

World Maritime University

# The Maritime Commons: Digital Repository of the World Maritime University

---

World Maritime University Dissertations

Dissertations

---

8-22-2020

## Port integration in the Yangtze River Delta area: practice and policy analysis

Jie Wang

Follow this and additional works at: [https://commons.wmu.se/all\\_dissertations](https://commons.wmu.se/all_dissertations)



Part of the [Economic Policy Commons](#), [Strategic Management Policy Commons](#), and the [Transportation Commons](#)

---

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact [library@wmu.se](mailto:library@wmu.se).

**WORLD MARITIME UNIVERSITY**

Shanghai, China



**PORT INTEGRATION IN THE YANGTZE**

**RIVER DELTA AREA:**

**Practice and Policy Analysis**

By

**WANG JIE**

**China**

A dissertation submitted to the World Maritime University in partial  
Fulfilment of the requirements for the award of the degree of

**MASTER OF SCIENCE**

**In**

**INTERNATIONAL TRANSPORT AND LOGISTICS**

2020

# 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.

(Signature): \_\_\_\_\_

(Date): \_\_\_\_\_

Supervised by: Professor Zheng Shiyuan

Supervisor's affiliation: Shanghai Maritime University

## **Acknowledgements**

First of all, I would like to express my sincere gratitude to my supervisor, Prof. Zheng Shiyuan. Although he is often busy with his work, he still replies to me immediately whenever I need help from him. With his instruction, I have the basic idea about how to write this kind of dissertation. In the beginning, Prof. Zheng recommended lots of information resources such as journal articles, reports to me for reference. After reading the information, I got more familiar with my topic. During the writing process, Prof. Zheng always helped to provide constructive comments and suggestions which have led to tremendous improvements to the dissertation. It is his careful guidance that has improved my academic writing ability and made this dissertation successfully completed. At the same time, Prof. Zheng's profound academic attainments and rigorous academic style also benefit me a lot. Therefore, I want to thank him for kind devote.

Then, I would like to thank the experts and scholars for accepting my interview and providing me with valuable information in the research of my dissertation.

I also owe a special debt of gratitude to all the professors in International Transport and Logistics (ITL) Programme, from whose devoted teaching and enlightening lectures I have benefited a lot and academically prepared for the dissertation.

Last but not least, I would like to thank my beloved family for their great support for my study and dissertation writing without a word of complaint.

## Abstract

Title of Dissertation: **Port Integration in the Yangtze River Delta Area:  
Practice and Policy Analysis**

Degree: **Master of Science**

Port integration in the Yangtze river delta (YRD) has become more and more important due to the eastward shift of shipping center, the intensification of regional shipping competition, the national strategic demand, excessive construction and resource idleness, etc.

The YRD port cluster is taken as the research object in the dissertation. Firstly, a brief look is taken at the development and integration status of the YRD port cluster. The definitions of port cluster and port integration are clarified, and the roles of them are examined.

Then the port integration modes in YRD is investigated, and detailed analysis and comparison of the port integration practice and integration degree of each province in YRD are made.

Base on mentioned modes above, a comprehensive evaluation mathematical model and a comprehensive evaluation indicator system are established to evaluate the integration efficiency of each provincial port cluster in YRD. The evaluation results show that integration efficiency of Shanghai port cluster is the highest, followed by Zhejiang, Jiangsu and Anhui, which also confirm the impact of the integration mode adopted by each provincial port cluster on the efficiency of port cluster integration.

Additionally, the current integration policies of the YRD port cluster are collated, and the existing problems in the process of the port integration are analyzed, then reasonable and feasible suggestions are proposed from the policy level for the reference of decision-makers.

The concluding chapter examines the results of the research and discusses the shortcomings. Several questions concerned are proposed for further investigation in the subject.

**Key words:** Port cluster; Integration mode; Efficiency evaluation; Policy support

# Table of contents

Declaration.....	ii
Acknowledgements.....	iii
Abstract.....	iv
Table of contents.....	v
List of figures.....	viii
List of tables.....	ix
List of abbreviations.....	x
<b>1. Introduction.....</b>	<b>1</b>
1.1. Research background.....	1
1.1.1. Global level.....	1
1.1.2. National level.....	2
1.1.3. Regional level.....	3
1.1.4. Port level.....	3
1.2. Research purpose.....	4
1.3. Literature review.....	5
1.3.1. Recent research on port integration.....	5
1.3.2. Existing problems.....	7
1.3.3. Amendments.....	8
1.4. Structure of the dissertation.....	9
<b>2. Development and integration status of the YRD port cluster.....</b>	<b>11</b>
2.1. Port cluster and integration.....	11
2.1.1. Port cluster.....	11
2.1.2. Port integration.....	14
2.2. Development status of the YRD port cluster.....	16
2.3. Integration status of the YRD port cluster.....	23
<b>3. Modes of the port integration in YRD.....</b>	<b>25</b>
3.1. Port integration practice of Shanghai municipality.....	25
3.1.1. Overview of Shanghai port.....	25
3.1.2. Reasons for the integration of Shanghai-Yangshan port.....	27

3.1.3. The integration process of Shanghai-Yangshan port .....	29
3.1.4. Analysis of the port integration practice of Shanghai municipality .....	34
3.2. Port integration practice of Zhejiang province .....	36
3.2.1. Overview of ports in Zhejiang province.....	36
3.2.2. The port integration process of Zhejiang province.....	38
3.2.3. Analysis of the port integration practice of Zhejiang province .....	43
3.3. Port integration practice of Jiangsu province.....	45
3.3.1. Overview of ports in Jiangsu province.....	45
3.3.2. The port integration process of Jiangsu province.....	46
3.3.3. Analysis of the port integration practice of Jiangsu province .....	49
3.4. Port integration practice of Anhui province.....	49
3.4.1. Overview of ports in Anhui province.....	49
3.4.2. The port integration process of Anhui province.....	49
3.4.3. Analysis of the port integration practice of Anhui province .....	52
3.5. Cross-provincial port integration practice in YRD .....	52
3.6. Comprehensive summarization of port integration modes in YRD.....	55
<b>4. Efficiency evaluation of the port integration in YRD .....</b>	<b>57</b>
4.1. Establishment of the port integration efficiency evaluation model .....	57
4.1.1. Establishment of comprehensive evaluation indicator system.....	58
4.1.2. The comprehensive evaluation method.....	61
4.2. Comprehensive evaluation of port integration efficiency in YRD .....	62
4.2.1. Comprehensive evaluation indicators of port integration efficiency in YRD .....	62
4.2.2. Measurement of comprehensive competitiveness of provincial port clusters in YRD.....	63
4.2.3. Determination of coordination coefficient of provincial port cluster in YRD ....	67
4.2.4. Calculation of comprehensive evaluation value of port integration efficiency in YRD.....	69
4.3. Result analysis of comprehensive evaluation of port integration efficiency in YRD.	70
<b>5. Policy supports to the port integration in YRD .....</b>	<b>73</b>
5.1. Policy development course of the port integration in YRD .....	73
5.2. Existing problems in the port integration in YRD .....	78
5.2.1. Fragmented governance and lack of a strong regulatory structure.....	78
5.2.2. Lack of long-term cooperation mechanism.....	79
5.2.3. Insufficient implementation strength on port division of labor and positioning .	80
5.2.4. Weak soft power of the port cluster .....	80
5.2.5. Abnormal development of collection and distribution system.....	81

5.2.6. Low international cargo transshipment ratio restricts the development of SISC	83
5.3. Policy suggestions to the port integration in YRD	83
5.3.1. Establish joint port authority to break the limits of administrative areas	83
5.3.2. Strengthen the rigor of planning to improve the efficiency of its implementation	84
5.3.3. Improve the mechanism for port cooperation to deepen port cooperation	85
5.3.4. Promote to establish a regional port information sharing mechanism	86
5.3.5. Accelerate the SISC construction by adjusting cargo structure and enhancing soft power	87
5.3.6. Improve the collection and distribution logistics network	88
5.3.7. Align national strategies to promote the port integration in YRD	88
5.3.8. Improve FTZs to deepen the port integration in YRD	89
<b>6. Conclusions and extensions</b>	<b>91</b>
6.1. Main conclusions	91
6.2. Research shortcomings and prospects	93
<b>Bibliography</b>	<b>95</b>
<b>Appendices</b>	<b>100</b>
Appendix A: Establishment of the judgment matrix	100
Appendix B: The indicator weights and consistency test in AHP	101



## List of figures

<b>Figure 1.</b> Technology roadmap of the dissertation.....	9
<b>Figure 2.</b> The spatial development of a port system .....	12
<b>Figure 3.</b> Evolvement of port cluster .....	13
<b>Figure 4.</b> Port clusters along the coast of China .....	16
<b>Figure 5.</b> Diagram of the port cluster in YRD .....	17
<b>Figure 6.</b> Evolution of the ports in YRD according to container throughput, 1979–2016....	18
<b>Figure 7.</b> Change of cargo throughput of YRD port cluster from 2011 to 2019 .....	19
<b>Figure 8.</b> Change of container throughput of YRD port cluster from 2011 to 2019.....	19
<b>Figure 9.</b> The change of cargo throughput of each port in YRD from 2013 to 2019.....	21
<b>Figure 10.</b> The change of container throughput of each port in YRD from 2013 to 2019....	22
<b>Figure 11.</b> Container throughput and its proportion of each port in YRD in 2019 .....	22
<b>Figure 12.</b> Shanghai Port and planned port development in the region. ....	26
<b>Figure 13.</b> The location of Yangshan Port.....	30
<b>Figure 14.</b> Spatial evolution model of a container port system.....	35
<b>Figure 15.</b> Port map of Zhejiang province .....	37
<b>Figure 16.</b> The General Layout of Ningbo-Zhoushan Port. ....	38
<b>Figure 17.</b> Port map of Jiangsu province .....	46
<b>Figure 18.</b> Map of the Yangtze River. ....	54
<b>Figure 19.</b> The recommended mode of resource integration in the YRD port cluster. ....	86

## List of tables

<b>Table 1.</b> Main contents, integration means and integration targets of port integration. ....	15
<b>Table 2.</b> Port throughput in YRD in 2019. ....	20
<b>Table 3.</b> Cases of the port integration in YRD. ....	24
<b>Table 4.</b> Container throughput of major ports in East Asia in 1996. ....	28
<b>Table 5.</b> Construction Plan of Yangshan port. ....	31
<b>Table 6.</b> SWOT analysis of Ningbo port. ....	39
<b>Table 7.</b> SWOT analysis of Zhoushan port. ....	39
<b>Table 8.</b> Complementary enumeration for Ningbo port & Zhoushan port. ....	40
<b>Table 9.</b> The modes of port integration in YRD. ....	56
<b>Table 10.</b> Efficiency evaluating indicator system for port integration in YRD. ....	61
<b>Table 11.</b> Comprehensive evaluation indicators and data of port integration efficiency in YRD. ....	63
<b>Table 12.</b> Determination of the level-1 indicator weights with AHP. ....	65
<b>Table 13.</b> The standardized evaluation data. ....	66
<b>Table 14.</b> Determine the comprehensive weights ( $W$ ). ....	66
<b>Table 15.</b> Calculate weighted evaluation value of the comprehensive competitiveness. ....	67
<b>Table 16.</b> Calculation of comprehensive evaluation value of port integration efficiency in YRD. ....	69
<b>Table 17.</b> Policy development course of the port integration in YRD. ....	74
<b>Table 18.</b> Policy development course of the port integration in YRD (continued). ....	75
<b>Table 19.</b> Policy development course of the port integration in Zhejiang province. ....	76
<b>Table 20.</b> Policy development course of the port integration in Jiangsu province. ....	77
<b>Table 21.</b> Policy development course of the port integration in Anhui province. ....	78
<b>Table 22.</b> Policy development course of the port integration in Shanghai municipality. ....	78
<b>Table 23.</b> The definition of judgement matrix. ....	100
<b>Table 24.</b> Result of judgment matrix of comprehensive competitiveness of port cluster ...	101
<b>Table 25.</b> Result of judgment matrix of regional economy ( $C_1$ ) ....	101
<b>Table 26.</b> Result of judgment matrix of scale of port cluster ( $C_2$ ). ....	101
<b>Table 27.</b> Result of judgment matrix of throughput of port cluster ( $C_3$ ) ....	101

## List of abbreviations

AHP	Analytic Hierarchy Process
APPSG	Anhui Provincial Port & Shipping Group Co., Ltd
B&R	The Belt and Road Initiative
COSCO	China Ocean Shipping (Group) Company
COSCP	Commission Office of Shanghai Combined Port
CPC	Communist Party of China
EDI	Electronic Data Interchange
FTZ	Free Trade Zone
JPG	Jiangsu Port Group Co., Ltd
MOT	Ministry of Transport
NPG	Ningbo Port Group Co., Ltd
NPMC	Ningbo-Zhoushan Port Management Committee
NZP	Ningbo Zhoushan Port Co., Ltd
NZPG	Ningbo Zhoushan Port Group Co. Ltd
PRC	People's Republic of China
RFID	Radio Frequency I Dentification
SIPG	Shanghai International Port (Group) Co., Ltd
SISC	Shanghai International Shipping Center
SWOT	Strengths Weaknesses Opportunities Threats
TEU	Twenty Feet Equivalent Unit
YBPA	Yangshan Bonded Port Area
YRD	Yangtze River Delta
YREZ	Yangtze River Economic Zone
YRS	Yangtze River Strategy
ZSDC	Zhejiang Seaport Development Committee
ZPG	Zhoushan Port Group Co., Ltd
ZPSIOG	Zhejiang Provincial Seaport Investment & Operation Group Co., Ltd

## **1. Introduction**

### **1.1. Research background**

#### *1.1.1. Global level*

Ports have always been a key element of world's economic development. According to statistics, around 90% of developed cities in the world are coastal cities, mainly benefiting from the fact that marine transportation is the main transportation mode of international trade. With the deep development of economic globalization, ports are not restricted to cargo handling and storage, but have become a bridge of global economic integration as well as a hub of international resources allocation. They bring together the flow of talent, capital, goods and information to become the most active market for reallocating resources. Therefore, the world's major ports launched a fierce competition for the status of international shipping center and logistics center.

At the same time, with the change of the global economic pattern, the pattern of ports in the world also presents a new development trend. Firstly, in recent years, with the rapid economic and trade development in Asia, international shipping resources have been gathering towards Asia, especially towards China. The eastward movement of the global shipping center will promote East Asia to become the main region of global container transportation and port development, which will bring a large number of shipping market demands. This also requires the YRD port cluster to accelerate the improvement of shipping service level, and upgrade to become the node region of global shipping resource allocation capacity. In addition, the scope of port competition in the world has become wider, especially in East Asia. The

competition among ports is no longer limited to domestic or adjacent ports. The competition area keeps expanding, and the competition for hub port status among ports of different countries in a larger region becomes a common phenomenon. Especially with the eastward migration of global shipping resources, the port competition in East Asia is particularly fierce. What's more, soft power competition becomes more important in term of international competitiveness. Most early port development benefits from good natural and geographical conditions. With the development of the time, more and more factors affect port international competitiveness. In particular, the fourth-generation ports should participate in international competition in the form of regional port alliances, integrate into the optimization of global supply chains, and become parts of the nodes of global logistics intelligence network, so as to build their international competitiveness.

In recent years, in order to improve the utilization efficiency of ships, expand market shares, enhance customer satisfaction degree, shipping companies build global shipping networks - shipping alliances, which can control which ports ships call at. They generally choose the ports with the largest volume of cargo and the highest generating efficiency of container. Besides, in order to achieve economies of scale, ships are developing towards gigantism in recent years. Because of the depth of water, however, only a few ports can handle large ocean ships. Therefore, the ports with deep water conditions must be used as hub ports and the other ports are used as branch ports and feeder ports, providing supporting services for the hub ports, so as to realize internal dislocation development and resource integration of the port cluster.

### ***1.1.2. National level***

At the same time, the YRD region bears a number of national strategic tasks, such as,

the Integrated Development of YRD, the Belt and Road Initiative (B&R), the Development Strategy of Yangtze River Economic Zone (YREZ) and the Shanghai International Shipping Center (SISC), etc. Firstly, with the goal of building world-class urban agglomeration, it has become a major regional unit participating in global competition. The YRD port cluster will become an important part of the regional integration of YRD and a key element of the international competitiveness of urban agglomeration. Besides, the YRD port cluster is an important hub for China to participate in the B&R, and its strategic position is extremely important. What's more, the YREZ strategy require it leads the middle and upper reaches of the Yangtze river to develop, thus radiating and driving the development of the central and western regions of China.

### ***1.1.3. Regional level***

The YRD is the foremost economic core area with the fastest economic development speed and the largest economic volume in China. The coordinated development of port cluster has become an important trend in the development of shipping in many countries. In addition, port cluster and urban agglomeration rely on and promote each other. Each of the six world-famous urban agglomerations has its own port cluster, which plays an important role in the development of urban agglomeration. The YRD urban agglomeration, as one of the six major urban agglomerations of the world, aims to be a world-class urban agglomeration. Port cluster integration becomes the key element of upgrading the urban agglomeration international competitiveness by drawing down the logistic cost.

### ***1.1.4. Port level***

Port industry is an industry with higher fixed costs and longer investment period. As

world economic growth has slowed in recent years, the volume of world trade has also declined, thus leading to a slowdown in the demand for shipping and an oversupply of port industrial facilities invested in the shipping growth period. What's more, vicious competition among / between the ports of the same area is intensifying. As a result, it is hard to avoid adverse outcomes, such as, port resources waste, excessive construction or resource idleness, etc. Therefore, different modes of port integration have been adopted successively abroad to realize dislocation development, thus enhancing the overall competitiveness and gradually transforming internal competition into competition with external ports. Their successful experience can be well referenced.

## **1.2. Research purpose**

Port integration in YRD is important and imperative while policies often play a decisive role due to China's political system. Therefore, the following problems will be solved in this dissertation in order to present a more comprehensive and in-depth study of the YRD port integration.

Firstly, what are the main modes of the port integration in YRD? What are the differences among them?

Secondly, how about the efficiencies of the port integration in YRD? How to evaluate them?

Finally, what are the current policy supports for the port integration in YRD? What are the problems existing? How to solve these problems at policy level?

### **1.3. Literature review**

#### ***1.3.1. Recent research on port integration***

Researchers have done many studies on port integration, especially in YRD in China. These studies have focused mainly on competition and / or cooperation.

In term of port competition, Notteboom and Yap (2012, chap. 27) suggest that port competition is not a well-defined concept as it depends on the type of port and the commodity handled. Port competition involves variety of competitions between shipping lines, terminals, logistics companies, land transporters, industries and the like. Tang (2010) points out that adjacent ports are typically fierce competitors, and the competitive interaction often results in strong market positions of the respective seaports. Zhuang and Song (2017) conduct the case study of the competition of Shanghai Port and Ningbo-Zhoushan Port and point out that port expansions have led to the increasingly-intensified competition among ports. Ports in proximity have been competing fiercely for shoreline resource, hinterland, hubs and feeders, and favorable economic policies. Based on the analysis of the concentration ratio of YRD by HHI index model, Li and Oh (2010) determine the ports of Shanghai and Ningbo-Zhoushan are in a very intensive competition. Ports are faced with competition from not only domestic ports but also their counterparts in other countries. Based on the assessment of shared hinterland, current supply and future expansion plans, the two ports' wider development strategies, price and quality of service, as well as political element, Cullinane et al. (2005) analyze the relative competitiveness of the neighboring container ports of Shanghai and Ningbo and to develop a view of the likely future outcome of the competition between them. Kim (2011) discusses the prospect of Premier Port competition in East Asia region and defines that Shanghai was evaluated as holding the highest probability toward



Premier Port rather than any other East Asian major ports based on the assessment on four elements including geographical advantages, scale of container volumes, cost advantage, as well as national port policy. Zhou et al. (2017) defines that Shanghai International Shipping Center is gradually developing into a multi-center overseas transportation hub through the output and data analysis. Shi et al. (2020) determine that Shanghai maritime clusters must be upgraded to feature ecologically friendly ports, global supply-chain hubs, and maritime resource allocation centers in order to cope with the fierce competition.

However, more and more researchers prefer to studying the cooperation and integration. Huo et al. (2018) generally discuss the evolution of port integration in China and conclude that the port integration in China has been transformed from national level to provincial level, while mainly discuss the port cooperation as well as port competition. Wang and Ducruet (2012) define the Shanghai–Yangshan dual hub port mode and a pattern of polycentric yet more compact multifunctional and multilayered gateway centered upon Shanghai. Ruan et al. (2018) propose a concept of port service network that consists of a huge hub and multiple ports to expand port capacity, reduce fixed integration cost, and finally enhance the port competitiveness of Zhejiang province. Song (2018) talks about the development of Ningbo-Zhoushan port from 2006 to 2009, and points out that along with its rapid growth, port integration in China will be increasingly pushed forward. Wang (2008) also takes Ningbo-Zhoushan port as an example to show that land lord port model is a relatively suitable one in China in order to better allocate resources of Chinese port industry. Hwang and Chiang (2010) explore causal relationships between influence factors, type of port cooperation, and port competitiveness in intra-regional container ports. The results indicate that two types of port cooperation would positively influence the competitiveness of adjacent ports in a region. Wang and Brian (2004)

analyze the case of YRD, where the competition, co-operation and governance of Shanghai and Ningbo, the two largest ports on Chinese mainland. Several chapters in Cullinane and Song (2007) are dedicated to the competition and cooperation issues in YRD. Ng (2013), Notteboom et al. (2009), Wang et al. (2015) discuss the cooperation among competing ports, especially the ports in proximity, is often regarded as a practical strategy to avoid the destructive inter-port competition and the disorderly or extravagant planning and construction. Lam et al. (2013), Song and Panayides (2008) discuss the necessity of port cooperation and integration, and point out more and more attention has been paid to the ways of port cooperation and integration.

