of the shipping industry. Therefore, the port should have three necessary characteristics: the first one is enlargement; the second one is deep-water and the third one is specialization. For the port, if there are no deep-water channels and berths, it will not be possible to provide berthing services for larger vessels, which will inevitably have weaknesses in attracting customers. At the same time, it will also be affected in terms of development, from the aspect of the functional orientation of the port, it can only provide supporting services for the hub port and help the hub port to complete a larger throughput. Based on the above factors, there is no relatively sufficient number of deep-water shoreline and deep-water berths, which is one of the reasons that affect the port logistics capacity of China's major ports. At the same time, in terms of infrastructure, the infrastructure of China's major ports is currently uneven, and a few China's leading ports have the infrastructure with higher specialization, but there is still a large gap between the level of infrastructure in those ports with leading international status, which causes the situation that although the large ports with strong capacity, such as Tianjin Port, Shanghai Port, and Shenzhen Port, have performed well in China, there is still a large gap between them and the advances ports in the world. On the other hand, the level of port infrastructure and facilities will also influence the level of port efficiency, which makes the dynamic capability of the ten ports uneven, too.

4.4 The empirical analysis of the logistics capacity of Chia's main ports

This section uses multi-level factor analysis method to evaluate the logistics service capability of 10 major ports along the "B & R" in China. The evaluation content mainly includes the two aspects of the port's static capabilities and dynamic capabilities. During the evaluation process, SPSS is used to extract the most influential public factors from each of the third-level indicators and calculate the score of the second-level indicators. Finally, the evaluation results of various secondary indicators are combined and integrated into new variables. And do the factor analysis again to obtain the comprehensive score and ranking of the first-level indicators, that is, to obtain the score and ranking of port logistics service capability.

4.4.1 The original data

According to the evaluation index system of port logistics service capability, the original data of the major ports along the “B & R” in China in 2016 are summarized.

The major ports along the “B & R” in China are Shanghai port, Ningbo-Zhoushan port, Shenzhen port, Xiamen port, Yingkou port, Rizhao port, Dalian port, Guangzhou port, Lianyungang port and Tianjin port. The source of the selected data is from YEARBOOK PORTS OF CHINA 2017, among them, the relevant data of Ningbo Zhoushan Port is the sum of data of Ningbo Port and Zhoushan Port.

X_{11} - X_{17} respectively represents: the length of the berth, the number of berth, the number of 10,000-ton berth, and the annual cargo passing capacity, the annual container annual passing capacity, container yard area and the number of the bridge crane.

X_{21} – X_{27} respectively represents: cargo throughput, container throughput, the foreign trade throughput, TEU per ship-hour, output per bridge crane-hour, the number of ship arriving at the port and the average time per container staying on the yard.

Table 2 – The original data of various indicators of China’s major ports

Port	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
Shanghai port	109200	1195	224	53000	1983	771.28	147
Shenzhen port	32448	156	74	23900	2222	486	128
Ningbo-Zhoushan port	71500	639	164	43500	1565	210	49
Guangzhou port	22849	152	76	25631	1067	117	33
Yingkou port	19709	93	61	10440	220	45	6
Tianjin port	39389	176	122	46400	1131	233.2	37
Xiamen port	29236	164	75	8673	1031	205.1	55
Dalian port	43956	222	103	28700	489.6	119	22
Rizhao port	17289	69	52	20467	65	68	15
Lianyungang port	16450	80	57	4770	320	19.6	2

Continued table

Port	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_{27}
Shanghai port	64482	3713	38012	100.29	38.25	55203	4.78
Shenzhen port	21410	2398	18022	93.8	32.04	28299	7.82
Ningbo-Zhoushan port	92209	2157	43135	120.44	48.99	7600	5.9
Guangzhou port	52254	1885	12596	104.67	34.95	28858	0.44
Yingkou port	35217	608.6	7955	143.25	60.25	1481	3.35
Tianjin port	55056	1452	29693	105.6	40.55	2026	6.3
Xiamen port	20911	961	9795	98.27	45.1	3155	5.81
Dalian port	43660	958	13910	135.41	51.31	2771	3.38
Rizhao port	35007	303	23246	98.3	46.8	1850	7
Lianyungang port	20082	470	11233	68	24.06	1436	7

Source: YEARBOOK PORTS OF CHINA 2017

4.4.2 Standardization of the data

Due to the problem of different dimensions of indicator data coexisting, for example, the unit of the length of the berth is metre, while the unit of the cargo throughput is 10,000 tons and the unit of the container throughput is 10,000 TEU. Thus, in order to make each index comparable and integrated to conduct more effective comparative analysis, it is necessary to standardize the original data first, so as to eliminate the influence brought by different dimension. The non-dimensionalized standard data processed by SPSS 22.0 is as follows:

Table 3 – The data after standardization

	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
Shanghai port	2.35193	2.52674	2.22838	1.59225	1.30548	2.33248	1.96415
Shenzhen port	-.26433	-.38894	-.48475	-.15940	1.62594	1.10899	1.58179
Ningbo-Zhoushan port	1.06684	.96647	1.14313	1.02040	.74502	-.07470	-.00805
Guangzhou port	-.59154	-.40017	-.44857	-.05520	.07729	-.47355	-.33004
Yingkou port	-.69857	-.56574	-.71988	-.96961	-1.05840	-.78234	-.87340
Tianjin port	-.02773	-.33282	.38346	1.19497	.16310	.02480	-.24954
Xiamen port	-.37382	-.36649	-.46666	-1.07597	.02902	-.09572	.11270
Dalian port	.12794	-.20373	.03979	.12953	-.69691	-.46498	-.55141
Rizhao port	-.78106	-.63309	-.88267	-.36605	-1.26622	-.68370	-.69228
Lianyungang port	-.80966	-.60222	-.79223	-1.31091	-.92431	-.89128	-.95390

Continued table

	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_{27}
Shanghai port	.89430	2.09197	1.39311	-.30146	-.37993	2.29390	-.17803
Shenzhen port	-.98899	.85417	-.22107	-.60185	-.97274	.82222	1.18179
Ningbo-Zhoushan port	2.10664	.62732	1.80678	.63120	.64531	-.31004	.32296
Guangzhou port	.35964	.37128	-.65921	-.09873	-.69495	.85280	-2.11936
Yingkou port	-.38529	-.83018	-1.03397	1.68697	1.72020	-.64476	-.81768
Tianjin port	.48216	-.03630	.72135	-.05568	-.16037	-.61495	.50188
Xiamen port	-1.01081	-.49847	-.88539	-.39495	.27397	-.55319	.28270
Dalian port	-.01613	-.50129	-.55311	1.32409	.86678	-.57419	-.80426
Rizhao port	-.39447	-1.11784	.20077	-.39357	.43625	-.62457	.81500
Lianyungang port	-1.04706	-.96065	-.76927	-1.79602	-1.73452	-.64722	.81500

4.4.3 Multi-layer factor analysis

Take the three-level index of dynamic capabilities as an example to evaluate the dynamic capacity that affect port logistics capabilities.

1) Extract factor and solve factor load matrix

   Use SPSS 22.0 to calculate the eigenvalue, variance contribution rate and cumulative contribution rate of the correlation matrix R to determine the number of common factors. Synthesize the original variables into fewer factors, maximally rotate the variance of the factor model, and then extract the factors based on the initial eigenvalues and cumulative variance contribution rates after the rotation. If the initial eigenvalue is greater than 1, and the cumulative variance contribution rate is closer to 80%, the extracted common factor will be able to reflect the original data information, which is more realistic. The results are shown in the following table:

Table 4 – Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.792	39.879	39.879	2.792	39.879	39.879	2.328	33.253	33.253
2	2.395	34.218	74.097	2.395	34.218	74.097	2.073	29.619	62.872
3	1.229	17.554	91.651	1.229	17.554	91.651	2.015	28.779	91.651
4	.467	6.668	98.318						
5	.088	1.264	99.583						
6	.023	.335	99.918						
7	.006	.082	100.000						

Extraction Method: Principle Component Analysis

   According to the above table, the initial eigenvalues of the first three factors are 2.792, 2.395 and 1.268 greater than 1, and the cumulative variance contribution rate is 91.651%, which is greater than 80%. Therefore, the information of the original data can be well represented, which is of practical significance.

2) Factor rotation

   By rotating the factor loading matrix, the common factor's load coefficient is closer to 1 or 0, which makes it easier to interpret and name variables. In this paper, the common factors are explained and named according to the rotated factor load matrix. The results are shown in the following table:

Table 5 – Rotated Component Matrix

	Component		
	1	2	3
X21	.382	.814	.260
X22	-.092	.520	.806
X23	-.087	.973	.179
X24	.947	.135	-.117
X25	.845	.170	-.387
X26	-.145	.198	.928
X27	-.730	.328	-.491

Extraction Method: Principle Component Analysis
Rotation Method : Varimax with Kaiser Normalization
a. Rotation converged in 7 iteration

According to the above table, for component one, TEU per ship-hour and output per bridge crane-hour indicate that component one mainly explains these two variables; for component two, cargo throughput and foreign trade throughput indicate the composition and explaining the two variables; for component three, the loads of container throughput and the number of ship arriving at the port are 0.806 and 0.928, respectively. Therefore, it can be considered that component 3 mainly explains these two variables, so that we can relate the obtained components to the original variables.