### ***1.3.2. Existing problems***

Though the researchers have tried their best to elaborate on the topic thoroughly, some fields still need to be further studied. Firstly, the studies are limited to specific ports and small-scale integration, such as, Ningbo-Zhoushan Port (e.g., Dong et al., 2018; Fan and Xu, 2017; Feng et al., 2019; Li, 2004; Li, 2015), Suzhou Port (e.g., Xu, 2003; Yan, 2012; Yue, 2004), Shanghai-Yangshan Port (e.g., Wang and Ducruet, 2012; Zhang, 2004). However, the substantial large-scale port resource integration in YRD is the provincial port resource integration led by the governments in recent years, there is a lack of research in this area; Secondly, only a few researchers have attempted to use the quantitative analysis to study port cooperation/integration problems (e.g., Dong et al., 2018; Li and Oh, 2010; Xing et al., 2018; Zhou, 2015), most of the studies use qualitative analysis while quantitative analysis is not sufficient relatively; What's more, there are few researches on the port integration policies in YRD and lack of analysis and suggestions on the port integration in YRD at policy level.

### ***1.3.3. Amendments***

Aiming to the existing problems talked above, the provincial port integration in YRD -- larger-scale port integration is discussed and analyzed in detail, and its integration modes are explored; Besides, in order to evaluate the integration efficiencies of the YRD port cluster more persuasively, a comprehensive evaluation mathematical model and a comprehensive evaluation indicator system are established in the dissertation; In addition, the port integration policies in YRD are collated and the existing problems are analyzed, reasonable and feasible suggestions from policy level are put forward in the dissertation.

### 1.4. Structure of the dissertation

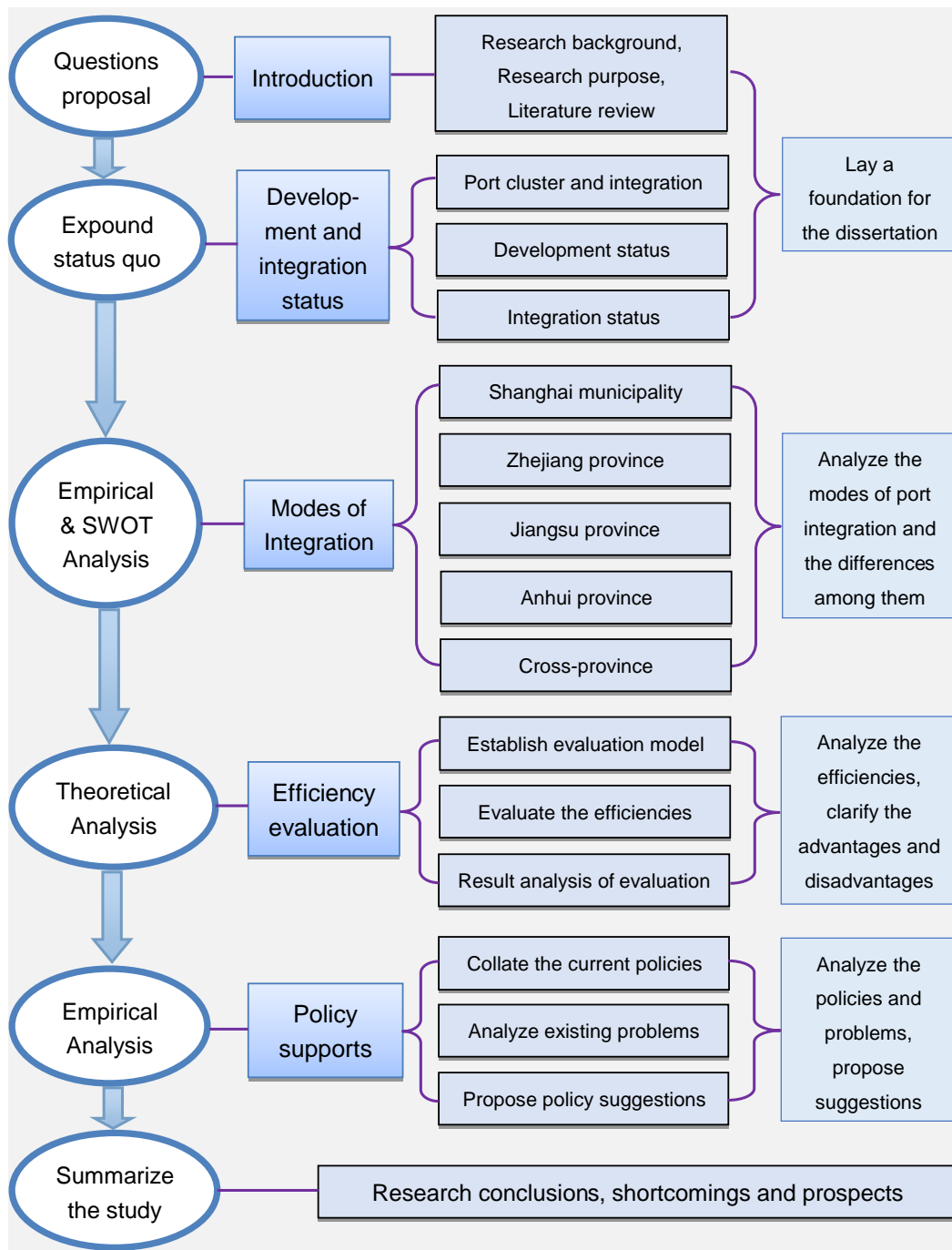


Figure 1. Technology roadmap of the dissertation

The rest of this dissertation is organized as follows: In Section **2**, the development and integration status of YRD port cluster are expounded, a foundation is laid for the dissertation; In Section **3**, modes of the port integration in YRD are studied, port integration practices are analyzed; In Section **4**, efficiencies of the port integration in YRD are evaluated, and the advantages and disadvantages of each mode are clarified; In Section **5**, policy supports to the port integration in YRD are discussed, and constructive suggestions at policy level are proposed. Finally, conclusions, shortcomings and prospects for future research are summarized in Section **6**.

## **2. Development and integration status of the YRD port cluster**

### **2.1. Port cluster and integration**

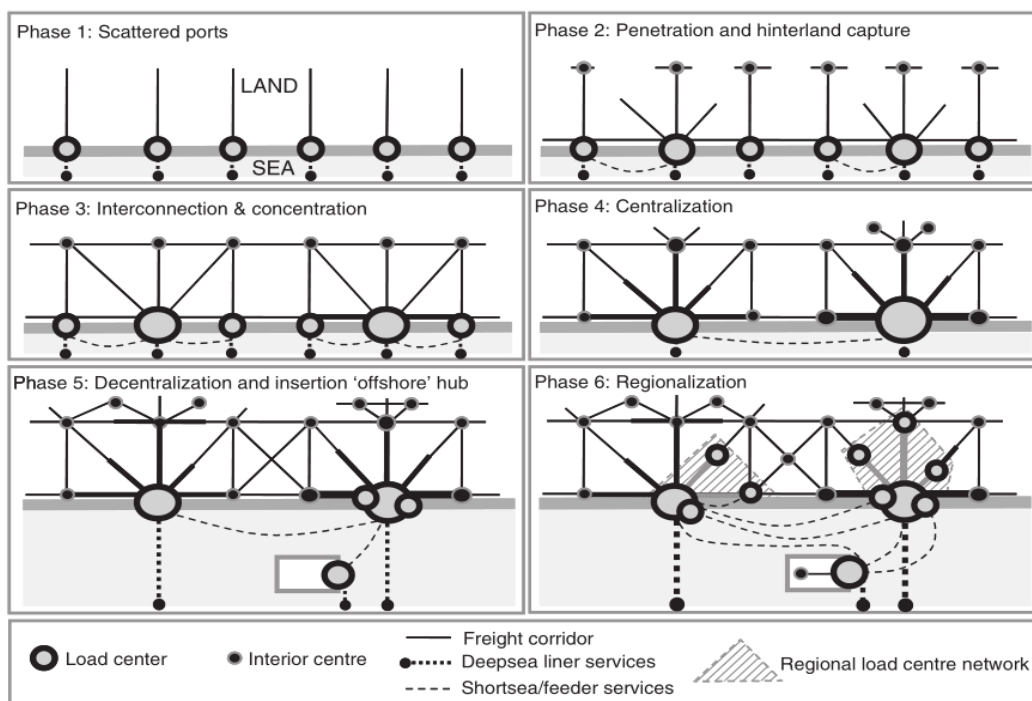
#### ***2.1.1. Port cluster***

Port cluster has been defined differently by various scholars. Peter W. de Langen (2006) and Freeman (1984) define it as all actors that can affect or are affected by the achievement of the firm's objectives. They point out that port clusters have a variety of stakeholders and consist of increasingly international firms (terminal operators, shipping lines, forwarders, manufacturing firms). These port clusters are often important specializations of the regional economy. However, among many other port cluster definitions, the core meanings are basically the same because port cluster is considered having the following basic elements in common: the same or similar hinterland, open ports and functional differences. Based on these definitions, it is defined as: A port cluster is a group of ports with same or adjacent cross hinterland in the same economic region, and part of port functions are complementary and alternative. Obviously, different from that defined to be a group of actors (stakeholders and firms) by De Langen (2006) and Freeman (1984), port cluster means a group of ports in this dissertation.

The core of overall performance of port cluster is to better realize the division of labor and cooperation of ports within a certain region, thus forming a highly specialized port cluster system with comprehensive service function. In a port cluster, there must be one or two central port(s) which play(s) an important role in the development of the port cluster. The central port(s) and other ports in the cluster have ability to attract each other in collection and distribution radiation. With the

improvement of port cluster productivity, the spatial interaction in the port cluster is increasingly strengthened, and the overall performance of the port cluster is also improved.

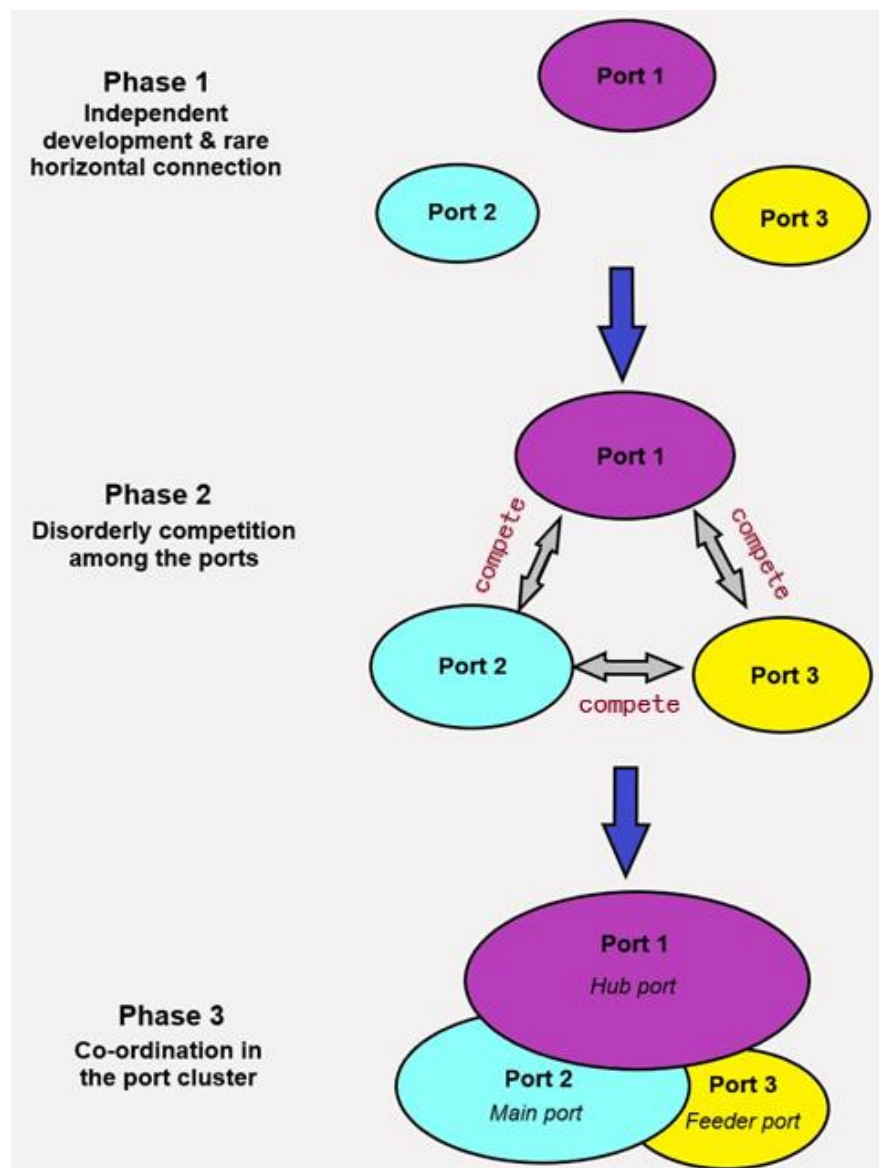
In terms of space layout, the development of ports has been expanded in land and sea directions. Notteboom and Rodrigue (2005) put forward “regionalization stage” of port development, and re-summarized the evolution process of port development, as shown in the **Figure 2**. They believe that modern ports have expanded in two aspects: The first is the construction of offshore hubs, especially the construction of deep-water container terminals, and the second is the cooperation with inland collection and distribution centers. The expansion of the two aspects strengthened the layout and integration of the port logistics system, making the development of the ports show regional characteristics.



**Figure 2.** The spatial development of a port system

Source: Notteboom and Rodrigue (2005).

Port regionalization is the process of port function development and layout expansion, leading to the relationship among ports much closer. This close relationship forms the basis of the emergence and development of port cluster. Wang (1993) proposes the formation of port cluster can be divided roughly into three phases, as shown in **Figure 3**.



**Figure 3.** Evolvement of port cluster

Source: Own realization based on various materials.



### **2.1.2. Port integration**

Port integration is the development process that the ports in the cluster take measures of creating a good open port development environment and establishing effective coordination mechanism, breaking the administrative barriers and constraints of market barriers, fully playing their respective advantages and functions, as well as forming “reasonable division of labor, complementary advantages, benign competition, common development, mutual benefit and win-win situation”, to realize continuous optimization of allocation of port resources, continuous improvement of port operation mechanism, and continuous enhancement of port comprehensive capacity and effective use. In a nutshell, port integration is to integrate the interrelated but separated functions within port cluster into a system with complementary functions of each port through organization and coordination, so as to achieve the effect of “ $1 + 1 > 2$ ” and rational allocation of port cluster resources.

In the process of regional economic integration, a single port can no longer bear the function of logistics node of the whole region, so it must reasonably assume the cargo transportation demand of the region through rational allocation of the port cluster resources. In addition, within a port cluster, due to cross overlap of hinterland or ports proximity, disorderly passive participation in competition, or even vicious competition would appear. At the same time, the division of labor among ports is very unclear, leading to some ports in over capacity and congestion while some ports in idle capacity. This cluster is an inefficient mix. In order to give full play to the overall strength of port cluster, generate economic benefits of agglomeration and form consistent external competitiveness, port integration needs to be carried out.

The contents of port integration generally include natural resources, administrative resources related to port management, as well as operational resources owned by port

enterprises. The integration means and targets of these port resources are summarized in **Table 1**.

**Table 1.** Main contents, integration means and integration targets of port integration.

Resource Types		Main Contents	Integration Means	Integration Targets
Natural resources		Water, lands, coastlines, economic hinterlands of ports	Under the guidance of the governments, relevant departments carry out the analysis of natural resources	Optimize the allocation, rational use of shoreline resources and economic capacity
Administrative resources		Port environment and policy systems, such as port management, pilotage, anchorages, border inspection, customs, inspection and quarantine, etc.	Reform of administrative management systems: Optimize administrative organization structures; And streamline administration and to delegate powers	Enhance administrative capacity
Operational resources	Logistics resources	Modes of supplier managing storage and goods procurement, modes of transportation organization, supply chain management services	1. Joint venture & cooperation 2. Agreement alliance 3. Leasing and hosting 4. Establishment of information sharing platform	Reduce the total logistics costs to enhance customer service ability and improve customer service level
	Customer resources	Related upstream and downstream enterprises in the port logistics supply chain, such as Shippers, carriers, freight organizers, distribution centers, shipping companies, etc.	Full range of services: 1. Real-time online tariff and tax assessment system 2. Distribution financial services for customers	The position & division of labor are clear, the service ability is strengthened, old customers are retained and new customers are increased.
	Capacity resources	Storage facilities and transportation equipment, freight organization and inventory control capacity, service knowledge, management experience	Service innovations: 1. Launch new service products and establish extensive strategic alliances 2. Improve logistics service networks	Information sharing of managerial resources, technical resources, human resources, enhance brand competitiveness
	Information resources	Ship information, port information, port owner information, information management systems	1. Establish information sharing mechanism 2. Utilize IT system	Information resources sharing, the establishment of a unified information platform

Source: Compiled by the author from various sources.

Port integration embodies the concept of coordinated development of port cluster and shows that the regional ports are developing towards the direction of optimal combination, and it is a process of increasing the degree of cooperation among regional ports (Zhen, 2009). It should include at least four aspects: ① geographical proximity, related coastlines, overlapped economic hinterlands and similar functions; ② a dynamic process of gradually coordinated development; ③ reflect strengthening the mutual connection within the region and achieve complementary strengths; ④ results: the regional port resources are effectively used, the internal competition tends to be reasonable, the internal consumption is distinctly

reduced, the competitiveness of the region is significantly enhanced.

## 2.2. Development status of the YRD port cluster

From the perspective of administrative region, YRD area includes Jiangsu province, Zhejiang province, Anhui province (included in 2015) and Shanghai municipality with provincial-level status. The port cluster in YRD refers to all ports located in this region. According to the National Plan for the Layout of Coastal Ports, there are five coastal port clusters in China from north to south. (**Figure 4**). Among them, the YRD port cluster is the biggest one.



**Figure 4.** Port clusters along the coast of China

Source: Own realization based on various materials.

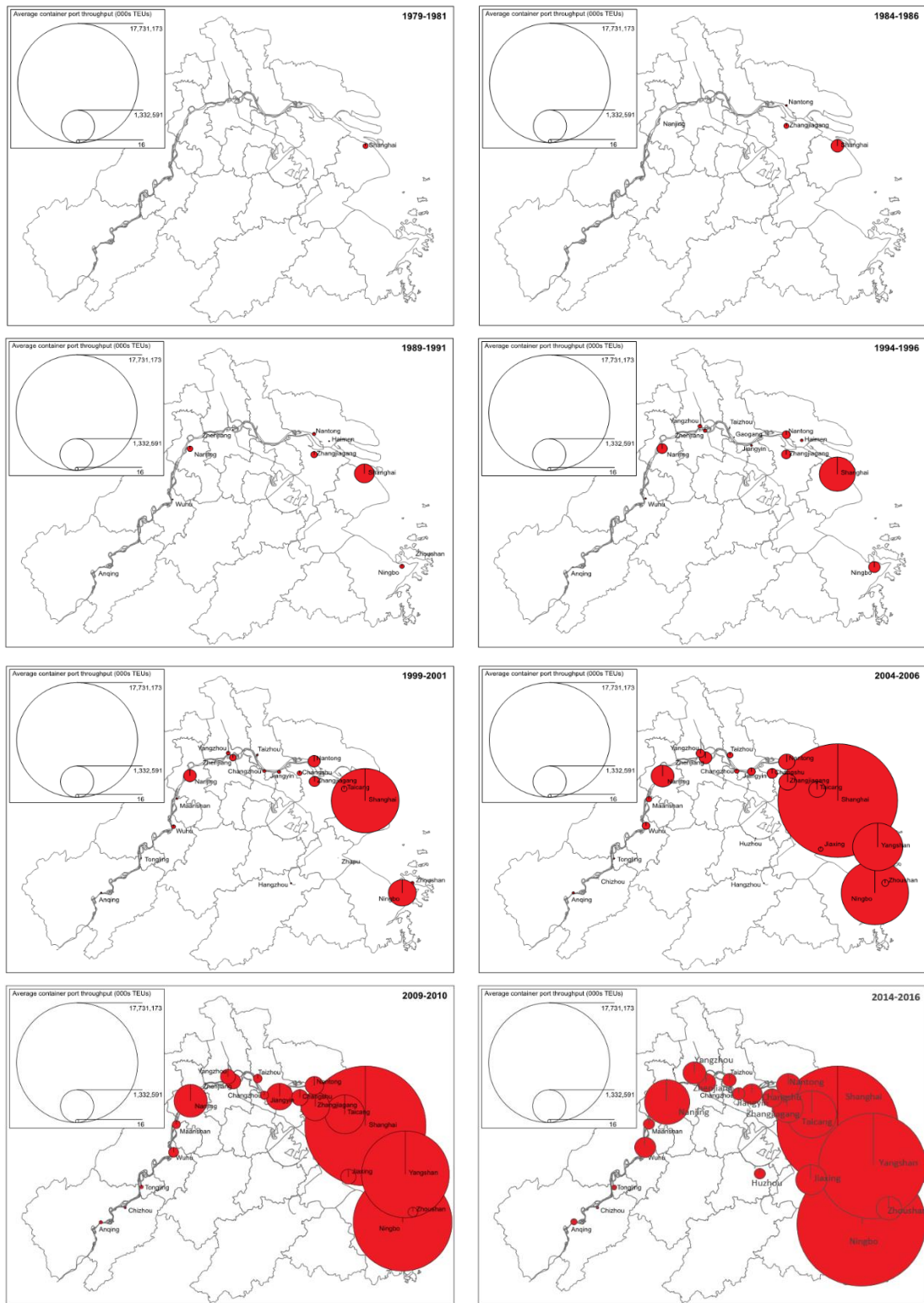
Relying on the golden geographical advantages of the intersection of the north-south trunk line of China's waterways and the trunk line of the Yangtze river, it gradually became the port cluster with the largest density of ports and shipping routes in the world. (Figure 5)



**Figure 5.** Diagram of the port cluster in YRD

Source: Own realization based on various materials.

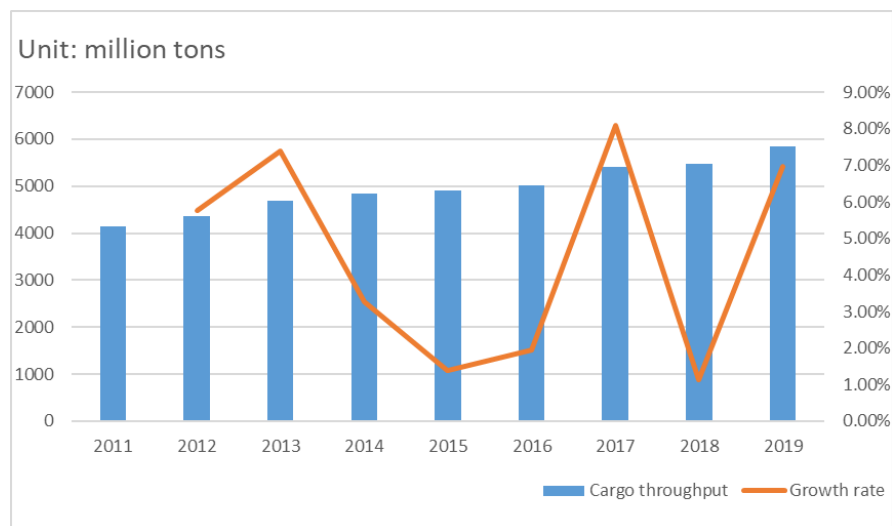
In 1997, the State Council (China's Central Government) made an important strategic decision to build Shanghai International Shipping Center (SISC) with Shanghai port as the center and ports in Jiangsu and Zhejiang as the two wings. Since then, the port cluster has developed rapidly, which can be reflected by the dramatical growth of cargo throughput, especially the container throughput (Figure 6).



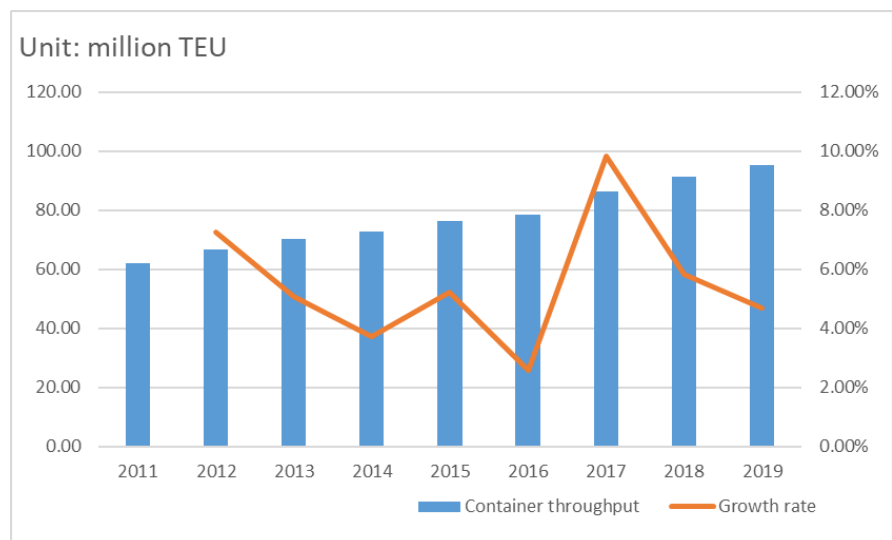
**Figure 6.** Evolution of the ports in YRD according to container throughput, 1979–2016.

Source: Modified from Wang and Ducruet, (2012).

After the 2008-09 world financial crisis, although the port throughput growth rate of the YRD port cluster has slowed down, the overall trend is still upward. (**Figure 7**, **Figure 8**). It has become the largest port cluster in the world according to port throughput.



**Figure 7.** Change of cargo throughput of YRD port cluster from 2011 to 2019  
Source: Author compiled according to the data released by the Ministry of Transport<sup>1</sup>, PRC.



**Figure 8.** Change of container throughput of YRD port cluster from 2011 to 2019  
Source: Author compiled according to the data released by the Ministry of Transport, PRC.

<sup>1</sup> Source: The Ministry of Transport (MOT) is a department under the State Council of the People's Republic of China.

According to the data in 2019, YRD completed 3.926 billion tons of waterway freight, an increase of 6.7% over the previous year, accounting for 52.5% of the country's waterway freight volume; Among the world's top ten ports in cargo throughput, YRD accounted for three, including Ningbo-Zhoushan port (No.1), Shanghai port (No.2) and Suzhou port (No.7). Ningbo-Zhoushan port has achieved a total cargo throughput of 1.119 billion tons, being the only super port in the world with an annual cargo throughput of over 1 billion tons, and it has been ranking No.1 in the world for 11 consecutive years. In term of container throughput, Shanghai port ranks the No.1 and Ningbo-Zhoushan port ranks No.3 in the world in 2019. The container throughput of Shanghai port has reached 43.30 million TEU and has been ranking No.1 in the world for 10 consecutive years.<sup>2</sup>

From the perspective of cargo throughput (**Table 2**), a measure of port scale, the cargo throughput of the YRD port cluster in 2019 reached 5.853 billion tons, accounting for 42.0% of cargo throughput of the total ports in the country; From the perspective of container throughput, a measure of port quality, the total container throughput of the port cluster has reached 95.45 million TEU, accounting for 36.6% of container throughput of the country's ports.

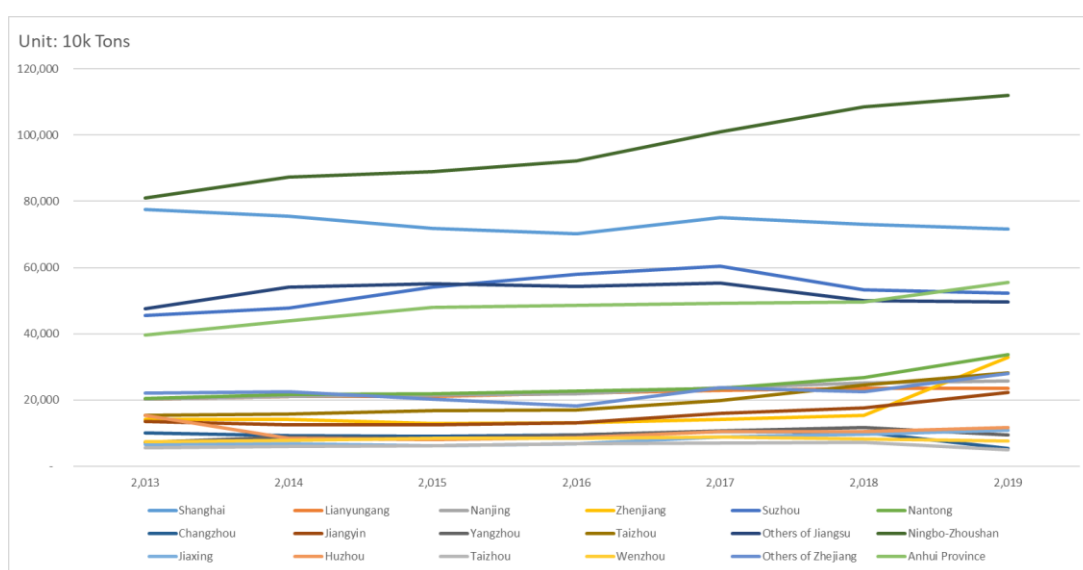
**Table 2.** Port throughput in YRD in 2019.

Province	Throughput of cargo (million tons)	% of YRD	Throughput of foreign trade goods (million tons)	% of YRD	Throughput of container (million TEU)	% of YRD
Shanghai	717	12.2%	396.64	26.9%	43.30	45.4%
Jiangsu	2831	48.4%	525.26	35.6%	18.78	19.7%
Zhejiang	1750	29.9%	536.55	36.4%	31.58	33.1%
Anhui	555	9.5%	15.91	1.1%	1.79	1.9%
TTL of the YRD	5853	100.0%	1474.36	100.0%	95.45	100.0%
<b>TTL of China</b>	<b>13950.83</b>		<b>4320.69</b>		<b>261.07</b>	
<b>% of YRD/China</b>	<b>42.0%</b>		<b>34.1%</b>		<b>36.6%</b>	

Source: Author compiled according to the data released by the Ministry of transport, PRC.

<sup>2</sup> Data source: Website of China Ports: <http://www.chinaports.com/portspnews/3656>

According to the cargo throughput developing status of each port in YRD (**Figure 9**), polarization between ports is relatively serious. The throughputs of Ningbo-Zhoushan port, Shanghai port and Suzhou port are above 500 million tons while those of the other ports are all less than 350 million tons. It is worth mentioning that Ningbo-Zhoushan port is gradually widening the gap with other ports, while other ports are developing steadily according to the current scale.

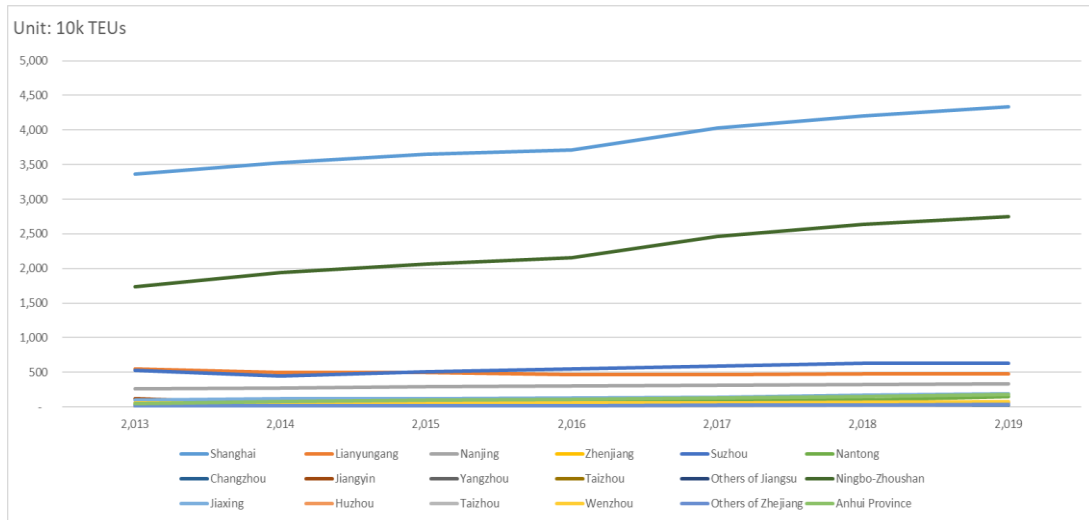


**Figure 9.** The change of cargo throughput of each port in YRD from 2013 to 2019.

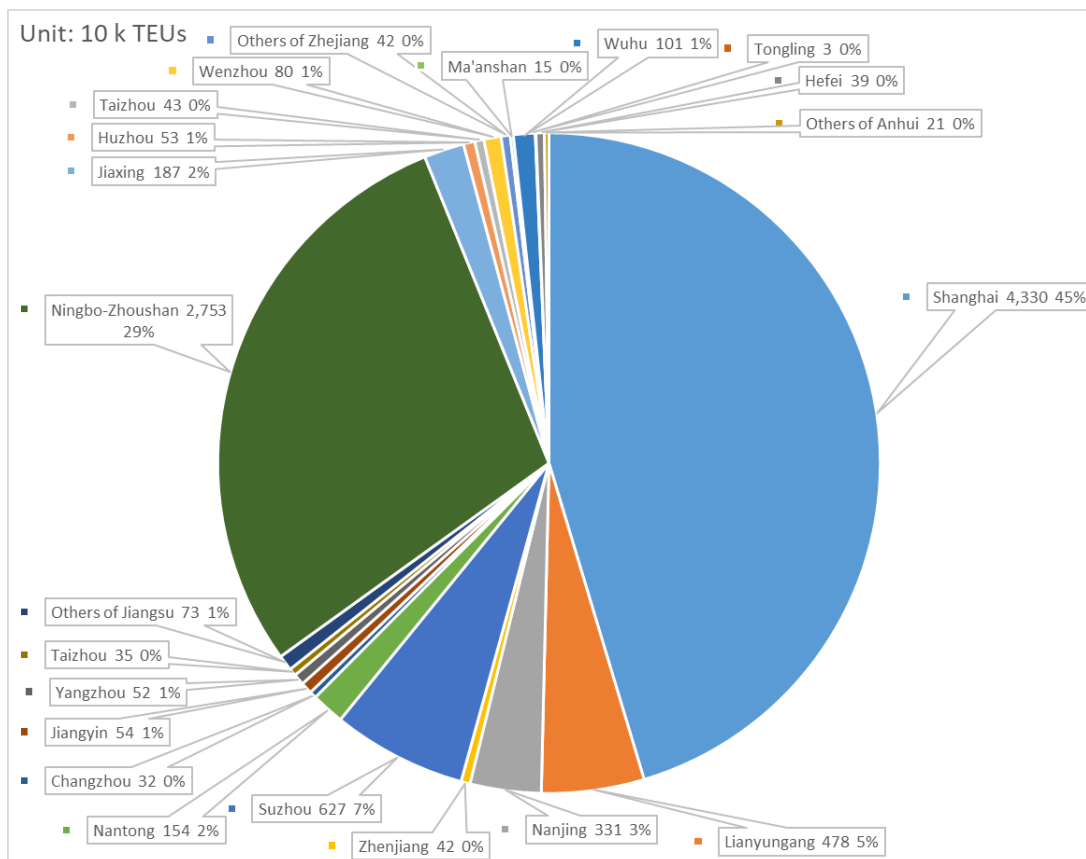
Source: Author compiled according to the data released by the MOT & COSCP.

**Figure 10** and **Figure 11** illustrate the container throughput developing status of each port in YRD. They present a two-strong independent development pattern. Shanghai port has always maintained the lead, accounting for 45%, followed by Ningbo-Zhoushan port, whose momentum of growth and change is very similar with that of Shanghai and proportion is 29%. The two ports are the main market force of the YRD ports cluster. The container throughputs of other ports are relatively low (< 7million) and change steadily, thus basically in the position of feeder. Therefore, the core of the integration of YRD container ports is to deal with the integration of Shanghai port and Ningbo-Zhoushan port.





**Figure 10.** The change of container throughput of each port in YRD from 2013 to 2019  
 Source: Author compiled according to the data released by the MOT & COSCP.



**Figure 11.** Container throughput and its proportion of each port in YRD in 2019  
 Source: Author compiled according to the data released by the MOT & COSCP.

At present, a “One-body + Two-wings” port cluster with Shanghai port as the core, ports in Jiangsu and Zhejiang as the two wings has been basically formed in the YRD region. And the ports in Anhui support the other ports in YRD a lot in the hinterland resources.

### **2.3. Integration status of the YRD port cluster**

In YRD, regional port integration, which was carried out by means of institutionalization for the first time, can be traced back to the establishment of Commission Office of Shanghai Combined Port (COSCP) in 1997. However, as a cross-provincial port coordination body, although it is an official body dominated by the Ministry of Transport (MOT), it failed to achieve the effect of substantial port integration due to the division of administrative subordination. In the 21st century, some large port enterprises began to integrate regional port resources mainly by means of capital (such as equity participation, merger and acquisition, etc.) so as to gain the leading position in the regional market and enhance their own strength. The “Yangtze River Strategy” proposed and implemented by Shanghai International Port (Group) Co., Ltd (SIPG) in 2002 is a typical example. Ningbo-Zhoushan port also began to implement this strategy through Ningbo Port Group Co., Ltd (NPG) in 2009. However, this is still a form of port resources integration led by market forces, which cannot fundamentally solve the problem of misallocation of regional port resources. In recent years, YRD port industry has entered a round of port reform, which takes the substantial integration of provincial port resources as the key while provincial governments became the leading force. The establishment of Shanghai-Yangshan port can also be discussed as a special mode of port integration, which realizes the complete unification of port administration and enterprise operation, and plays a decisive role in the construction of SISC. (see **Table 3** for details)

**Table 3.** Cases of the port integration in YRD.

Integration cases	Territorial scope	Focus of integration	Start-up time
Establishment of Shanghai Combined Port (Commission Office of Shanghai Combined Port (COSCP))	Cross-provincial region (YRD region)	Administrative coordination	1997
"Yangtze River Strategy" implemented by Shanghai port and Ningbo-Zhoushan port	Cross-provincial region (Yangtze river valley)	Enterprise operation	2002 / 2009
Port integration of Shanghai (Construction of Shanghai-Yangshan Port)	Cross-provincial region (Shanghai/Zhejiang)	Administration and enterprise operation	2002
Port integration of Zhejiang (Set up Zhejiang Seaport Development Committee (ZSDC) / Zhejiang Provincial Seaport Investment & Operation Group Co., Ltd (ZPSIOG))	Main seaports, inland ports and dry port in the province	Administration and enterprise operation	2015
Port integration of Jiangsu (Set up Jiangsu Port Group Co., Ltd (JPG))	Main seaports and inland ports in the province	Enterprise operation	2017
Port integration of Anhui (Set up Anhui Provincial Port & Shipping Group Co., Ltd (APPSG))	Main inland ports in the province	Enterprise operation	2018

Source: Compiled by the author.

### **3. Modes of the port integration in YRD**

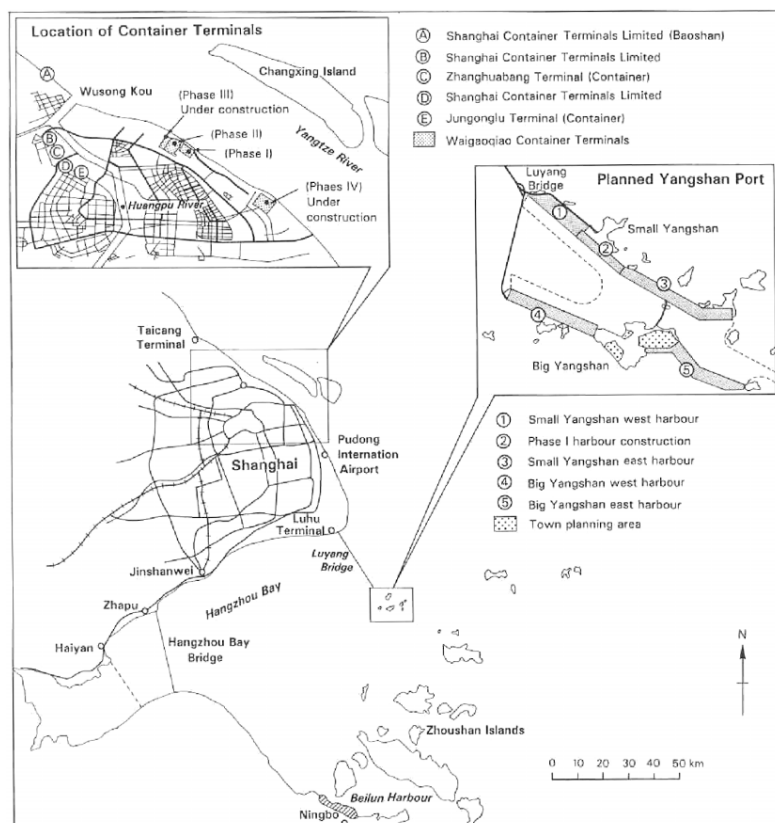
In recent years, China's economic development has entered a “new normal”, and comprehensively deepening reform has become the mainstream of development. At the same time, the state has formulated a series of reform measures and development strategies, and the economic and social functions of ports have become more prominent. It has become extremely urgent to further deepen the reform of port management system and improve the service function and development performance of ports. In the current administrative hierarchy structure of China, the provincial governments have good macroeconomic coordination ability, and have direct leadership functions to the municipal and county governments, thus have become the main promoters of the integration of regional port resources. Therefore, the port integration practice of each province in YRD will be expounded and then analyzed in this chapter. Particularly necessary to point out that the port integration scheme of Shanghai is made and promoted by the state according to the national strategy of building SISC, instead of being decided and promoted by the Shanghai municipal government alone. Therefore, the port integration mode of Shanghai is quite different from those of other provinces and needs to be analyzed separately. As a supplement, the practice of cross-provincial port integration will also be briefly expounded and analyzed in this chapter.

#### **3.1. Port integration practice of Shanghai municipality**

##### ***3.1.1. Overview of Shanghai port***

Shanghai is a municipality directly under the central government of China, at the same administrative level as a province. Located at the mouth of the Yangtze river and the center of the coastline of Chinese mainland, it is the intersection of the

horizontal axis of the Yangtze river from west to east and the vertical axis of the coastline from north to south. The land area of Shanghai port consists of the south bank port area of Yangtze estuary, the north bank port area of Hangzhou bay, the Huangpu river port area and the Yangshan port area. (**Figure 12**)



**Figure 12.** Shanghai Port and planned port development in the region.

Source: Wang and Ducruet (2012).