3) Calculate the score of the factor

To calculate the comprehensive score, first use SPSS 22.0 to calculate the value of each factor.

Table 6 – Component Score Coefficient Matrix

	Component		
	1	2	3
X21	.135	.380	.002
X22	-.018	.126	.352
X23	-.088	.517	-.112
X24	.401	.042	-.033
X25	.335	.126	-.205
X26	-.013	-.079	.488
X27	-.376	.337	-.407

Extraction Method: Principle Component Analysis
Rotation Method：Varimax with Kaiser Normalization
Component Scores

The composition expression is as follow:

$F_{21} = 0.135*X_{21} – 0.018*X_{22} – 0.088*X_{23} + 0.401*X_{24} + 0.335*X_{25} – 0.013*X_{26} – 0.376*X_{27}$

$F_{22} = 0.380*X_{21} + 0.126*X_{22} + 0.517*X_{23} + 0.042*X_{24} + 0.126*X_{25} – 0.079*X_{26} + 0.337*X_{27}$

$F_{23} = 0.002*X_{21} + 0.352*X_{22} – 0.112*X_{23} - 0.033*X_{24} - 0.205*X_{25} + 0.488*X_{26} – 0.407*X_{27}$

4) Calculate the comprehensive score

After obtaining the factor score, the comprehensive score of each sample can be obtained according to the variance contribution rate of each factor,

ie:

$F_2 = (33.253/91.651)*F_{21} + (29.619/91.651)*F_{22} + (28.779/91.651)*F_{23}$

Then, according to the above method of factor analysis, conduct the factor analysis on the third-level indicator of the remaining influencing factor, the result is shown in the following table:

Table 7 – The component score of the corresponding three-level indicators

	Component		Component		
	1		1	2	3
X11	.170	X21	.135	.380	.002
X12	.166	X22	-.018	.126	.352
X13	.167	X23	-.088	.517	-.112
X14	.148	X24	.401	.042	-.033
X15	.148	X25	.335	.126	-.205
X16	.166	X26	-.013	-.079	.488
X17	.154	X27	-.376	.337	-.407

According to the composition score coefficient matrix of the above table, the score of each component can be obtained, as shown in the following table:

Table 8 – The score of each factor of the secondary indicator

	F11	F21	F22	F23
Shanghai port	2.307101	-0.25224	1.021441	1.862417
Shenzhen port	0.453795	-1.15184	-0.19727	0.463458
Ningbo-Zhoushan port	0.779753	0.465565	2.055662	-0.41334
Guangzhou port	-0.3675	0.611909	-1.03216	1.629296
Yingkou port	-0.89666	1.622666	-0.72248	-0.56755
Tianjin port	0.171156	-0.25417	0.747179	-0.56238
Xiamen port	-0.35576	-0.21449	-0.74755	-0.50654
Dalian port	-0.25105	1.186622	-0.41625	-0.2891
Rizhao port	-0.84598	-0.35947	0.176399	-1.12942
Lianyungang port	-0.99485	-1.65454	-0.88498	-0.48683

According to the score of each factor and the ratio of its variance contribution ratio to its cumulative contribution ratio, the comprehensive scores of the two second-level indicators can be obtained, and then conduct the factor analysis on the two second-level indicators to obtain the final comprehensive score. The table shows as follow:

Table 9 – First-level index score and ranking and comprehensive score and ranking

	F1	Ranking	F2	Ranking	F	Ranking
Shanghai port	2.307101	1	0.823393	1	1.711809	1
Shenzhen port	0.453795	3	-0.33614	7	0.064338	4
Ningbo-Zhoushan port	0.779753	2	0.70346	2	0.811047	2
Guangzhou port	-0.3675	7	0.400058	3	0.017802	5
Yingkou port	-0.89666	9	0.177036	5	-0.3935	7
Tianjin port	0.171156	4	-0.02734	6	0.07864	3
Xiamen port	-0.35576	6	-0.47847	9	-0.45617	8
Dalian port	-0.25105	5	0.205234	4	-0.02506	6
Rizhao port	-0.84598	8	-0.42806	8	-0.69667	9
Lianyungang port	-0.99485	10	-1.03917	10	-1.11224	10

Based on the above table, the average value of each port factor analysis score and the comprehensive score is zero. A positive value indicates that its capacity is above the average level, and a negative value indicates that its capacity is below the average level. In terms of the comprehensive scores, Shanghai port owned the highest scores among the ten ports, which was 1.711809. Also, the ranking of port logistics static capacity and dynamic capacity were both at the first position. In addition to Shanghai port, the comprehensive logistics capacities of Ningbo-Zhoushan port, Tianjin port, Shenzhen port and Guangzhou port was above the average level, while the logistics capacity of the remaining ports was relatively weaker than these five ports.