Shanghai has been the largest and most important seaport city in China since the end of the nineteenth century. The city and the port mutually supported each other's development in the twentieth century. Since Malcom McLean initiated container transportation in the middle of the 20th century, it had become popularized quickly and developed tremendously in the world for its virtues in multimodal transportation and efficiency (Cudahy, 2006; Parker, 2013). In 1977, Shanghai port became the first port of China to handle international standard containers. Higher traffic levels at

traditional port terminals were limited due to the lack of specialized handling facilities. Therefore, the introduction of container technology greatly promoted the traffic concentration in Shanghai. Since the early 1980s, the policy of reform and open up has promoted the development of export-oriented industries in YRD, causing a rapid increase of containerized cargoes and the popularization of container technology. More and more ports developed international container shipping. Shanghai acquired a leading role through constructing numerous terminals along the Huangpu River (i.e. Zhanghuabang, Jungonglu, Gongqing, Zhujiamen, and Longwu) and the south bank of Yangtze River (i.e. Baoshan, Luojing, and Waigaoqiao) providing the infrastructure to transship containers along the emerging Yangtze corridor (Wang and Ducruet, 2012). These can also be reflected in the **Figure 6**.

### ***3.1.2. Reasons for the integration of Shanghai-Yangshan port***

Shanghai port is a typical estuary port. At the beginning of its opening, it had the advantages of adjoining both the Yangtze river and the ocean, which gradually turned into a disadvantage in the early 1990s. The fundamental reason for this change is that the channel depth of the Yangtze estuary is not enough to meet the needs of modern ocean transport ships. Without deep-water port area, the further development of Shanghai port was greatly restricted, especially under the trend of further economic globalization and the upsizing of container transportation.

For container ships with large tonnage, their cargoes can only be handled after entering ports and berthing because they need fixed docks as storage yards as well as fixed loading/unloading bridge cranes on docks to load or unload containers. It is impossible and not allowed to handled and lightered containers at sea due to the consideration of ship's stability and falling containers into sea. In order to achieve economies of scale, ships become larger and larger. A port without a deep-water

channel and deep-water berth (international standard for depth of deep-water channel is over -15m) cannot accept gigantic container ships while can only be a feeder port and provide supporting services for a large deep-water port.

With the rise of Asia's new economic power, the world's top five container ports, except Rotterdam, were almost all concentrated in East Asia, such as Hong Kong, Singapore, Kaohsiung and Busan. Besides these four ports, other ports ranking ahead of Shanghai in the region were Yokohama, Tokyo, Keelung and Kobe (see **Table 4**). There are more than 40 deep-water container berths under construction in East Asia, which basically form a container transport port chain from Busan in the north to Singapore in the south, and the ports of Busan, Kaohsiung, and Kobe were forming a closed encirclement of Shanghai. The competition between ports for the position of East Asia Shipping Center was very fierce, and the core of the competition was to compete for the strategic point of global container hub. If China's coastal ports do not participate in this competition, they may all become the feeder ports of Busan, Kobe and Kaohsiung. In order to cope with the fierce international competition, the State Council (China's Central Government) made an important strategic decision in 1996 to build Shanghai into an international shipping center.

**Table 4.** Container throughput of major ports in East Asia in 1996.

Rank in the world	Port	Container throughput (Unit: 10,000 TEU)
1	Hongkong	13328.0
2	Singapore	1295.0
3	Kaohsiung	506.3
5	Busan	468.4
10	Yokohama	240.0
11	Tokyo	229.0
12	Keelung	227.5
16	Kobe	205.7
19	Shanghai	197.1

Source: Author compiled according to Containerization International Yearbook(1997E).

According to relative theoretical research, to solve the problem of insufficient water depth, a so-called offshore hub (deep-water port) need be developed in the vicinity of the large gateway Shanghai port and so maintain the significant role of the port while meeting the needs of the international carriers and terminal operators (Baird, 2003). The main gateway Shanghai may compensate the shifts of container services to the offshore hub by expanding its involvement in the logistics integration of the hinterland and also via increased activity at dry ports (Palmer, 1999), as seen in the regionalization phase described by Notteboom and Rodrigue (2005). At the same time, the offshore hub can develop value-added activities in relation to a local cargo base (Rodrigue and Notteboom, 2010). The deep-water berths and deep-water channels of the offshore hub must be located relatively close to the coast (i.e., the deep-water coastline) to facilitate the loading/unloading and collecting/distributing goods. Therefore, the key to solve the problem is looking for the location to build the offshore hub.

After many years of comparison, feasibility study and debate, Yangshan islands site was finally selected as the best place to establish the offshore hub of Shanghai port. In fact, Yangshan port was built to meet the functional requirements of not only the port but also the city. According to the 1999-2020 Masterplan launched by Shanghai municipality, Luchaogang zone, situated at the southeast corner of Shanghai, is planned as the administrative base of Yangshan port by providing comprehensive functions including container distribution and storage, offshore processing, shipping market, residential, financial and commercial services, amenity and tourism, thus to achieve the function upgrade of the urban peripherals.

### ***3.1.3. The integration process of Shanghai-Yangshan port***

In May 2001, the State Council (China's Central Government) finally approved the



plan to establish the new deep-water port in Yangshan islands site, which is located at the mouth of Hangzhou bay, outside the Yangtze river mouth, to the southeast of Luchao port in Shanghai Nanhui, 27.5 kilometers away from Luchao port, and only 104 kilometers away from the international shipping route. It is the nearest reasonable harbor site to Shanghai with a water depth of more than 15 meters. (Figure 13). However, Yangshan islands are not under the jurisdiction of Shanghai municipality, but under the jurisdiction of Zhejiang province. Therefore, the construction of Yangshan port must be approved by Zhejiang government, which involves cross-provincial cooperation. Through the coordination of the State Council, the right to use and manage Yangshan port belongs to Shanghai, and the administrative subordination relationship remains unchanged. All the pilotage income of Yangshan port belongs to Zhejiang. Residents on the original islands would be resettled by Shanghai if they like. This also realized the preliminary cooperation between Shanghai and Zhejiang on port integration.



**Figure 13.** The location of Yangshan Port.

Source: Own realization based on various materials.

The project of Yangshan port was planned to be constructed over four phases (**Table 5**). According to the master plan, the whole project shall be fully completed by 2020, with about 30 deep-water berths having a total handling capacity of 15 million TEUs. Yangshan port area has a long-term plan with a container throughput capacity of more than 20 million TEU.

**Table 5.** Construction Plan of Yangshan port.

Phase	Time range	No. berths	Ton grade/tons	Quay length (m)	Handling capacity (million TEUs)
I	2002–2005	5	70–100	1600	2.5
II	2005–2006	4	70–100	1400	2.1
III	2006–2010	7	70–150	2600	4.7
IV	2011–2020	14	70–150	4400	5.7
Total		30	70–100	10,000	15.0

Source: Wang and Ducruet, (2012).

In June 2002, Yangshan deep-water port officially commenced to be constructed. When the first phase of the project was completed and put into operation at the end of 2005, Shanghai port achieved ‘cross the river into the sea’. Since then, its container throughput has been soaring, overtaking Hong Kong as the world's second largest port in 2007 and surpassing Singapore to become the world's largest container port in 2010. In December 2017, the fourth phase of the project was completed and put into operation, which became the largest single fully-automated container terminal with the highest degree of comprehensive automation in the world. The annual container throughput of Shanghai port exceeded 40 million TEU, which was almost equal to the total throughput of all the ports in North America combined and reached 1/10 of the annual throughput of global ports. In 2019, the container throughput of Yangshan port area reached 19.808 million TEU, almost close to the combined container throughput of all US ports.

The completion and operation of Yangshan deep-water port has further established Shanghai's status as an international shipping center and strongly supported the development of the urban belt in YRD with Shanghai as the core. Several cities in

YRD have built new logistics facilities, such as numerous logistics parks in Shanghai, Suzhou, Nanjing, Changzhou and Wuxi. Dedicated rail services have been established between Shanghai and the hinterland (e.g., Nanjing, Chengdu, Hefei, Bengbu, Changsha, Xi' an, Zhengzhou, Chongqing, Yiwu, Wenzhou, Ningbo, Nanchang, and Zhuzhou). Most cargo moves a short distance; the cargo coming from Yangtze river valley currently accounts for 95% of Shanghai's rail-sea integrated traffic.

Yangshan port is one of the port areas of Shanghai port in terms of business, and the core of the construction of SISC. It includes Yangshan Deep-water Port Area and Yangshan Bonded Port Area (YBPA)<sup>3</sup>, which are located respectively in Yangshan town of Zhejiang province and Lingang new town of Shanghai. They are complementary to each other, which not only greatly improves the level of shipping infrastructure, but also reverses the policy disadvantage of ports competition between China and neighboring countries, and plays a very important role in promoting the agglomeration/radiation and international transshipment function of SISC. While west port area is a distribution center of river-sea combined transport. Cargoes on the small and medium-sized ships from inland ports along the river, such as Chongqing, Wuhan and Nanjing, are distributed in the west port area, and then transshipped to other parts of the world through the north port area, which greatly improved the river-sea transshipment capacity of Yangshan port and strengthen the core role of SISC.

Yangshan was planned by the Chinese government as a value-added and integrated

---

<sup>3</sup> YBPA was approved by the State Council in 2005 as China's first bonded port following the Reply of the State Council on Approval of Establishing Yangshan Bonded Harbor District and Directory of Industrial Development and Investing Policies in Yangshan Bonded Zone. It covers 8.14 square kilometers including an export processing area, a bonded area, and the port area itself, providing storage and supervision of import and export cargo, processing of imported raw materials and semi-finished goods as well as reprocessing, assembling and exporting components.

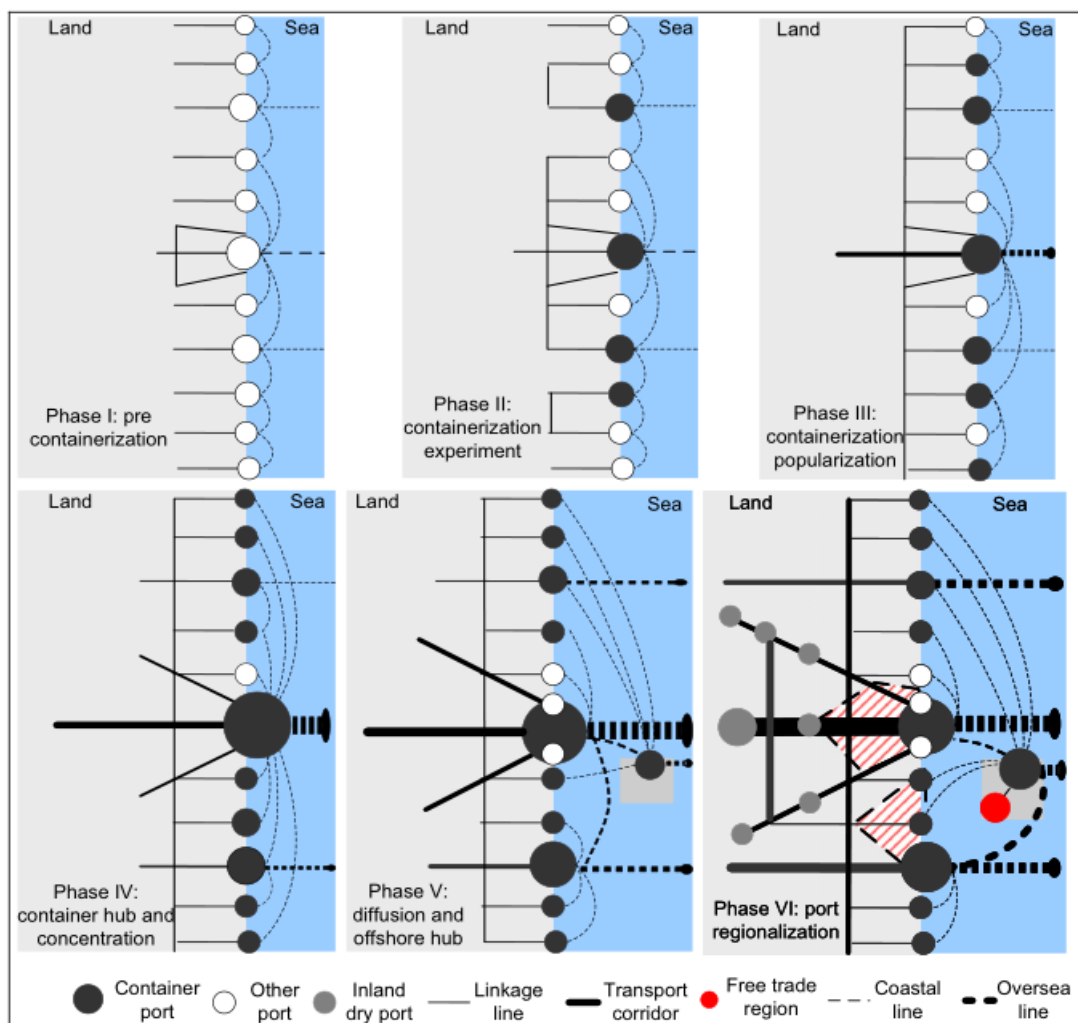
industrial, logistics, and shipping complex rather than a sole transshipment node. The YBPA is a multimodal logistics center for transshipment, distribution, insurance, finance, and entrepôt trade. This facility is designed to provide a local manufacturing base limiting truck and shipping flows to and from mainland China in addition to its first transshipment function. Up to now, hundreds of foreign companies have registered in this area, including third party logistics (e.g., Maersk, ProLogis), storage, manufacturers (e.g., non-ferrous metals, electronics, automobile parts), and many carriers (e.g., Sinotrans, COSCO, Maersk). The total gross value of the bonded supervised goods in Yangshan reaches a total of tens of billions of dollars. Domestic cargoes fall under the same customs, tax, and currency exchange procedures than foreign goods. Registered companies are exempted from business taxes if they engage in shipping, transportation, loading and unloading, and storage. A cooperation across YRD makes it possible for registered companies to declare at any of the 69 customs offices in mainland China. Crude oil and liquefied natural gas terminals are also being built.

However, as the economic benefits of Yangshan port became more significant, the competition between Zhejiang and Shanghai escalated. But both sides gradually realized that cooperation was more important than competition. In July 2017, the two sides held a new round of high-level meeting, and subsequently signed the Memorandum of Understanding on Deepening and Promoting the Cooperative Development of Xiaoyangshan as well as the Cooperation Agreement on Comprehensive Development of Xiaoyangshan Port Area. Their core is about YBPA expand and Xiaoyangshan equity cooperation. Shanghai and Zhejiang designated SIPG and Zhejiang Provincial Seaport Investment & Operation Group Co., Ltd (ZPSIOG) respectively to jointly develop and operate Xiaoyangshan by means of equity cooperation, so as to realize the strategic cooperation between the two

enterprise groups and comprehensively accelerate the development and construction of the north side of Xiaoyangshan. Yangshan port is the product of deepening cooperation between Zhejiang and Shanghai, which is a win-win result. It will play a very important role in the process of building Shanghai into an international economic, financial and trade center, and will also promote the development of Zhoushan islands.

#### ***3.1.4. Analysis of the port integration practice of Shanghai municipality***

The process of Shanghai port integration can be regarded as that, in accordance with the principle of international hub port construction, Shanghai port construction went from the Huangpu river to the Yangtze river, then to the ocean, and finally realized cross-provincial cooperation. Wang and Ducruet, (2012) studied the development of Shanghai-Yangshan port and made a new port development model (**Figure 14**) based on the Notteboom and Rodrigue (2005) model (**Figure 2**). They think that the construction of Yangshan port well fits with the phase of diffusion and offshore hub, and define Shanghai-Yangshan port as a dual hub or multilayered gateway hub. With reference to the model, it can be seen that the key of Shanghai port integration is the co-development of the main gateway port and of the offshore hub through a mixture of deep-sea and short-sea services, thus taking the form and function of a dual hub and gateway. The Shanghai-Yangshan dual hub port exhibits important differences with generic models due to the development of activities other than sole transshipment, notably in the manufacturing and tertiary sectors, and to the connection of the new port with the hinterland through logistics regionalization. They also point out that the decisive role of the central government in such processes adds to the originality of the Shanghai-Yangshan case compared with other examples of new port development in Asia.



**Figure 14.** Spatial evolution model of a container port system.

Source: Wang and Ducruet, (2012).

The Shanghai Yangshan dual hub in fact fully participates to the building of a global city, a process in which the reorganization of physical infrastructure and flows is a major factor. Such strategy even takes the form of a multimodal hub including seaport, airport, and many centers (i.e. trade, financial, technical, information, tourism, and industrial) such as Lujiazui in Pudong, Waitan in Puxi (finance), and Zhangjiang (high-tech). Lingang new town provides not only shipping-related services but also urban functions (i.e. residence, leisure, education and training) as well as industrial functions (equipment manufacturing industry, industrial park,

export processing), thus becoming a new growth pole in Shanghai.

Looking back at the integration process of Shanghai-Yangshan port, it can be seen that it is strongly promoted by the national government according to the positioning of SISC, which is part of the national strategy. It has broken the limitation of provincial administrative barriers completely, made Shanghai effectively use the idle coastline resources of other province and built it into a part of Shanghai port. It has been completely unified in the port administration and port operation, and realized the highest level of integration. Therefore, the Shanghai-Yangshan mode is hard to be duplicated in the rest of China.

## **3.2. Port integration practice of Zhejiang province**

### ***3.2.1. Overview of ports in Zhejiang province***

Zhejiang province has a vast sea area and lots of islands. Its coastline is 6,696 kilometers long, ranking the first in the country, and the deep-water coastline is 650 kilometers long, accounting for more than a third of the country. It is in a good position to connect international shipping lanes and domestic branch lines. At present, it has formed a coastal port cluster with Ningbo-Zhoushan port as the center, Jiaying port, Taizhou port and Wenzhou port as the backbone, and 39 other small local ports supporting. Besides the coastal ports, there are 105 inland ports scattered in Zhejiang province, including Hangzhou port, Jiaying river port, Huzhou port, Shaoxing port, Jinhua port, Qingtian port, etc. (**Figure 15**)



**Figure 15.** Port map of Zhejiang province

Source: Own realization based on various materials.

Among the ports in Zhejiang, Ningbo-Zhoushan port is in the core position. Located in the middle of Chinese coastline, facing the busy main shipping route of the Pacific Ocean and backing the most dynamic economic circle of YRD in Chinese mainland, it is an ideal distribution center for Chinese coastal transportation to ports in all continents. It is composed of 19 port areas (**Figure 16**) and has become a multi-functional and comprehensive modern port with integration of the estuary ports, sea ports and inland river ports, and a complete set of large, medium and small berths. Ningbo-Zhoushan port is a rare deep-water port with superior natural conditions, abundant deep-water coastline and water resources. The annual operating time are about 350 days, the water depth of the main channel in the core port areas is more than 22.5 meters, 300,000-ton ships can enter and leave the port freely, and 400,000-ton or more gigantic ships can do so by the tide.





**Figure 16.** The General Layout of Ningbo-Zhoushan Port.

Source: Modified from the official website of Ningbo-Zhoushan Port Co., Ltd.

### 3.2.2. *The port integration process of Zhejiang province*

Port integration of Zhejiang began with the integration of Ningbo port and Zhoushan port. Although the two ports are adjacent and located in the same sea area, each port had independent policies and directions in the aspects of port planning, construction, operation and management in the past, resulting in inefficient allocation of resources.

In 1996, Zhejiang province issued the Medium-term Plan for Ningbo Port and Zhoushan Port, which for the first time put forward the idea of unified planning,

unified construction and unified management of the two ports. In January 2003, Xi Jinping, then Secretary of Zhejiang Provincial Party Committee (the highest leader of Zhejiang province), visited Zhoushan for the first time and proposed to “accelerate the integration process of Ningbo port and Zhoushan port”. However, the integration between ports cannot be achieved by only an administrative order, there must be a basis, that is, the feasibility and necessity of their cooperation. So is the integration of Ningbo port and Zhoushan port, the SWOT analysis of which can be listed as **Table 6** and **Table 7**.

**Table 6.** SWOT analysis of Ningbo port.

Strengths (S)	Weaknesses (W)
1. Unique natural conditions; 2. Complete port infrastructure; 3. vast economic hinterland; 4. Mature logistics transportation network; 5. Highly unified port management; 6. Efficient and complete operation system	1. Coastline development is nearly saturation; 2. Anchorage resources are scarce; 3. Large bulk terminals are relatively scarce; 4. High external trade dependence
Opportunities (O)	Threats (T)
1. Opportunities brought by port integration; 2. Opportunities brought by port popularity	1. Competitive threat from Shanghai port; 2. The challenge of ship upsizing

Source: Own realization based on various materials.

**Table 7.** SWOT analysis of Zhoushan port.

Strengths (S)	Weaknesses (W)
1. Port development potential is huge; 2. Large numbers of shipping enterprises; 3. The location advantage of docking river-sea multimodal transportation center; 4. Late-mover advantage in large projects.	1. The port's economic hinterland is limited; 2. Poor infrastructure and distribution conditions; 3. Backward management soft environment; 4. Lack of unified port scheduling.
Opportunities (O)	Threats (T)
1. Opportunities brought by the projects of connecting islands; 2. The opportunity of the pilot free trade zone policy.	1. Constraints brought about by environmental inspections; 2. Weak domestic demand leads to reduced supply demand.

Source: Own realization based on various materials.

Through the comparison of **Table 6** and **Table 7**, it can be seen that the two ports are complementary in many aspects as shown in **Table 8**.

**Table 8.** Complementary enumeration for Ningbo port & Zhoushan port.

Ports	Channel anchorage	Port development potential	Ports scheduling	Economic hinterland	Policy opportunity
Ningbo	Weaknesses (W)	Weaknesses (W)	Strengths (S)	Strengths (S)	Weaknesses (W)
Zhoushan	Strengths (S)	Strengths (S)	Weaknesses (W)	Weaknesses (W)	Strengths (S)

Source: Own realization based on **Table 6** and **Table 7**.

Through the comparison, it can be found that the advantages and disadvantages of the two ports are very complementary, the integration of Ningbo port and Zhoushan port seems quite necessary and reasonable. On the one hand, the port merger can dislocate Ningbo port and Zhoushan port. Zhoushan mainly develops bulk and general cargo transportation, while Ningbo concentrates on container transportation; on the other hand, Ningbo gains valuable deep-water coastline resources, Ningbo port area can mainly develop deep-sea direct-call transportation, and Zhoushan port area engages in transshipment activities, which would achieve a win-win situation in Ningbo and Zhoushan.

In order to realize the complementary and interconnected development of the two ports, improve the overall competitiveness and resource utilization efficiency, the government of Zhejiang province decided to break the restriction of administrative division and merge the two ports into one and established the Ningbo-Zhoushan Port Management Committee (NPMC) on December 20, 2005, who was authorized to be responsible for the planning, management, development and construction of the two port areas according to the principle of “unified planning, unified construction, unified brand and unified management”. At the opening ceremony of the NPMC, Xi Jinping said that the port construction will be a big measure in the economic development of Zhejiang province, and its key point is the integration of the two

ports. Since January 1, 2006, the name of "Ningbo-Zhoushan port" has been officially used instead of the original names of "Ningbo port" and "Zhoushan port".

However, in the initial stage of the integration of the two ports, the port administrative departments of Ningbo and Zhoushan still performed specific port management functions according to the principle of territorial management. Subject to the game of the local interests and the limitation of NPMC itself in the establishment of institutions, the integration of the two ports did not made substantive progress. In order to integrate the coastal ports and related resources of the province, with the support of the central government, Zhejiang province took a rare series of integration measures, thus finally completing the most important step in regional port integration through asset integration at the provincial level. The integration steps are as follows:

In August 2015, Zhejiang province established a substantive port governing body at the provincial level -- Zhejiang Seaport Development Committee (ZSDC), and built Zhejiang Provincial Seaport Investment & Operation Group Co., Ltd (ZPSIOG) through integrating related assets.

In September 2015, Ningbo Port Group Co., Ltd (NPG) and Zhoushan Port Group Co., Ltd (ZPG) merged into Ningbo Zhoushan Port Group Co. Ltd (NZPG) through shareholding.

In December 2015, the assets of NZPG were injected into ZPSIOG, becoming a wholly-owned subsidiary of ZPSIOG.

In 2016, the assets of Jiaxing port, Wenzhou port, Taizhou port, and Yiwu dry port were injected into ZPSIOG.

In September 2016, Ningbo Port Co., Ltd was renamed as Ningbo Zhoushan Port Co.,

Ltd (NZP), whose main shareholder is ZPSIOG.

The ports of the whole province are integrated into a game of chess and uniformly operated, and substantially integrated from the system, mechanism, capital, and platform, thus realizing the in-depth integration and development of them. The breakthrough of the comprehensive integration of the province's ports is the substantive integration of Ningbo-Zhoushan port. ZSDC directly manages the port construction and coastline resources utilization of the two port areas, and coordinates their coastline development and port business integration, breaking the previous situation that they developed independently.

At present, it has basically formed a new regional port structure of "One Body, Two Wings and Interactive Development", namely, with Ningbo-Zhoushan port as the main body, the southeast seaports (Wenzhou port, Taizhou port, etc.) and Hangzhou bay ports (Hangzhou port, Jiaxing port, etc.) in north Zhejiang as the two wings, interactively developing Yiwu international dry port and other inland ports such as Jinhua, Quzhou, Lishui and Huzhou, etc. It has effectively promoted the intensive utilization of port resources, high-efficient of port operation, ordering of market competition, modernization of port services, and effectively enhanced the comprehensive strength, overall competitiveness and external influence of Zhejiang ports.

Since the integration of Ningbo-Zhoushan port in 2006, the port transportation production has developed rapidly and the throughput scale has been continuously increasing. Cargo throughput rose from 424 million tons in 2006 to 1.02 billion tons in 2019, with an average annual growth rate of 8.2%, ranking the first of ports in the world for 11 consecutive years; Container throughput climbed from 7.14 million TEU in 2006 to 27.535 million TEU in 2019, with an average annual growth rate of

11.9%, ranking the second in China and the third in the world. It has become China's fastest - growing comprehensive port and established business cooperation with more than 600 ports in more than 100 countries and regions in the world, becoming an important international hub port on the B&R corridor.

### ***3.2.3. Analysis of the port integration practice of Zhejiang province***

Through the port integration practice of Zhejiang province, it can be seen that it is led by the provincial government. As Ningbo port and Zhoushan port have prominent status, adjacent location and complementary advantages, the government started the port integration from the integration of the two ports, and then gradually expanded it to the ports of the whole province, including seaports, river ports and dry ports. In the process, the government broke the regional administrative restrictions and established a new provincial port regulatory authority -- ZSDC, then established ZPSIOG and integrated the ports of the province at the enterprise operation level.

The key of Zhejiang port integration lies in that the provincial government has considered the different situation of each port, as well as the role of the port on the socio-economic development of the city and the path differences, combined with the ports' own location conditions, hinterland economies, resources endowment, business operations, etc., primely coordinated the interests of different port cities, different government departments and port enterprises, and made efficient and reasonable use of the ports' natural resources, administrative resources and operating resources.

Under the existing administrative divisions, Zhejiang provincial government further straightened out the relationship between the functional departments related to sea and port, and established a modern enterprise management system with reasonable division of labor and clear responsibilities: ① As the administrative department,

ZSDC is in charge of port administration as well as the development of marine economy and marine ports in the province, mainly responsible for the overall control and efficient use of the province's marine port resources, the preparation and implementation of laws, regulations and policies related marine port development and management, as well as the comprehensive management work of province's ports and shorelines, etc.; ② ZPSIOG (also named NZPG) is in charge of asset management and operation. As the platform for the development, construction and financing of provincial marine resources, it is mainly responsible for the development and utilization of marine resources, marine industry investment, management and basic operation of resources related to sea and ports, port investment and construction and other sectors; ③ NZP is the operator of port business, which mainly focuses on the actual operation of the ports and adopts the management mode with the port operation as the core and the port logistics and capital management as the focus.

From the integration process of Zhejiang ports, it can be seen that "Top-level design and strategic planning are the key links to promote the development of port integration". The success of Zhejiang port integration depends on two key links: The first is the attitude of the top level; The second is the power structure among each port in the province (the game between the ports as well as the cities where the ports are located). Particularly the second point, the substantive effect of integration is affected greatly by to what extent can the administration-led power overcome the resistance brought by multi-party game in the process of integration. In sight of the port integration of Zhejiang province is relatively complete and entirely carried out by the government through administrative means from top to bottom, and the comprehensive integration of administrative management and enterprise operation has been realized, so this mode also belongs to the close-type of government-led

even though it is not so close as that of Shanghai-Yangshan port.

### **3.3. Port integration practice of Jiangsu province**

#### ***3.3.1. Overview of ports in Jiangsu province***

Jiangsu is the only province in China with both the coastal axis and the axis along the Yangtze river, across the river and next to the sea, and at the junction of T-shaped structure, thus the locational advantage is extremely rare. As a major waterborne province, it has a coastline of 1000km and variegated rivers. In Jiangsu province, the Yangtze river runs 425 kms from west to east and the Beijing-Hangzhou grand canal runs 687 kms from north to south, thus the water transport system is very developed.

In the province, there are three coastal ports, Lianyungang port, Nantong port (both along the river and the coast) and Yancheng (Dafeng) port; There are numerous inland river ports distributed on both sides of the Yangtze river, including large ports of hundred-million-ton such as Nanjing port, Suzhou port, Nantong port, Zhenjiang port, Yangzhou port, Taizhou port, Wuxi (Jiangyin) port, etc. In addition, some inland river ports, such as Xuzhou port, Suqian port and Huai'an port, are located along the Beijing-Hangzhou grand canal (**Figure 17**).

In 2019, the cargo throughput of the provincial ports reached 2.831 billion tons, accounting for 48.4% of YRD, and the container throughput reached 18.78 million TEU, accounting for 19.7 % (**Table 2**). The port cargo throughput has ranked the first in China for five consecutive years. It ranks the first in China in a number of indicators, such as port handling capacity, number of berths above 10,000 tons, cargo throughput, number of hundred-million-ton ports, etc.





**Figure 17.** Port map of Jiangsu province

Source: Own realization based on various materials.

### ***3.3.2. The port integration process of Jiangsu province***

Although Jiangsu is a big port province, it developed separately for a long time. After port management authority was delegated to the local authorities in 2001, the lack of overall planning and coordination led to many problems among the ports, such as similar functions, scattered distribution, unreasonable structure and disordered competition, thus causing a serious waste of resources and the overall competitiveness is not powerful. In addition, compared with Shanghai and Zhejiang, it lacks leading port enterprises with strong comprehensive strength though the port scale of Jiangsu is larger. It has become the biggest restriction factor of port integration that ports are divided by administrative divisions and the administrative barriers formed for a long time.

According to the port system reform principle of “One city, one port, one administration” regulated by the MOT, three original national first-class open ports

of Zhangjiagang port, Changshu port and Taicang port, which were affiliated to Suzhou city, were combined into Suzhou port in 2002. The three ports correspondingly became three port areas of Suzhou port. At the same time, the resources of port anchorage, shoreline and liner route are integrated. Since then, the competitiveness of Suzhou port has been greatly improved and become the third biggest port in YRD, only after Shanghai port and Ningbo-Zhoushan port.

However, the port integration in Suzhou city alone cannot change the problems mentioned above among the ports of the whole province. Since the global financial crisis in 2008-09, Jiangsu port development is in urgent need of a new round of reform and adjustment in the face of the severe challenges of domestic and foreign economic downturn, overcapacity and insufficient supply.

In 2015, the MOT took the integration of Jiangsu ports along the Yangtze river, as one of the pilot reforms. Through two years' efforts, it has preliminarily realized the centralized command and scheduling and intelligent management of anchorage operation, the standardized and intensive utilization of port coastline, and the reasonable distribution and cooperative operation of port container routes.

In order to further strengthen the integration of the provincial ports and enhance the comprehensive competitiveness of them, Jiangsu Port Group Co., Ltd (JPG) was established by the provincial government in May 2017. Provincial port and shipping enterprises and the state-owned port enterprise of the cities along the river and coast such as Nanjing Lianyungang, Suzhou, Nantong, Zhenjiang, Changzhou, Taizhou and Yangzhou, were integrated into JPG. It has become an important platform for the resource integration of ports along the river and coast in Jiangsu province, and also the main investment and operation body of state-owned capital in the fields of provincial shipping enterprises, ports and port industry. The establishment of JPG is a

major measure of Jiangsu provincial government to promote the integration of port resources in the whole province, marking that Jiangsu port integration reform has entered a new stage. JPG takes the ports along the river and coast in the province as a whole, carries out unified planning and layout, and implements integrated operation.

The establishment of JPG is conducive to the integration of resources, the elimination of competition and the improvement of the overall competitiveness of ports in Jiangsu on the basis of exerting the advantages of each port, and also an important measure to link up with the YREZ.

In June 2017, Jiangsu provincial government issued Opinions on Deepening the Integration Reform of Ports along the River and Coast, which plans to basically form a shipping logistics center with the function of regional hub through 3-5 years' efforts, cultivate and expand JPG, and take it as an important platform for the port integration reform of the whole province. It also encourages mergers and reorganizations of large port enterprises where conditions permit, and guides high-quality resources to actively participate in the integration reform of ports in the province.

In 2019, JPG continuously deepened its reform, strengthened resource coordination, realized improvement in efficiency and benefits, significantly improved main business benefits, and achieved gradual effects in the integration. Its total revenue and profit both increased. The number of large vessels visiting the ports and the container throughput increased by 22% and 2% respectively. JPG also endeavors to transform from a terminal operator to a modern logistics provider. The channels of ports and navigation in Yangtze river are much smoother and more efficient, and the service efficiency of river-sea transshipment routes to Shanghai port and Ningbo-Zhoushan port has been significantly improved.

### ***3.3.3. Analysis of the port integration practice of Jiangsu province***

Through the port integration practice of Jiangsu province, it can be seen that it is also promoted by the provincial government and has basically followed the mode of port integration in Zhejiang province, for example, established a provincial-level port group (JPG) and integrated the state-owned operators of major ports in the province. The difference is that, in addition to horizontal integration (integration of port enterprises), the provincial port group (JPG) also carried out vertical integration (integration of state-owned shipping companies in the province). What's more, Jiangsu province has not made the reform in port administration, still used the previous administrative system. Therefore, its port integration reform is not as complete as that of Zhejiang province, the degree of integration among ports also appears not so close as Zhejiang ports.

## **3.4. Port integration practice of Anhui province**

### ***3.4.1. Overview of ports in Anhui province***

Anhui province is an inland province and has a total of 16 inland ports, including four main ports of Tongling port, Wuhu port, Ma'anshan port and Hefei port. Though the first three ports are ports of hundred-million-ton, the ports in Anhui are relatively small and underdeveloped, compared with the ports in other provinces in YRD. In 2019, the port cargo throughput and container throughput of the province is 555 million tons and 1.79 million TEU (**Table 2**), accounting for only 9.5% and 1.9% of those of YRD respectively.

### ***3.4.2. The port integration process of Anhui province***

After Jiangsu province started the port integration at provincial level, Anhui province

also accelerated the port integration reform.

In May 2017, Anhui provincial government officially issued the Waterway Construction Plan of Anhui Province (2017-2021). According to the plan, Anhui province will promote port construction in an orderly manner, comprehensively integrate port resources, build a unified port operation and management platform, and deepen strategic cooperation with Shanghai port, Ningbo-Zhoushan port and Nanjing port.

In December 2018, Anhui Provincial Port & Shipping Group Co., Ltd (APPSG) was established by the provincial government. Combined with the fact of the ports in the province, APPSG commenced to integrate 10 large and competitive port and shipping enterprises with high proportion of state-owned assets in ports of Ma'anshan, Wuhu, Tongling, Anqing, Chizhou, Hefei and Bengbu.

On the day of listing of APPSG, it signed strategic cooperation agreements with the leading enterprises in the industry, such as SIPG, ZPSIOG, and China COSCO Shipping Group.

Since the establishment of APPSG, it has integrated port and shipping resources in the province through market-oriented approaches such as policy guidance, scale improvement and cost reduction. In addition, in order to successfully complete the container shipping layout of “One core and Two wings” (with Wuhu-Shanghai direct route as the core, two provincial branch routes of Hefei-Wuhu and Anqing-Chizhou-Tongling-Wuhu as the two wings), and comprehensively improve the service capacity of ports, APPSG and Hefei customs established a port cooperation mechanism, thus maximizing the efficiency of container shipping services to meet the needs of enterprises to reduce costs and increase efficiency.

In May 2019, the port resource integration in Anhui province was basically completed, the development platform of port and shipping was initially built, and the overall container shipping layout of “One core and Two wings” was initially completed. The transshipment time from Anhui port to Shanghai-Yangshan port has been reduced by 5 to 7 days, the container transportation has changed from waiting ship to waiting cargo, and enterprises have significantly reduced cost and increased efficiency.

In July 2019, Wuhu port successfully opened the trans-provincial transshipment route for foreign trade containers from Chongqing to Wuhu, achieving the breakthrough of zero trans-provincial transshipment business in Anhui.

In September 2019, the first foreign trade route of Huaihe river and the direct route from Bengbu to Shanghai were opened, with Bengbu as the center. The layout of Anhui liner routes is gradually improved.

APPSG has established a business cooperation mechanism with SIPG to realize all-round coordination in port berth utilization, routes and shipping schedule arrangement. At present, APPSG is actively promoting the construction of a unified marketing center and production scheduling center in Anhui province, and focusing on optimizing the provincial port marketing and production scheduling management mode. The next step is to establish a unified management system and operation mechanism, create a unified platform for the provincial opening to the outside world, realize unified planning, unified construction, unified operation, unified management, unified service, and unified external relations, form a new pattern of coordinated development of ports in the region.

The effect of port integration has appeared. Data shows that APPSG achieved a port throughput of 100 million tons in 2019, a year-on-year growth of 24%; the container

throughput reached 1,607,000 TEU, a year-on-year growth of 23%. Till 2019, container throughput of Wuhu port has exceeded 1 million TEU and ranked the third among the river ports in China.<sup>4</sup> Ports in Anhui province are experiencing rapid growth, which will be a win-win future for Anhui province and the YRD region.

### ***3.4.3. Analysis of the port integration practice of Anhui province***

Through the port integration practice of Anhui province, it can be seen that it is also promoted by the government and has basically followed the mode of port integration in Jiangsu province, such as, established a provincial-level port group (APPSG) and integrated the state-owned port and shipping enterprises in major ports of the province, still used the previous administrative system, and the degree of integration among ports also appears not as close as Zhejiang ports. However, due to the relatively weak strength of Anhui ports, its positioning is very clear in the integration process, and it chooses the strategy of cooperation with other large port and shipping enterprises in YRD such as SIPG, ZPSIOG and COSCO shipping, introduces capital and technology, and achieves rapid development.

### **3.5. Cross-provincial port integration practice in YRD**

In YRD, there are many cases of port integration at cross-provincial level in addition to the port integration mode formed within each province. Such as mentioned before, the formation of Shanghai Combined Port and the signing of strategic cooperation agreements among provincial port groups, due to their practical roles are limited, no more detailed analysis will be done. In fact, the mode of Shanghai-Yangshan port discussed in detail before is also cross-provincial integration of resources. However, due to its specificity and non-reproducibility, it has been analyzed separately and will

---

<sup>4</sup> Source: Data from <http://xhs.anhuinews.com/system/2020/01/22/008323380.shtml>.

not be re-discussed here.

Among the cases of cross-provincial port integration, the most representative is the “Yangtze River Strategy” (YRS) implemented successively by Shanghai port and Ningbo-Zhoushan port. The YRS refers to a resource integration strategy adopted by Shanghai port or Ningbo-Zhoushan port to realize the aims of expanding the economic hinterland and attracting sources and complementary functions of ports, etc. (**Figure 18**)

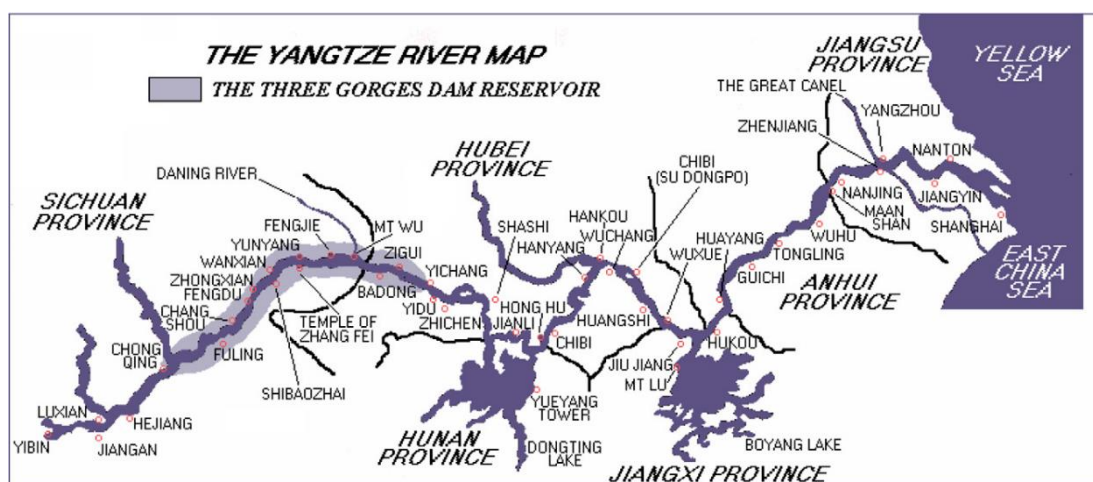
As early as 2002, Shanghai port has begun to implement the YRS through SIPG. Through export of capital, technology and management, it cooperates with the regions along the Yangtze river, leads and cultivates the regional hub ports in Yangtze river valley, and radiates the surrounding areas, thus carrying on the trans-administrative region port resources integration. In June 2010, Yangtze River Port Logistics Co., Ltd (Yangtze River Company, for short), a company solely owned by SIPG, was established in Shanghai. It is the result of the integration of the resources along the Yangtze river originally and previously acquired by SIPG, including 18 port enterprises in the port cities of Yangtze river valley. With Shanghai as the home port, it operates major ports in Yangtze river valley, such as Chongqing, Wuhan, Jiujiang, Nanjing, Jiangyin, Changsha, Yibin, etc., and sets up large logistics parks and warehouses in some ports. Previously, the 18 enterprises operated independently and lacked synergies with each other. Through establishing the Yangtze River Company, SIPG has substantially integrated its assets along the Yangtze river. It has invested in 22 projects in 12 cities along the Yangtze river, forming a complete comprehensive logistics network. The aforementioned cooperation between APPSG and SIPG is also a part of the YRS.

Shanghai-Taicang cooperation is a good example of the YRS. Since the strategic



cooperation between the two sides, the capital, management and talents of Shanghai port have been injected into Taicang port, while Waigaoqiao river-sea transshipment platform has transferred to Taicang port, thus promoting the integration of customs clearance between Shanghai and Taicang. Taicang port has gradually participated in the division of labor of SISC, and established the status of river-sea transit hub port.