As for the static capacity, the capacities of Shanghai port, Ningbo-Zhoushan port, Shenzhen port and Tianjin port were all above the average level with Shanghai port far ahead of the other ports

As for the dynamic capacity, those greater than the average level of the capacity were Shanghai port, Ningbo-Zhoushan port, Guangzhou port, Dalian port and Yingkou port, and the other ports owned the capacity under the average level.

4.5 Evaluation of the logistics service capability of China’s main ports

According to the multi-level factor analysis method, this paper has obtained the ranking of major ports in China's logistics capacity. The ten strategic ports along the maritime silk road as the focus of this dissertation, are respectively located in the four port groups, the Yangtze River Delta, Pearl River Delta, Bohai Rim, and Southeast Coast port group. The logistics capacities of each port will more or less affect the position of their respective port groups in China and in the global market. Therefore, this chapter divides the main ports along the “B & R” in China by the port groups where the major ports of China are located, and then refines them to all levels affecting the logistics of the port and evaluates its capacity.

4.5.1 The evaluation of the main ports in Yangtze River Delta region

Shanghai Port and Ningbo-Zhoushan Port selected in this article is located in the economically developed Yangtze River Delta port group, dedicated to serving the economic and social development of the Yangtze River Delta and areas along the Yangtze River

(1) Shanghai port

Not only does Shanghai port got the highest comprehensive score among the ten ports, but also holds the leading position on the two aspects of static capacity and dynamic capacity. Although Shanghai Port has the largest number of tons of berths, the ratio of the number of 10,000-ton berth is still not at the high level for Shanghai port. Thus, it is necessary for Shanghai port to keep developing the deep-water berths to attract more potential customers. On the other hand, with the high efficiency of container handling and the sufficient infrastructure, Shanghai port’s container business is quite outstanding.

In general, Shanghai Port should consolidate its own port infrastructure, and at the same time continue to improve its service efficiency so as to increase its ability to attract customers and actively participate in international competition.

(2) Ningbo-Zhoushan port

The Ningbo-Zhoushan Port ranks second in overall score and has absolute leading edge over other ports. From the aspect of port infrastructure, Ningbo Zhoushan Port has good port infrastructure and adequate specialized facilities. In particular, the new port merged between Ningbo Port and Zhoushan Port possesses much better port coastline resources and terminal resources than ever before. Whether it is the length of the shoreline or the number of berths, or whether it is far ahead of other ports in terms of annual capacity, this undoubtedly has an important effect on the overall capacity of the port. at present, the cargo throughput of Ningbo-Zhoushan port has held the first position, while the container throughput only gets the third position. Therefore, Ningbo-Zhoushan Port needs to strengthen the integration of port resources, make more reasonable allocation of its own resources, and vigorously expand the development space of Ningbo Zhoushan Port container terminal to enhance the port's dynamic capacity.

(3) Lianyungang port

Despite the ratio of the number of 10,000-ton berth and the ratio of the foreign trade throughput are relatively high. However, from the aspect of the comprehensive capacity, Lianyungang Port is the weakest one among the ten ports. The regional government should invest more money on the construction of the infrastructure of Lianyungang port, and Lianyungang port should constantly expand the business and greatly enhance the efficiency of the port to enhance the strength of the port.

Although Lianyungang port is weak, the Yangtze River Delta port-group still have the two strong ports that makes the YRD port-group the leading position among China's other port-groups.

4.5.2 The evaluation of the main ports in Circum-Bohai-Sea region

Of the ten major ports selected in this paper, Dalian port, Tianjin port, Yingkou port and Rizhao port are all located in the Bohai Rim port-group. This section evaluates the logistics capabilities of these four ports.

(1) Tianjin port

Tianjin Port ranks third in terms of overall score. From the point of port infrastructure, Tianjin Port's static capacity is above the average of ten ports with the complete infrastructure and the strong port's annual passing capacity. At present, Tianjin Port has started to build additional railways. Based on the positioning of the international shipping center in the north, the infrastructure of the port is improved, and a more scientific and similar plan is made for the entire port, so as to ensure a good development of the port infrastructure. Tianjin Port should make full use of the advantages of the Tianjin Free Trade Zone and other policies and trade to vigorously develop the level of international trade in the port area, and improve service efficiency, providing better services for shipping companies and making Tianjin Port an important node connecting countries along the "B & R".