Followed the footsteps of Shanghai port, Ningbo-Zhoushan port joined the YRS in 2009. In March 2010, the Wanfang International Terminal in Taicang (Jiangsu), invested by NPG (later merged into ZPSIOG), was officially opened. So far, Ningbo-Zhoushan port has operational berths in Taicang port area, Suzhou port and Nanjing port, and is accelerating the acquisition of stakes in Jiangyin container terminal, aiming to enhance the business layout in the ports along the Yangtze river.



**Figure 18.** Map of the Yangtze River.

Source: Solid Software Pty., Ltd (permission to use this map was kindly granted by Solid Software Pty., Ltd, Australia).

It can be seen that the YRS implemented by Shanghai port and Ningbo-Zhoushan port is only the integration of enterprise operation and does not involve administrative management, thus actually an loose-type of enterprise-oriented port integration.

### 3.6. Comprehensive summarization of port integration modes in YRD

In order to better understand the practical modes of port integration in YRD, they can be analyzed and summarized from five perspectives of dominant power, territorial scope, realization path, degree of integration and focus of integration, which are actually to answer the five basic questions about port integration: who has led the integration; how much is the geographical scope for integration; what are the specific paths to be accorded to implement integration; to what extent have the ports been integrated; which fields of the ports have been integrated. According to the foregoing, the detailed summary of the port integration modes in YRD is shown in **Table 9**.

At present, in term of the port integration in YRD at provincial level, the core main bodies have been basically completed. However, as far as the whole YRD port cluster is concerned, the main contradiction restricting its development has not been solved. Shanghai port and Ningbo-Zhoushan port, as the two most powerful ports in YRD, have promoted some cooperation in the past few years such as joint developing of Xiaoyangshan, but most of the cooperation is for the purpose of competition and substantive integration is rare. Therefore, the main contradiction of development of the YRD port cluster is the contradiction of resource integration between Shanghai port and Ningbo-Zhoushan port. In addition, it can be seen that the functional complementarity of the port cluster resource integration is not more reflected in the YRD port cluster, but more is the merger of similar port enterprises, even though functional complementarity is the core of port cluster resource integration. Therefore, it can be concluded that the port integration in YRD is still in development stage, and only should substantial integration be carried out between Shanghai port and Ningbo-Zhoushan port, the qualitative breakthrough of port integration in YRD would appear.

**Table 9.** The modes of port integration in YRD.

Integration cases	Dominant power	Territorial scope	Realization path	Degree of integration	Focus of integration	Start-up time
Establishment of Shanghai Combined Port (Commission Office of Shanghai Combined Port (COSCP))	The state council	Cross-provincial region (YRD region)	Coordinate the development of port and shipping in the YRD.	Loose	Administrative coordination	1997
"Yangtze River Strategy " implemented by Shanghai port and Ningbo-Zhoushan port	SIPG, NPG	Cross-provincial region (Yangtze river valley)	Through the export of capital, technology, management and cooperates with the regions along the Yangtze river	Loose	Enterprise operation	2002 / 2009
Port integration of Shanghai (Construction of Shanghai-Yangshan Port)	Shanghai port administration authorised by the state council	Cross-provincial region (Shanghai/Zhejiang)	Establish a new offshore hub within the administrative areas of other province	Close	Administration and enterprise operation	2002
Port integration of Zhejiang (Set up Zhejiang Seaport Development Committee (ZSDC) / Zhejiang Provincial Seaport Investment & Operation Group Co., Ltd (ZPSIOG))	Set up a new provincial port administration and a new provincial platform company as the main bodies of integration	Main seaports, inland ports and dry port in the province	Blocky integration mode for municipal port enterprises	Close	Administration and enterprise operation	2015
Port integration of Jiangsu (Set up Jiangsu Port Group Co., Ltd (JPG))	Set up a new provincial platform company as the main body of integration	Main seaports and inland ports in the province	Strip integration mode for specific business segments	Loose-Close	Enterprise operation	2017
Port integration of Anhui (Set up Anhui Provincial Port & Shipping Group Co., Ltd (APPSG))	Set up a new provincial platform company as the main body of integration	Main inland ports in the province	Strip integration mode for specific business segments	Loose-Close	Enterprise operation	2018

Source: Compiled by the author.

## **4. Efficiency evaluation of the port integration in YRD**

### **4.1. Establishment of the port integration efficiency evaluation model**

The comprehensive efficiency evaluation of the port integration is the evaluation of the overall performance of the port cluster after the integration, whose connotation mainly includes:

First of all, the direct performance of port integration is to enhance the overall competitiveness of the port cluster. It reflects the development level and scale of ports in a certain region, especially the production capacity of ports, port economic level, port efficiency, port service level and its importance in international trade. The core port(s) and other ports in the port cluster have the ability to attract each other, gather and spread radiation. With the port integration, the spatial interaction in the port cluster is increasingly strengthened, and the overall performance of the port cluster is also improved. The contribution of the port cluster to the social and economic development of the region is a measure of the efficiency of integration.

In addition, the core goal of port integration is to better realize the division of labor and cooperation of ports within a certain geographical scope. The port cluster integration can realize reasonable allocation of port resources in a relatively large range and make the connection between ports closer, which is more conducive to the coordinated development of ports and achieve the effect of “1 + 1 > 2”. The core of port cluster integration is to form a port cluster system with highly specialized and comprehensive service function.

To sum up, port integration efficiency is thought to be the effect of port integration, which can be reflected by the comprehensive competitiveness and coordination of

the ports after integration. Therefore, the efficiency evaluation of the port integration can be made by analyzing the comprehensive competitiveness of the port cluster and the coordination among ports after the integration. At present, the port integration in YRD mainly based on provincial level, therefore, the ports of each province can be regarded as a port cluster and its comprehensive competitiveness and coordination can be analyzed to evaluate the port integration efficiency of each province. This process can be realized by establishing an evaluation model of port integration efficiency.

#### ***4.1.1. Establishment of comprehensive evaluation indicator system***

In order to establish the comprehensive evaluation model of integration efficiency of port cluster, the comprehensive evaluation indicator system should be established first, which require not only focusing on the comprehensive competitiveness of the port cluster, but also investigating the cooperation and competition among the member ports, systematically analyzing the correlation between them, and comprehensively and hierarchically evaluating the port cluster. At the same time, for the purpose of making the indicator system objectively evaluate the overall situation of port cluster, the quantitative indicator should be used and the qualitative indicator should be quantified as much as possible in the indicator setting process, so as to establish the evaluation indicator system with high comparability and operability. In addition, the evaluation indicator system should be moderate, the calculation in the evaluation should be simple, and the data needed for the evaluation indicator should be easy to collect.

Base on the analysis above, the comprehensive evaluation indicator system of port integration efficiency in YRD established in this dissertation includes two categories of indicators: the comprehensive competitiveness of provincial port cluster and the

system coordination of provincial port cluster. The specific Level-2 and Level-3 indicators are shown in **Table 10**.

### **(1) Comprehensive competitiveness factors of provincial port cluster**

#### **① Regional economy**

The development of port cluster is closely related to the level of regional economic development. The regional economic aggregate, the degree of opening to the outside world, the volume of import-export, and the degree of port marketization all have great influence on the development of the port cluster.

#### **② Scale of port cluster**

It includes length of port shoreline, total amount of berths, total number of deep-water berths, total port cargo throughput capacity, total port container throughput capacity.

#### **③ Throughput of port cluster**

Throughput, as the main indicator reflecting the port output, can best reflect the port's attraction to the source of goods and the port's importance in international cargo transport, is the key factor to measure the port's competitiveness. It mainly includes total cargo throughput, total container throughput, proportion of foreign trade cargo, etc.

#### **④ Core port(s) competitiveness**

As the representative and leader of port cluster, the core port(s) can provide favorable conditions for the development of surrounding ports through its (their) intensive voyages, efficient cargo-handling efficiency and centralized port auxiliary industry.

In addition, with continuous development of the core port(s), the construction of national or international shipping center will attract more ships to visit, thus cause more ocean routes opening, foreign trade transit link reducing, can greatly reduce logistics cost, save the goods transportation time, thus improve the competitiveness of the whole port cluster in international trade transportation. It can be said that the development level of the core port(s) has a crucial impact on the development of the port cluster.

## **(2) System coordination of port cluster**

The purpose of port integration is to make the ports coordinate and cooperate with each other, to realize resource optimization and dislocation development, and to avoid disordered competition and resource waste. Therefore, the coordination between ports is one of the most important aspects of port integration efficiency evaluation, measured by the degree of competition and the level of cooperation within the port cluster.

### **① The degree of port competition**

The competition of ports mainly includes the competition of shipping routes and the competition of berth construction, whose essence is the competition for goods of public hinterland.

### **② The level of port cooperation**

The level of cooperation between ports is mainly measured by the degree of port differentiation and the development level of regional feeder transport. The differentiation of ports is mainly manifested in the differentiation of port size and goods. Port size differentiation refers to the coordinated development of all kinds of ports with different sizes and reasonable positioning, such as hub port, main port and

feeding port etc. The specialization of goods is to build specialized ports and terminals according to the differences of goods, such as container ports, dry bulk ports, oil ports, etc. Through differentiated development, regional feeder transport services are supplied, mutual coordination and supplement among ports can effectively reduce vicious competition and improve the output level of the whole port cluster.

**Table 10.** Efficiency evaluating indicator system for port integration in YRD.

Level-1 indicators	Level-2 indicators	Level-3 indicators
The comprehensive competitiveness of provincial port cluster	Regional economic determinants	Economic aggregate
		Total export-import volume
	Scale of port cluster	Total number of berths
		Total number of deep-water berths
		Total port cargo throughput capacity
		Total port container throughput capacity
	Throughput of port cluster	Total cargo throughput
		Total container throughput
		Proportion of foreign trade goods
	Core port(s) competitiveness	The core ports in the construction of national or international shipping center competition competition level
The system coordination of provincial port cluster	The competition degree and the cooperation level within the port cluster.	

Source: Compiled by the author.

#### **4.1.2. The comprehensive evaluation method**

Comprehensive evaluation is an evaluation method that applies quantitative methods (including mathematical statistics) to process and refine the data of multiple indicators of a complex system, so as to obtain their ranks of advantages and disadvantages. It is the premise of decision making.

Generally, the steps of comprehensive evaluation are as follows: Selecting evaluation indicators and determining evaluation indicator system; Select evaluation method;



Determine the relevant standard value according to the requirements of comprehensive evaluation; The indicator observation value is converted into dimensionless indicator evaluation value; Determine the weight coefficient of each indicator; Integrated the evaluation value of a single indicator into a total evaluation value for ranking or other analysis.

In this dissertation, the weighted comprehensive evaluation is adopted, combined with the coordination mechanism of port cluster, the traditional linear weighted model is improved, and the multiplication model is adopted to comprehensively evaluate the integration efficiency of the YRD ports. The evaluation model is as follows:

**(Equation 1)** 
$$L = C * h$$

Note:  $L$  --- Comprehensive evaluation score of port cluster integration efficiency;

$C$  --- Comprehensive competitiveness of port cluster;

$h$  --- Coordination coefficient of port cluster.

## **4.2. Comprehensive evaluation of port integration efficiency in YRD**

### **4.2.1. Comprehensive evaluation indicators of port integration efficiency in YRD**

According to comprehensive evaluation indicator system of port cluster integration efficiency established above, relevant data of YRD were collected from various sources, as shown in **Table 11**.

**Table 11.** Comprehensive evaluation indicators and data of port integration efficiency in YRD.

Port cluster		Shanghai port cluster	Zhejiang port cluster	Jiangsu port cluster	Anhui port cluster
Evaluation Indicator					
Regional economy $C_1$	Economic aggregate $C_{11}$ (billion Yuan)	3816	6235	9963	3711
	Total export-import volume $C_{12}$ (billion Yuan)	3405	3083	4338	474
Scale of port cluster $C_2$	Total number of berths $C_{21}$ (Pc)	2058	4690	5545	1148
	Total number of deep-water berths $C_{22}$ (Pc)	251	270	509	17
	Total port cargo throughput capacity $C_{23}$ (million ton)	633	1145	2100	510
	Total port container throughput capacity $C_{24}$ (million TEU)	20	18	20	1
Throughput of port cluster $C_3$	Total cargo throughput $C_{31}$ (million ton)	717	1750	2831	555
	Total container throughput $C_{32}$ (million TEU)	43	32	19	2
	Proportion of foreign trade goods $C_{33}$	0.27	0.36	0.36	0.01
Core port(s) competitiveness $C_4$		300	190	110	30

Source: Data are from National Bureau of Statistics, Annual report of each port, City statistics bulletin, website of Chinese port (<http://www.chineseport.cn>) etc. The data of core port(s) competitiveness are adopted the scores of Shanghai port, Ningbo-Zhoushan port, Suzhou port and Wuhu port.

#### 4.2.2. Measurement of comprehensive competitiveness of provincial port clusters in YRD

In order to determine the indicator weight scientifically and reasonably, this dissertation uses Delphi method to compare the importance of each evaluation indicator, establishes a judgment matrix (see **Appendix A** for principle), and then uses Analytic Hierarchy Process (AHP) to obtain the weights of comprehensive competitiveness evaluation indicators of the port cluster (see **Appendix B**). Taking the four level-2 indicators (regional economy  $C_1$ , scale of the port cluster  $C_2$ , throughput of the port cluster  $C_3$ , and core port(s) competitiveness  $C_4$ ) as examples, the weight determination process is as follows:

**(1) Establishment of the judgment matrix**

In order to establish the judgment matrix, a questionnaire was designed based on the established evaluation system to compare the importance of various evaluation indicators. The questionnaire survey was conducted among 40 experts in the field of port and shipping in YRD, including 10 port enterprise managers (accounting for 25%), 10 port enterprise operators (accounting for 25%), 12 port authority commissioners (accounting for 30%), 2 commissioners of the COSCP (accounting for 5%), 6 research scholars on port and shipping (accounting for 15%). A total of 32 valid questionnaires were received. The data of each indicator from the survey were averaged. If there was a decimal in the average, the median was selected.

According to the results of the questionnaire, the importance degree of the four level-2 indicators is compared and the judgment matrix is established as follows:

$$A = \begin{bmatrix} 1 & 1/2 & 1/3 & 2 \\ 2 & 1 & 1/2 & 4 \\ 3 & 2 & 1 & 6 \\ 1/2 & 1/4 & 1/6 & 1 \end{bmatrix}$$

**(2) Calculation of the eigenvalue and the normalized weight vector**

According to the eigenequation  $|A - \lambda E| = 0$ , calculate the largest eigenvalue of the judgment matrix, get  $\lambda_{\max} = 4.0210$ . Then the level-1 indicator weight vector is gained after normalizing the corresponding eigenvector. (**Table 12**)

$$W_0 = (\omega_1, \omega_2, \omega_3, \omega_4)^T = (0.15, 0.28, 0.49, 0.08)^T.$$

It can be seen that according to the consistency test,  $CR = 0.0038 < 0.1$ , so the above eigenvectors all meet the compatibility conditions.

**Table 12.** Determination of the level-1 indicator weights with AHP.

Pairwise comparisons among objectives Matrix					Normalized matrix				Weights ( $W_o$ )	Product Ratios ( $\lambda$ )	
	C <sub>1</sub> Regional economy	C <sub>2</sub> Scale of port cluster	C <sub>3</sub> Throughput of port cluster	C <sub>4</sub> Core port(s) competitiveness							
C <sub>1</sub>	1	1/2	1/3	2	0.1538	0.1333	0.1667	0.1538	0.15	0.61	4.0046
C <sub>2</sub>	2	1	1/2	4	0.3077	0.2667	0.2500	0.3077	0.28	1.14	4.0113
C <sub>3</sub>	3	2	1	6	0.4615	0.5333	0.5000	0.4615	0.49	1.97	4.0210
C <sub>4</sub>	1/2	1/4	1/6	1	0.0769	0.0667	0.0833	0.0769	0.08	0.30	4.0046
$\lambda_{\max} = 4.0210$ ; CR = 0.0038 < 0.1, satisfy the consistency test										CI	0.0035
										CR	0.0038

Source: Constructed by the author with computer.

In the same way, the weight vectors of level-2 indicators are respectively:

Regional economy  $C_1$ ,  $W_1 = (\omega_{11}, \omega_{12})^T = (0.33, 0.67)^T$ ;

Scale of port cluster  $C_2$ ,  $W_2 = (\omega_{21}, \omega_{22}, \omega_{23}, \omega_{24})^T = (0.11, 0.19, 0.29, 0.41)^T$ ;

Throughput of port cluster  $C_3$ ,  $W_3 = (\omega_{31}, \omega_{32}, \omega_{33})^T = (0.31, 0.49, 0.20)^T$ ;

Core port(s) competitiveness  $C_4$ ,  $W_4 = 1$ .

### (3) Standardization of the evaluation data

Before the data can be analyzed, they need to be standardized to remove the limitation of data units and convert them into dimensionless values. There are several methods of data standardization and the normalization method is used to standardize the data of the established indicator system here. By scaling the data to a decimal number between (0,1), it is more convenient to process the data. At the same time, the unit limitation of the data is removed, and they are converted into dimensionless pure values, so that the indicators of different units or orders of magnitude can be compared and weighted.

According to the normalization formula (**Equation 2**) to standardize the evaluation data, the standardized evaluation data are obtained, as shown in the **Table 13**.

$$\text{(Equation 2)} \quad r_{ij} = r'_{ij} / \sum_{j=0}^k r'_{ij} \quad (i = 1, 2, \dots, n)$$

**Table 13.** The standardized evaluation data.

Evaluation Indicator \ Port cluster		Shanghai port cluster	Zhejiang port cluster	Jiangsu port cluster	Anhui port cluster
Regional economy $C_1$	$C_{11}$	0.16	0.26	0.42	0.16
	$C_{12}$	0.30	0.27	0.38	0.04
Scale of port cluster $C_2$	$C_{21}$	0.15	0.35	0.41	0.09
	$C_{22}$	0.24	0.26	0.49	0.02
	$C_{23}$	0.14	0.26	0.48	0.12
	$C_{24}$	0.34	0.30	0.34	0.02
Throughput of port cluster $C_3$	$C_{31}$	0.12	0.30	0.48	0.09
	$C_{32}$	0.45	0.33	0.20	0.02
	$C_{33}$	0.27	0.36	0.36	0.01
Core port(s) competitiveness $C_4$		0.48	0.30	0.17	0.05

#### (4) Determination of the comprehensive weights

According to the weights of single ranking of each level, the comprehensive weights of the total ranking are calculated, as shown in the **Table 14**.

**Table 14.** Determine the comprehensive weights ( $W$ ).

Level-1 \ Level-2	$C_1$ 0.15	$C_2$ 0.28	$C_3$ 0.49	$C_4$ 0.08	$W$
$C_{11}$	0.33	0	0	0	<b>0.05</b>
$C_{12}$	0.67	0	0	0	<b>0.10</b>
$C_{21}$	0	0.11	0	0	<b>0.03</b>
$C_{22}$	0	0.19	0	0	<b>0.05</b>
$C_{23}$	0	0.29	0	0	<b>0.08</b>
$C_{24}$	0	0.41	0	0	<b>0.12</b>
$C_{31}$	0	0	0.31	0	<b>0.15</b>
$C_{32}$	0	0	0.49	0	<b>0.24</b>
$C_{33}$	0	0	0.20	0	<b>0.10</b>
$C_4$	0	0	0	1	<b>0.08</b>

**(5) Calculation of weighted evaluation value of the comprehensive competitiveness of each provincial port cluster**

The standardized evaluation data of the level-3 indicators of the provincial port clusters are weighted, so as to obtain the weighted evaluation value of the comprehensive competitiveness of the provincial port clusters, as shown in the **Table 15**.

**Table 15.** Calculate weighted evaluation value of the comprehensive competitiveness.

Indicators	W	Shanghai port cluster		Zhejiang port cluster		Jiangsu port cluster		Anhui port cluster	
		Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score
$C_{11}$	0.05	0.16	0.0080	0.26	0.0130	0.42	0.0208	0.16	0.0077
$C_{12}$	0.10	0.30	0.0303	0.27	0.0274	0.38	0.0386	0.04	0.0042
$C_{21}$	0.03	0.15	0.0046	0.35	0.0105	0.41	0.0125	0.09	0.0026
$C_{22}$	0.05	0.24	0.0126	0.26	0.0135	0.49	0.0255	0.02	0.0009
$C_{23}$	0.08	0.14	0.0118	0.26	0.0214	0.48	0.0393	0.12	0.0095
$C_{24}$	0.12	0.34	0.0387	0.30	0.0352	0.34	0.0391	0.02	0.0023
$C_{31}$	0.15	0.12	0.0187	0.30	0.0457	0.48	0.0739	0.09	0.0145
$C_{32}$	0.24	0.45	0.1090	0.33	0.0795	0.20	0.0473	0.02	0.0045
$C_{33}$	0.10	0.27	0.0261	0.36	0.0352	0.36	0.0345	0.01	0.0010
$C_4$	0.08	0.48	0.0381	0.30	0.0241	0.17	0.0140	0.05	0.0038
<b>TTL score (C)</b>		<b>0.2979</b>		<b>0.3057</b>		<b>0.3453</b>		<b>0.0511</b>	

**4.2.3. Determination of coordination coefficient of provincial port cluster in YRD**

The function of port cluster coordination coefficient is established in this dissertation, which is proportional to the port cooperation level and inversely proportional to the port competition degree, as shown in equation (**Equation 3**):

**(Equation 3)** 
$$h = f(c_1, c_2) = a + b * c_1 / c_2$$

Note:  $c_1$  --- Level of port cooperation;

$c_2$  --- Degree of port competition.

In order to evaluate the coordination of provincial port cluster in YRD, the undetermined coefficient method is used to construct the function of port cluster coordination coefficient. For the sake of calculation, set  $c_1 + c_2 = 1$ ,  $c_1, c_2 \in (0, 1)$ . According to the characteristics of the port cluster and the fact, only benign competition and cooperation can make the port cluster give full play to the overall function of the maximum, both excessive competition and cooperation will have a negative impact on its development. Therefore, set  $0.5 \leq h \leq 2$ , make  $h_1 = f(0.2, 0.8) = 0.5$ ,  $h_2 = f(0.45, 0.55) = 1$ , by the method of undetermined coefficients, finding  $a = 0.28$ ,  $b = 0.88$ . Thus, the coordination coefficient function of port cluster **(Equation 3)** is converted to

**(Equation 4)** 
$$h = f(c_1, c_2) = 0.28 + 0.88 * c_1 / c_2$$

Based on analysis of the provincial port integration modes in YRD in the previous chapter, it can be seen that after integration, the port cooperation level of Shanghai is much higher than the port competition degree, the port cooperation level of Zhejiang is higher than the port competition degree, and the port cooperation level of Jiangsu is lower than the port competition degree, Anhui is basically similar with Jiangsu. Therefore, the ratio of each provincial port cooperation and competition can be set as:

Shanghai:  $c_1 / c_2 = 1.6$ ;

Zhejiang:  $c_1 / c_2 = 1.2$ ;

Jiangsu:  $c_1 / c_2 = 0.8$ ;

Anhui:  $c_1 / c_2 = 0.8$ .

By substituting the above ratios into the function (**Equation 4**), the coordination coefficient of each provincial port cluster in YRD can be obtained as follows:

Shanghai:  $h_s = 0.28 + 0.88 * 1.6 = 1.688$ ;

Zhejiang:  $h_z = 0.28 + 0.88 * 1.2 = 1.336$ ;

Jiangsu:  $h_j = 0.28 + 0.88 * 0.8 = 0.984$ ;

Anhui:  $h_a = 0.28 + 0.88 * 0.8 = 0.984$ .

#### 4.2.4. Calculation of comprehensive evaluation value of port integration efficiency in YRD

Base on the port integration efficiency evaluation model previously built, substitute the weighted evaluation value of the comprehensive competitiveness ( $C$ ) and the coordination coefficient ( $h$ ) of each provincial port cluster into (**Equation 1**)  $L = C * h$ , the comprehensive evaluation scores of provincial port cluster integration efficiency in YRD ( $L$ ) are as follows: (**Table 16**)

Shanghai:  $L_s = 0.50$ ;

Zhejiang:  $L_z = 0.41$ ;

Jiangsu:  $L_j = 0.34$ ;

Anhui:  $L_a = 0.05$ .

**Table 16.** Calculation of comprehensive evaluation value of port integration efficiency in YRD.

Port cluster	The weighted evaluation value of the comprehensive competitiveness ( $C$ )	The coordination coefficients ( $h$ )	The comprehensive evaluation value of port integration efficiency ( $L$ )	Rank
Shanghai	0.2979	1.688	0.50	1
Zhejiang	0.3057	1.336	0.41	2
Jiangsu	0.3453	0.984	0.34	3
Anhui	0.0511	0.984	0.05	4



### 4.3. Result analysis of comprehensive evaluation of port integration efficiency in YRD

The higher the comprehensive evaluation value of provincial port cluster integration efficiency ( $L$ ) and the higher the rank, then the higher the efficiency of the port integration in the province. Through the above analysis, combined with the value and rank, it can be seen that Shanghai ranks the highest, followed by Zhejiang, Jiangsu and Anhui. (Table 16)

Shanghai topped the list, 0.09 points higher than the second-place Zhejiang. This is mainly due to the high degree of integration realized in the process of Shanghai-Yangshan port integration by building Yangshan port into a part of Shanghai port. As a result, its coordination coefficient is far higher than those of other three provinces. In addition, although Shanghai is at a disadvantage in terms of regional economy and scale of port cluster, it is far better than the other three provinces in terms of port container throughput, an important indicator of port quality, which is also a major advantage in the comprehensive competitiveness of port clusters. What's more, in the core port(s) competitiveness evaluation, the advantage of Shanghai is far greater than the other three provinces, it is ahead of other cities in YRD almost in every aspect. Shanghai is an international metropolis with a high level of economy, an important hub of comprehensive transportation in China and the largest port in the world. At present, the biggest problem of Shanghai port is that its container throughput capacity (about 20 million TEU) is severely limited due to the limited deep-water shoreline, which is less than half of its throughput (about 43 million TEU), resulting in severe congestion at the port, insufficient development potential and limited space for re-integration.

The comprehensive evaluation value of Zhejiang port cluster integration efficiency

( $L_z$ ) ranks the second. Although there is a big gap with Shanghai, it also has a great advantage compared with other provinces. This is mainly due to the integration of enterprise operation and port administration realized through the reform in the process of Zhejiang port integration, which is a relatively high degree of integration. Therefore, though not so good as Shanghai, its port cluster coordination coefficient is still far higher than those of the other two provinces. In addition, Zhejiang also has greater advantages than other provinces in the port container throughput and the core port(s) competitiveness. Especially in terms of core port(s) competitiveness, thanks to natural and regional advantages, Ningbo-Zhoushan port has become an important hub port and the second only to Shanghai in YRD region, and is constantly widening the gap with other ports due to its development momentum is rapid. Its disadvantage is that the port's container throughput capacity (about 18 million TEU) is obviously insufficient compared with its throughput (about 32 million TEU), which leads to the congestion of the port. It is urgent to develop new berths and increase its throughput capacity. In general, the development potential of Zhejiang ports is huge and there is space for re-integration.

The comprehensive evaluation value of Jiangsu port cluster integration efficiency ( $L_j$ ) ranks the third, far lower than Shanghai, and shows a big gap with Zhejiang. This is mainly due to the fact that in the process of port integration, Jiangsu has only realized the enterprise operation integration of some ports, and has not made reform in port administration. As a result, the degree of its integration is far less than that of Shanghai and Zhejiang, leading to a large gap between its port cluster coordination coefficient and those of Shanghai and Zhejiang. Although the comprehensive competitiveness of its port cluster ranks the highest in YRD, this is mainly due to its advantages in regional economy and scale of the port cluster, and its port cargo throughput is the largest, which also helps to some extent. It can be seen that

although its port cargo throughput is the largest, Jiangsu is obviously at a disadvantage in terms of core port(s) competitiveness. In addition to the limitation of water depth in major ports, the main reason is that the vicious competition among ports is serious due to the local port administrative system, and it is difficult to form synergy. Even Suzhou port with the strongest comprehensive strength in Jiangsu still has a huge gap with Shanghai port and Ningbo-Zhoushan port. Generally, integration potential of Jiangsu ports is huge, especially in port administration, but its integration is the most difficult among the four because of the similar endowment and balanced strength of each main port.

The comprehensive evaluation value of Anhui port cluster integration efficiency ( $L_A$ ) ranks the lowest, and far lower than the other provinces in YRD. This is mainly due to its disadvantages in all the four level-2 indicators and the huge gap with other provinces, leading to its absolute disadvantage in the comprehensive competitiveness of port cluster. In addition, its port integration process and degree are similar to those of Jiangsu, resulting in its port cluster coordination coefficient is also the smallest. In general, due to the natural disadvantages and port integration started late, the integration potential of Anhui ports is moderate and the integration is not so difficult.

## **5. Policy supports to the port integration in YRD**

In China, governments traditionally hold high control over the port industry. As can be seen from the previous chapters, the governments played an irreplaceable and leading role in the process of port integration reform in YRD. The formulation of port policies may bring far-reaching influence on the development of the ports. Therefore, how to formulate policies to coordinate the ports will be the key to the success of port integration in YRD in the future.

In order to correctly formulate the policies of port integration development in YRD in the future, the following two issues must be made clear:

- (1) What are the existing port integration policies?
- (2) What problems exist in the port integration in YRD?

Finally, based on the current integration policies, reasonable policy suggestions for the problems existing in the integration could be proposed.

### **5.1. Policy development course of the port integration in YRD**

In order to make the policy development course of port integration in YRD clear and intuitive, the policies are collated and shown in **Table 17** and **Table 18**. In addition, the policy development course of port integration in each province is shown in **Table 19**, **Table 20**, **Table 21**, and **Table 22**.

**Table 17.** Policy development course of the port integration in YRD.

Port integration policy	Policy maker	Territorial scope	Policy contents related to port integration in the YRD	Start-up time
Make a major strategic decision to build Shanghai International Shipping Center(SISC)	The state council	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	It is proposed to build the SISC with Shanghai as the main body, Zhejiang and Jiangsu as the two wings	1996
The state council on the approval of Shanghai combined port construction program	The state council	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	Approved the establishment of Shanghai Combined Port	1997
Establish Shanghai Combined Port (Commission Office of Shanghai Combined Port (COSCP))	The state council and the provincial governments of Shanghai, Jiangsu and Zhejiang	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	According to the overall arrangement of the state council on the construction of SISC, the COSCP is responsible for coordinating the related affairs of the port shipping development within the jurisdiction of YRD.	1997
The Tenth Five-year Plan Outline of the Economic and Social Development in the People's Republic of China.	Central government	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	It included the newly published plan (2001-2005) "to build Shanghai international shipping center".	2001
The Yangshan deep-water port area was approved	The state council	Shanghai / Zhejiang	Construct Yangshan port area as a part of Shanghai port for the purpose of SISC.	2002
Coastal Port Construction Planning in Yangtze River Delta, Pearl River Delta and Bohai Bay (2004-2010)	Ministry of Transport (MOT)	YRD, Pearl River Delta and Bohai Bay	The system positioning is clearly defined: ① Focusing on Shanghai port and Ningbo port, the container transport system of SISC is composed of Suzhou port and other ports in the lower reaches of the Yangtze river; ② Based on Ningbo port and Zhoushan port, the import ore transshipment transportation system of ports of Shanghai, Nantong, Suzhou and Zhenjiang shall be developed accordingly; ③ Ningbo, Zhoushan as the main port, the corresponding development of Nanjing and other ports of import crude oil transshipment system; ④ It is a coal unloading and transshipment transportation system based on Shanghai, zhoushan and power enterprise self-use terminals.	2004
Outline of Modern Highway and Waterway Transportation Planning for the Yangtze River Delta Region	Ministry of Transport (MOT)	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	The outline stipulates that the main container ports with Shanghai as the center, Ningbo and Suzhou as the two wings, and ports of Lianyungang, Nantong, Nanjing, Zhenjiang and Wenzhou as branch ports will be developed.	2004
Yangtze river delta regional customs clearance construction cooperation memorandum	Provincial governments of Shanghai, Jiangsu and Zhejiang	YRD (Shanghai, Jiangsu and Zhejiang)	Decided to establish the YRD region "Faster customs clearance" construction cooperation mechanism.	2005
National Plan for the Layout of Coastal Ports	Ministry of Transport (MOT)	Coastal ports of China	The main ports in the YRD are positioned	2006
the Memorandum of Understanding on Cooperation in the Construction of 'Faster Customs Clearance'	Provincial governments of Shanghai, Jiangsu and Zhejiang	YRD (Shanghai, Jiangsu and Zhejiang)	Decide to establish a cooperative mechanism in the construction of 'Faster customs clearance ' in the YRD.	2007

**Table 18.** Policy development course of the port integration in YRD (continued).

Port integration policy	Policy maker	Territorial scope	Policy contents related to port integration in the YRD	Start-up time
Guidance of the State Council on Further Promoting Reform and Opening up and Economic and Social Development of the Yangtze River Delta	The state council	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	It pointed out that the SISC with Shanghai as the center and Jiangsu ports and Zhejiang ports as the two wings should be built as soon as possible.	2008
Regional Planning for the Yangtze River Delta Region	The state council	Ports in YRD (Shanghai, Jiangsu and Zhejiang)	Make clear the position of the main ports in the YRD	2010
Development Plan for Urban Agglomeration in Yangtze River Delta	The state council	YRD (Shanghai, Jiangsu, Zhejiang and Anhui)	Anhui was formally incorporated into the YRD	2016
Six Action Plans on collaboratively Promoting Port and Shipping Integration Development in the Yangtze River Delta	The state council and the provincial governments of Shanghai, Jiangsu, Zhejiang and Anhui	YRD (Shanghai, Jiangsu, Zhejiang and Anhui)	Improve the pattern of SISC with "one body, two wings", promote the coordinated development of SISC, Zhoushan river-sea multimodal transport service center and Nanjing Yangtze-river-regional shipping and logistics center, promote the integrated development of ports and shipping in the YRD.	2018
Strategic Cooperation Framework Agreement on Interconnected Development of Pilot Free Trade Zones in Shanghai, Jiangsu and Zhejiang	The provincial governments of Shanghai, Jiangsu and Zhejiang	YRD (Shanghai, Jiangsu, Zhejiang)	Jointly build a platform for institutional innovation, promote industrial development, carry out scientific and technological innovation, promote integration of financial services, strengthen overseas investment cooperation, promote data connectivity, promote integration of government services, conduct exchanges and studies.	2019
Outline for Building a Transportation Power	The state council	YRD (Shanghai, Jiangsu, Zhejiang and Anhui)	Build a multi-level, integrated comprehensive transport hub system, build international seaport hubs with global competitiveness, promote the integrated planning and construction of comprehensive transportation hubs, and improve the collection and distribution system.	2019
Outline of Regional Integration Development Plan for the Yangtze River Delta	The CPC central committee and the state council	YRD (Shanghai, Jiangsu, Zhejiang and Anhui)	The port function positioning is clearly defined. It is clearly put forward that the YRD should promote the integration of port and shipping resources, optimize the layout of ports, improve the integrated development mechanism, enhance the ability to serve the whole country, and form a world-class port cluster with reasonable division of labor and mutual cooperation.	2019
Integrated Development Plan of Higher Quality Transportation in the Yangtze River Delta Region	The state council	YRD (Shanghai, Jiangsu, Zhejiang and Anhui)	It is proposed to accelerate the construction of a modern comprehensive transportation system in the YRD with the focus on integrated development, promote the coordinated development of port clusters with higher quality, coordinate the development of combined transport between seas and rivers, and coordinate the improvement of shipping service functions.	2020

**Table 19.** Policy development course of the port integration in Zhejiang province.

Port integration policy	Policy maker	Territorial scope	Policy contents related to port integration in the YRD	Start-up time
The Medium-term Plan for Ningbo Port and Zhoushan Port	Zhejiang provincial government	Ningbo-Zhoushan port	Put forward the idea of unified planning, unified construction and unified management of the two ports for the first time.	1996
Establish the Ningbo-Zhoushan Port Management Committee (NPMC)	Zhejiang provincial government	Ningbo-Zhoushan port	Be responsible for the planning, management, development and construction of the two port areas according to the principle of "unified planning, unified construction, unified brand and unified management".	2005
Master Plan of Ningbo-Zhoushan Port (2009 edition)	MOT & Zhejiang provincial government	Ningbo-Zhoushan port	Plan defines the functional positioning and land area of the 19 port areas of Ningbo-Zhoushan port, the port is a major coastal port in China and an important hub of the country's comprehensive transport system, an important part of the SISC, and a transshipment port for energy, raw materials and other bulk materials in the YRD and regions along the Yangtze river.	2009
Zhejiang Marine Economic Development Demonstration Zone Planning	The state council	Coastal areas of Zhejiang province	Build Zhejiang into an international logistics center for bulk commodities in China, and put forward "one core, two wings, three rings, nine zones and multiple islands" as the spatial layout.	2011
Master Plan of Ningbo-Zhoushan Port (2014-2030)	MOT & Zhejiang provincial government	Ningbo-Zhoushan port	The plan proposes to speed up the deep integration of Ningbo-Zhoushan port, with the focus on the transshipment of bulk energy and raw materials and the trunk transport of containers, to build a river-sea combined transport service center, and realize the transformation from a big port to a strong one.	2014
Establish Zhejiang Seaport Development Committee (ZSDC)	Zhejiang provincial government	Ports in Zhejiang province	To be responsible for the macro management and comprehensive coordination of the economic development of marine ports, and to promote the integration and coordinated development of marine ports in the whole province	2015
The 13th Five-year Plan of Marine Ports in Zhejiang Province	Zhejiang provincial government	Ports in Zhejiang province	Focuses on the integration of ports in the whole province from a higher level and a larger scope, and puts forward the port development pattern of "One Body, Two Wings and Interactive Development", so as to build a world-class port cluster and vigorously develop the economy of the bay area.	2016
Ningbo-Zhoushan Port Core Port Area Traffic Organization Integration Implementation Plan & Interim Measures for the Organization and Implementation of Vessel Traffic in the Core Port Area of Ningbo-Zhoushan Port	Zhejiang maritime safety administration	Ningbo-Zhoushan port	The integrated mechanism of vessel traffic organization shall be launched to form a unified organization, announcement and joint implementation of the arrangement of vessel traffic entering and leaving ports for vessels in the port areas of Ningbo and Zhoushan as well as vessels passing by sea.	2019

**Table 20.** Policy development course of the port integration in Jiangsu province.

Port integration policy	Policy maker	Territorial scope	Policy contents related to port integration in the YRD	Start-up time
Establishment of Suzhou port	Suzhou municipal party committee and government		Merge the original Taicang port, Changshu port, Zhangjiagang port into one port to establish Suzhou port	2002
Development Plan for Jiangsu Coastal Areas	The state council	Coastal ports in Jiangsu province	Build coastal ports in Jiangsu into important comprehensive transportation hubs in China, a new type of industrial base in the coastal area, and the eastern bridgehead of the new Eurasian land bridge with strong radiation driving capacity.	2009
Jiangsu Inspection and Quarantine Regional Integration Work Plan	Jiangsu inspection and quarantine bureau	Ports in Jiangsu province	Through "unified information platform, unified management mode, unified joint law enforcement, unified decision-making and maintenance", break administrative and regional restrictions, fully implement the regional integration work mode of inspection and quarantine through paperless declaration and electronic release, and promote trade facilitation.	2015
The Implementation plan of promoting the Pilot Reform work of the Integration of Ports along the Yangtze River Below Nanjing in Jiangsu Province	Jiangsu provincial government	Ports along the Yangtze river below Nanjing	The sub-task of resource integration of anchorages, coastlines and routes is defined item by item.	2016
Layout Planning of Ports along the Yangtze River and Coastal Ports in Jiangsu Province (2015-2030)	Jiangsu provincial government	Ports in Jiangsu province	To guide and promote the comprehensive, coordinated and sustainable development of coastal ports and ports along the Yangtze river in Jiangsu province.	2017
Opinions on Deepening the Integration Reform of Ports along the River and Coastal Ports	Jiangsu provincial government	Ports in Jiangsu province	It is suggested that leading port enterprises such as JPG should be cultivated and strengthened as an important platform for port integration reform of Jiangsu province, and large port enterprises with conditions should be encouraged to merge and reorganize, and high-quality resources should be guided to actively participate in the integration reform of ports along the river and along the coast of Jiangsu province.	2017
Layout Plan of Inland River Ports in Jiangsu Province (2017-2035)	Jiangsu provincial government	Inland river ports in Jiangsu province	The inland river ports of the province are planned into three levels.	2018
Regulations on Water Transportation of Jiangsu Province	Jiangsu provincial government	Ports in Jiangsu province	Establish the provincial port investment and operation platform, promote the integration of port resources, guide the division of labor, cooperation and operation of ports, promote the integrated development of ports, and support the development of regional shipping and logistics centers.	2019



**Table 21.** Policy development course of the port integration in Anhui province.

Port integration policy	Policy maker	Territorial scope	Policy contents related to port integration in the YRD	Start-up time
The Waterway Construction Plan of Anhui Province (2017-2021)	Anhui government	Ports in Anhui	promote port construction in an orderly manner, comprehensively integrate port resources, build a unified port operation and management platform, and deepen strategic cooperation with Shanghai port, Ningbo-Zhoushanport and Nanjing port.	2017

**Table 22.** Policy development course of the port integration in Shanghai municipality.

Port integration policy	Policy maker	Territorial scope	Policy contents related to port integration in the YRD	Start-up time
Shanghai Will Accelerate the Construction of an International Shipping Center during the Period of "12th Five-year Plan"	Shanghai government	Shanghai	Enhance the soft power of SISC, cooperate with port cities in the YRD to build SISC, and speed up the process of internationalization of SISC construction	2012
Three-year Action Plan for the Construction of Shanghai International Shipping Center (2018-2020)	Shanghai government	Shanghai	According to international first-class standard, build the world's advanced air and sea hub; Establish the brand concept, comprehensively improve the level of modern shipping service; Regional coordination should be strengthened to enhance global shipping resource allocation capacity.	2018

## 5.2. Existing problems in the port integration in YRD

Since the construction of SISC was launched, the port integration in YRD has been carried out gradually, and the central and local governments have made various policies to promote the integration, which are demonstrated above. However, for more than 20 years, there are many problems in the process of integration, resulting in the slow progress of overall regional port integration, which cannot fully adapt to the current development situation.

### 5.2.1. *Fragmented governance and lack of a strong regulatory structure*

There has been lots of cooperation in the development of the YRD port cluster, but it is difficult to form regional cooperation or alliance, which is largely due to the lack

of a strong management body to plan and coordinate the functions and positioning of ports in this region. The state attaches great importance to the resource integration of the YRD port cluster, and has made relevant regulations on the positioning of the cluster. However, the ports belong to administrative regions of Shanghai, Jiangsu, Zhejiang and Anhui respectively, each local government has actual control over its own ports and put forward the development direction of its respective ports for its respective interests, there is lack of necessary communication and cooperation between ports. As a result, the port cluster planning in YRD is disordered, the development of some ports deviates from their overall regional positioning, the synergy is reduced, the vicious competition is intensified, the port structural contradiction is outstanding, the resource utilization rate is low, and the resource integration degree of the port cluster is reduced.