(2) Dalian port

The overall ranking of Dalian Port is NO.6, and its port dynamic capacity is above the average level of the ten ports, which benefits from its relatively good port efficiency, however its static capacities are weak. Therefore, Dalian Port should focus its development on the construction of port infrastructure, actively link the "B & R" strategy, and build itself into a multi-functional domestic strong port. also, it should promote the transformation and upgrading of the port, driving with innovation, improve its own strength in all aspects, speed up the construction of port automation, improve the port's efficiency, and optimize the allocation of port resources.

(3) Yingkou port and Rizhao port

Yingkou Port and Rizhao Port ranked seventh and ninth respectively in terms of comprehensive scores. Their static capabilities and dynamic capabilities are very weak, especially for the container business, the container yard area and the number of bridge cranes are insufficient. Therefore, while increasing investment in port infrastructure, these two ports must also vigorously develop container business in order to catch up with the development of other ports.

4.5.3 The evaluation of the main ports in Southeast Coastal Area

(1) Xiamen port

Xiamen Port’s logistics capacities are relatively weak. The main reason is that port infrastructure and port production are also relatively backward. However, in terms of port infrastructure construction, Xiamen Port actively responds to the development trend of large-scale ships in the port and shipping industry, and makes the planning of the future development of the port. it is expected that by the end of 2018, a cumulative investment of 10 billion yuan will be spent on the infrastructure construction of the port, aiming to build a deep-water waterway that can meet the requirements for ships of 200,000 tons or more.

4.5.4 The evaluation of the main ports in Pearl River Delta region

Guangzhou port and Shenzhen port selected in this article belong to the Pearl River Delta port-group and serve as the main hubs of the southern and southwest region in China, which promotes exchanges between Guangdong Province, inland areas and Hong Kong and Macao.

(1) Guangzhou port

The overall score of Guangzhou Port ranks fifth and the logistics capacity is above the average level of China's major ports. The length of the berth, the number of 10,000-ton berth and the number of the facilities for handling the container are not sufficient, influencing the static capacity under the average level, while owing to its port throughput and port efficiency, the dynamic capacity is above the average level. Therefore, Guangzhou port need continuous improvement of the infrastructure, and at the same time, the port resources should be effectively configured to make the port operations more efficient.

(2) Shenzhen port

Shenzhen Port ranks fourth behind Tianjin Port in overall score. Its port static capacity and dynamic capacity are above the average level, which benefits from its outstanding container business. In 2016, the container throughput of Shenzhen port was 23.98 million TEU, which was the second largest container throughput among the China's major ports. Overall, Shenzhen Port should have an in-depth understanding of the advantages and disadvantages of the port itself and do a good job of the port's functional orientation, steadily improving the static capacity and dynamic capacity of Shenzhen port.

5 Suggestion and conclusion

In this chapter, the author will give the suggestion and conclusion.

5.1 Suggestion

Static capabilities play a major role in port logistics service capabilities, while dynamic capabilities are a dynamic improvement on a static basis. Therefore, in the process of coordinating and advancing the construction of the 21st Century Maritime Silk Road, China's major ports should improve the port infrastructure through a series of measures to raise the overall efficiency and give full play to the basic role of ports in interconnection.

The infrastructure of the port is the guarantee for the normal operation of the port. Only when a port has a complete infrastructure can it serve the ship company normally, thus achieving a certain production capacity. The infrastructure of the port mainly includes the shoreline resources of the port, the number of deep-water berth in the port, the length of the berth and the yard area of the port. The larger the port and the specialized port infrastructure, the more efficient the port will be. In addition, the construction of professional terminals, like container terminals, is also an important part of infrastructure construction. Ports should rationally increase and allocate investment in infrastructure construction, improving infrastructure conditions and maintaining the sustainable development of infrastructure under the “B & R” policy to establish a good material foundation for improvement of service level of port logistics, attracting more and more customers.

5.2 Conclusion

The digital results obtained by the multi-factor analysis method are basically consistent with the actual situation of each port, and the scores and rankings are obtained through calculation and analysis. The port logistics service capacity evaluation model established by multi-factor analysis method can correctly reflect the logistics service capability of each port, and the model established in this paper can find the shortage of logistics service capability from static and dynamic levels, which can provide a reference for improving port logistics services.

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