In order to solve this problem, the central and provincial governments set up the COSCP in 1997, responsible for coordinating the related affairs of the development of ports and shipping in YRD according to the overall arrangement of the State Council on the construction of SISC. However, due to its committee nature, its functions are easily neglected by the local governments, resulting in the lack of its management functions and failure of achieving the expected effects.

### ***5.2.2. Lack of long-term cooperation mechanism***

In addition to the first problem above, there is also a lack of effective long-term cooperation mechanism in the YRD port cluster. At present, the competition between Shanghai port and Ningbo-Zhoushan port, the two most important ports in YRD, is still very fierce for the position of hub port, which has become the core problem of the port integration in YRD. The layout structure of “One body, two wings” of the YRD port cluster is changing to the structure of two hub ports and multiple trunk

ports, which indicates that all ports have been engaged in fierce competition in order to compete for the status of hub port. Therefore, it is difficult to form an effective alliance or long-term stable cooperation between ports to some extent. The weakness of the soft environment for cooperation between ports is gradually becoming the bottleneck that restricts the further development of SISC.

### ***5.2.3. Insufficient implementation strength on port division of labor and positioning***

The national and local governments have issued a series of planning policies on the resource integration of the YRD port cluster, among which, the Regional Planning for the Yangtze River Delta Region further clarifies the functional positioning of the major ports in YRD. Despite the high support of the state, the implementation is still led by the local governments who decompose the task of positioning the port cluster. In the process of decomposition, the local governments lack communication and cooperation with each other, thus planning and construction synchronization is poor, and the project schedules are different. In addition, due to the long period of port construction while the periods of relevant planning are usually only 5 years, local governments lack incentive mechanism and may delay the port construction projects on the pretext of long construction time. Instead, they may invest in the construction of port projects that are beneficial to local economy but may not conform to the division of labor among the ports in YRD. The shortsightedness and inaction of the local governments lead to low efficiency of the relevant national planning and slow progress of the port integration in YRD.

### ***5.2.4. Weak soft power of the port cluster***

In recent years, the YRD port cluster takes the port throughput as the main target, and

ignores the importance of constructing service ports. The strength of port service capability is reflected in port soft power, including comprehensive services such as insurance and finance. The YRD ports cluster lags far behind other advanced ports in the world in soft power construction. Taking London port as an example, although lagging far behind Shanghai or Ningbo-Zhoushan port in terms of port throughput, it is the world's largest market for shipping services, particularly in shipping finance and maritime professional services, which include banking, insurance, ship broking, legal accounting, classification society, publishing, and so on. In addition, its accounting service, research service, education training service, technology and engineering consulting service also occupy a very important position in shipping service industry. At present, London's shipping service industry has an international market share of almost 50% in many areas. The value created by these shipping services is even greater than that created by port logistics entities, and shipping services have no destructive impact on environment. In contrast, the soft power of ports in YRD is particularly weak, and the logistics service system of port and shipping needs to be improved.

#### ***5.2.5. Abnormal development of collection and distribution system***

Data shows that the logistics cost in China is far higher than that in the US, mainly because that the lack of proper multimodal transport leads the transshipment of goods to account for a large proportion of cost, approximately 30% - 50%.

At present, in the port collection and distribution system of YRD, the proportion of highway is too high while those of inland waterway and railway are relatively low, and various modes of transport do not connect smoothly. As way of collection and distribution which is economic, efficient and environmental-friendly, sea-rail combined transport has become one of the competitive advantages of ports in

developed countries in Europe and America. In Hamburg, the second largest container port in Europe, the proportion of sea-rail combined transport accounts for 30%, and the proportion of container transport over 150 kilometers accounts for 70%. However, in YRD, most of the railways do not extend to the ports, and the goods need to be transported by trucks between docks and railway freight stations. Even in the most developed city of Shanghai, road transportation still accounts for 51.3% and railway transportation only accounts for about 1%. The logistics network based on water, railway, road and air transportation needs to be further connected, and the logistics channel construction needs to be improved. The progress of the high-grade renovation of the five main waterways connecting Shanghai with Jiangsu and Zhejiang varies from place to place, which affects the overall water transfer efficiency.

In addition, due to the independent operation of various modes of transport, it does not achieve the integration of their transport, services, charges and management, which affects the convenience of regional multimodal transport. For example, the construction of freight railway is out of sync with the construction of port terminals in Shanghai, resulting in additional barge fees and the total cost higher than other ports. Moreover, China's transportation implements the management of different modes and departments, causing different information systems are used in different transportation modes. At present, information systems of ports, shipping, roads and railways, have not been connected yet, and there is a lack of unified data sharing platform and business docking interface. To some extent, this has affected the interconnection of logistics and information flow, and hindered the development of combined transport of road-rail and rail-water.

### **5.2.6. *Low international cargo transshipment ratio restricts the development of SISC***

The international main hub port is the main function of the international shipping center, while the transshipment volume of containers is a very important index to measure the international hub port. Comparatively speaking, the volume of international transshipment containers in YRD is insufficient at present. Although Shanghai now has the world's largest throughput of container for many years, its international transshipment ratio is still very low, represented only 5.7% in 2017. By contrast, that of Singapore is over 80%. International cargoes are thus generally transshipped via foreign hubs. For instance, about 40% of Busan's traffic is fed by transshipment with Chinese ports, which represents 2 million TEUs annually. Such evidence confirms that Shanghai's port development has so far been driven by hinterland-related dynamics rather than hub-related dynamics. (Lu and Yang, 2006).

### **5.3. Policy suggestions to the port integration in YRD**

In view of the problems in the process of port integration in YRD at present, and based on the existing policies of port integration, the following suggestions are put forward for reference of the decision-makers to formulate port policies of YRD.

#### **5.3.1. *Establish joint port authority to break the limits of administrative areas***

In order to break through the bottleneck that the YRD port cluster is divided by the four administrative regions of Shanghai, Zhejiang, Jiangsu and Anhui, the decision-makers can learn from the resource integration experience of the joint port authority of New York - New Jersey port cluster in the US and the high consistency of the local governments in Tokyo bay in Japan, to jointly establish "YRD Joint Port

Authority” across administrative regions. It could be set up under the leadership of the MOT and would have the final administrative authority over the planning and construction of the YRD port cluster. The MOT should stipulate that the local governments have to actively cooperate with the work of the joint port authority and must not interfere in the planning and construction of the YRD port cluster, so as to prevent the interest conflicts between them. The joint port authority shall lead the cross-provincial port integration in the region, break through the restrictions of administrative divisions, and carry out unified planning, construction and management in the areas involving regional public resources.

In addition, considering that the main contradiction in the resource integration of the YRD port cluster lies between Shanghai port and Ningbo-Zhoushan port, the management of the YRD Joint Port Authority should focus on these two ports. The joint port authority can be built on the basis of the COSCP. Through the establishment of the joint port authority, the decision-makers can break through the shackles of administrative regions, better plan and build the port cluster, reduce unnecessary competition, avoid the confusion of planning and other problems, and greatly liberate and develop the productivity of the port cluster. This is the most fundamental way to the resource integration of the YRD port cluster.

### ***5.3.2. Strengthen the rigor of planning to improve the efficiency of its implementation***

The functional positioning of the main ports in the YRD cluster has been clearly stated in the relevant plans of the national and local governments and is very reasonable. The focus of the current work is to enhance the rigor of the planning and improve the efficiency of its implementation, which must be under the leadership of the YRD Joint Port Authority. Since the resource integration of the port cluster is a

systematic project with many participants, all interested parties in the YRD port cluster should fully communicate with each other about the resource integration projects to be constructed and divide the planned projects reasonably. Projects under division of labor should be in line with local capacity and able to keep pace with other projects. In addition, in the port key projects to be built in the planning, the details such as starting time, completion time, required fixed investment, additional investment, implementing subject, cooperating units, annual construction schedule, etc., must be specified in the form of annex. At the same time, the YRD Joint Port Authority should strengthen the supervision and management of the resource integration project, and the parties who achieve the set goals in advance or on time can be given certain rewards, while the parties who fail to complete the project as required can be given certain penalties.

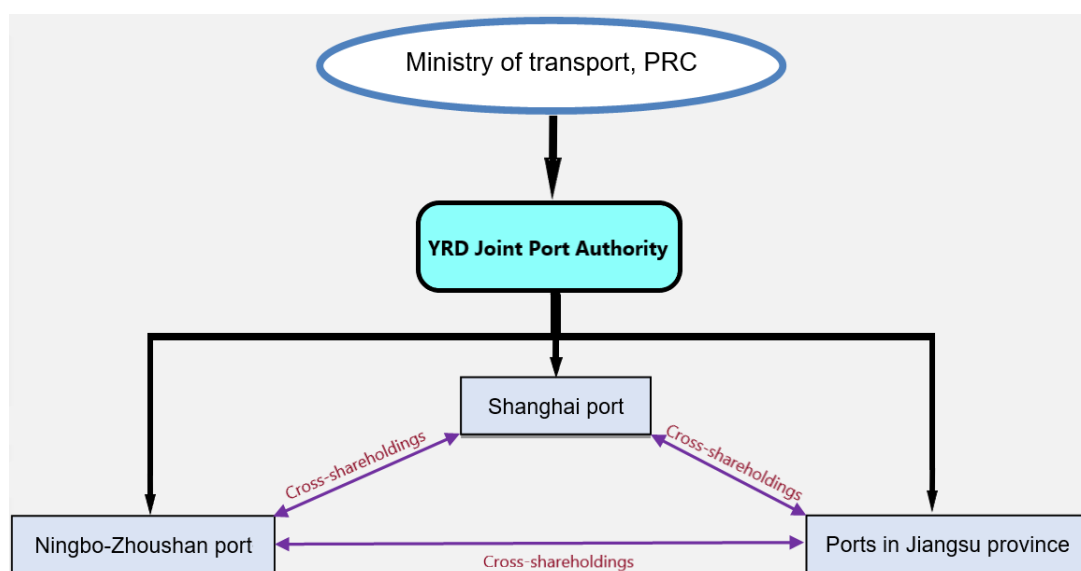
### ***5.3.3. Improve the mechanism for port cooperation to deepen port cooperation***

Horizontal association of ports should be further promoted. It is an important way to adjust port structure and promote rational division of labor. Relevant laws should be enacted to strengthen exchanges and cooperation within and outside the region, so that the integration could develop to a higher form. Cross-shareholding is one of the good ways to establish a long-term cooperation mechanism between ports. Through capital joint, ports can achieve the state of sharing benefits and risks, effectively avoid the problems of repeat and confusion of port division of labor, duplicate construction of infrastructure and vicious price competition. At the same time, it can promote the free flow of production factors between ports and give play to their maximum value. The recommended mode of resource integration in the YRD port cluster is shown in **Figure 19**.

In addition, market regulation and regulatory mechanism, such as YRD port



association, shipowners' association, shipping agency association, freight forwarding association, etc., should be promoted to establish and strengthen so as to make up for the shortage of port cluster cooperation leading by the government and the market.



**Figure 19.** The recommended mode of resource integration in the YRD port cluster.

Source: Constructed by the author base on the policy suggestions.

#### 5.3.4. Promote to establish a regional port information sharing mechanism

Decision-makers should actively formulate relevant policies to promote to build the logistics information system of the YRD port cluster, and promote the information resource sharing of the YRD ports. It is suggested that the governments take the lead in developing a new system to integrate with the existing logistics information systems in ports and e-government systems at all levels of governments. By making full use of new technologies and new processes, relying on the port EDI platform, governments could promote the application of intelligent technologies such as Internet of Things, RFID, 5G, Beidou satellite navigation system, etc., and build and improve information management systems, so as to realize the integration of port cluster logistics and port operation service of intelligence and automation. Finally,

the data docking and sharing among all stakeholders in the port cluster should be realized, and a comprehensive information network covering the entire port cluster supply chain should be formed to provide a series of information interconnection and integration services such as online booking, warehousing management, transportation scheme consultation, etc.

***5.3.5. Accelerate the SISC construction by adjusting cargo structure and enhancing soft power***

The construction of SISC is a national strategy and the ports in YRD bear the common responsibility. International shipping center takes the scale of container transshipment as the main index. In sight of this, the government should formulate corresponding policies to make Shanghai port focus on the development of international container transport and make reasonable adjustment to the cargo structure. For example, the transshipment of bulk cargo such as raw materials and energy can be diverted to other ports in YRD, so as to ensure that the container transportation in Shanghai port is the key point and important growth point for the development of shipping center in the future, meanwhile, promote the development of other ports in YRD.

Besides, relevant policies should be formulated to vigorously develop high-end shipping services such as shipping finance, shipping insurance, maritime law, maritime arbitration, and so on, thus promoting the transformation of the development mode of SISC, from the original simple pursuit of port throughput to the improvement of the comprehensive allocation of shipping related resources or value creation efficiency, from the original amount of labor-intensive to knowledge/technology-intensive value creation.

In addition, the governments should introduce policies to promote the upgrade of comprehensive service function of the ports, enhance the abilities on freight logistics service and ship's integrated service, cultivate some characteristic modern shipping services with great influence, develop “Internet + port and shipping services”, build a modern shipping service industrial cluster, promote the construction of a maritime silk road shipping big data center and improve the maritime silk road index system, thus enhancing the shipping service influence of the YRD port cluster.

#### ***5.3.6. Improve the collection and distribution logistics network***

Policies should be actively introduced to promote the construction of infrastructure for the collection and distribution of goods, and unify the standards for connecting different regions. The governments should actively promote the interconnected development of sea ports, inland ports, air ports and info ports, optimize the multimodal transport system, and speed up the building of a platform for smooth and efficient interconnection between internal and external forces. They should promote the effective connections among different modes of transport, focus on promoting the construction of special railway lines and feeder lines for ports and open up the last kilometer of the railway entering the ports. In addition, the governments should strengthen the cultivation of multimodal transport operators thus realizing the integration of multimodal transport services. By improving the collection and distribution logistics network, the transshipment efficiency can be improved.

#### ***5.3.7. Align national strategies to promote the port integration in YRD***

When making port policies, policy makers should actively align major national strategies to promote the integrated development of ports in YRD.

- **Align the “Integrated Development of YRD” Strategy**

The policies of port integration development should be combined with the policies of integrated development of YRD. The port integration in YRD is an important part of the YRD integration. The policy makers should take the YRD integration as the general outline to formulate the relevant port policies. They should actively promote the coordination of port development, industrial distribution and urban development, thus supporting industrial cluster and city cluster development with port cluster.

- **Align the “Belt and Road Initiative (B&R)” Strategy**

The governments should promote the YRD port cluster to strengthen the international exchanges and cooperation, accelerate the international layout, build international logistics channels, build important hub ports of B&R, and further expand the level of opening-up. They should also promote the YRD port cluster to fully participate in the global resource allocation, and enhance the level of internationalization.

- **Align the “Development Strategy of Yangtze River Economic Zone”**

The governments should introduce favorable policies to guide the cooperation between ports in YRD and ports in the middle and upper reaches of the Yangtze river, so as to expand the hinterland and influence of ports in YRD while promoting the development of the middle and upper reaches of the Yangtze river.

#### ***5.3.8. Improve FTZs to deepen the port integration in YRD***

Facing the fierce competition in the international container port markets, the policy of port liberalization is the key to increase the transshipment ratio of international containers. The governments should further deepen the policies of Free Trade Zones (FTZs) in YRD and improve their openness. The Specific measures include: First,

expanding the scope of FTZs, especially the bonded port areas, simplifying the clearance procedures for international container imports and exports, simplifying inspection procedures for foreign vessels entering and leaving ports and shortening their stay in ports; Second, carrying out territorial tax refund policy to the containers imported and exported from the bonded ports, so as to attract the containers to be transshipped from the bonded port, thus reducing the outflow of international containers.

In addition, the governments should create favorable conditions for the matching of port logistics, vigorously develop the port-related industries, focus on land resources and preferential policies to the ports of the logistics park, particularly focus on the construction of port-related industrial base, thus accelerating the development of port-related industrial cluster based on industrial parks.

At present, the pilot FTZs have been established in Shanghai, Zhejiang (Zhoushan) and Jiangsu (Nanjing, Suzhou and Lianyungang). The governments should actively copy the foreign advanced FTZ shipping policies, and extend these advanced policies and management to the pilot FTZs of YRD, so as to promote the development of port integration in YRD and further enhance the voice of China in international shipping.

## **6. Conclusions and extensions**

### **6.1. Main conclusions**

Based on the status quo of development and integration of the YRD port cluster, the modes of port integration in YRD are discussed firstly in the dissertation. It is found that since the end of last century, the YRD has carried out the integration of port resources in many different forms, such as the establishment of COSCP and joint investment between ports, however, in recent years, the main mode of port integration in YRD has developed into the deep integration of provincial port resources on a large scale. Therefore, this dissertation innovatively takes provincial port clusters as the research objects to discuss and analyze their integration practice modes, breaking the previous studies on modes of resource integration only between two or among three ports in YRD. Through the analysis, it is found that the port integration mode of Shanghai is the most integrated mode. By establishing Yangshan port area, it has realized high integration on both the port administration and enterprise operation. However, this mode is hard to be duplicated because it bases on the high support of the central government in policy. Zhejiang first integrated Ningbo port and Zhoushan port, then expanded to the province's port integration, also achieved a high degree of port integration through the integration at the levels of port administration and enterprise operation. However, Jiangsu and Anhui have only realized the integration at the level of enterprise operation, which are less integrated modes.

After that, the integration efficiencies of the provincial port clusters are evaluated systematically and comprehensively on the basis of the foregoing. This dissertation adopts system theory and the overall point of view, and creatively establishes

multiplication model: the comprehensive score of port cluster integration efficiency is regarded as the product of comprehensive competitiveness and system coordination level of port cluster. A systematic comprehensive evaluation indicator system of port clusters is established, and the comprehensive analysis method and AHP are used to establish a mathematical model to calculate the comprehensive competitiveness of the provincial port clusters in YRD. The system coordination coefficient of port cluster is set and regarded as a function of the level of cooperation and degree of competition in the port cluster. Then, the multiplication model is used to comprehensively evaluate the integration efficiency of the provincial port clusters in YRD. The evaluation results show that integration efficiency of Shanghai port cluster is the highest, followed by Zhejiang, then Jiangsu and Anhui. This ranking also confirms the impact of the integration mode adopted by each provincial port cluster on the efficiency of port cluster integration.

Finally, this dissertation systematically collates the current integration policies of the YRD port cluster, and analyzes the existing problems in the process of the port integration in YRD. Based on the current integration policies and aiming at the above problems, reasonable and feasible suggestions are put forward to the governments from the policy level, so as to provide reference for the development of the YRD port cluster. It is believed that the large-scale port integration of YRD must rely on the power of the high-level government to break the administrative barriers, unify the planning of using resources, give full play to the role of market regulation, and promote the establishment of mutually beneficial cooperation mechanism. In addition, the governments also needs to promote and guide the YRD port cluster from the aspects of information sharing mechanism, soft power, collection and distribution system, aligning national strategies, FTZ construction, etc., so as to better integrate the port resources and accelerate the rapid and healthy development

of YRD in the future.

## **6.2. Research shortcomings and prospects**

The research on the resource integration of the YRD port cluster involves a wide range of subjects and many stakeholders, thus problems are complicated. Due to the limited academic ability of the author, this dissertation still has deficiencies in some aspects. For example, there are still some loopholes and defects in the comprehensive evaluation indicator system and method of the port cluster, especially in the establishment of the multiplication model and the coordination coefficient of the port cluster; the comprehensive competitiveness evaluation method of the port cluster is greatly influenced by the selection of the indicator system, and every provincial port cluster is taken as an independent individual, which fails to reflect the intricate hinterland relation among each provincial port cluster and the influence of other port clusters in the region on the competitiveness of the port cluster. Although mathematical method like the AHP adopted in this dissertation uses the judgment matrix to determine the maximum eigenvalue, its basic point is the expert's judgment on the relative importance of two factors, which still belongs to the subjective weighting method, so there are some deviations. In addition, in terms of policy supports, due to space limitation, it does not fully analyze China's national conditions and political factors, so it seems that the arguments are slightly inadequate.

Next, it will be the focus of research that according to what mode to carry out the cross-provincial integration of ports in the YRD area thus realizing the regional port integration. As far as future research is concerned, there are three areas of concern: the first is how to deal with the relationship between the central regulatory authority and the local governments in YRD, so as to avoid it to be the same as the COSCP which is a leader department in name only in the integration of port resources; the



second is how to ensure the effective division of labor between governments and markets in the process of cross-provincial port resources integration, and how to avoid the excessive intervention of administrative forces in the allocation of port market resources; the third is how to avoid and limit the potential monopoly caused by the reform of regional port integration.

## Bibliography

- Baird, A. J. (2003). Global strategic management in liner container shipping. *Handbook of Container Shipping Management, vol. 1*. Institute of Shipping and Logistics, Bremen.
- China's port throughput ranking for 2019 released. (January 21, 2020). Retrieved from the website of China Ports: <http://www.chinaports.com/portlspnews/3497>
- Cudahy, B.J. (2006). The Containership Revolution: Malcom McLean's 1956 Innovation Goes Global, *TR news, Issue 246*, 5-9. Transportation Research Board. ISSN: 0738-6826
- Cullinane, K., Song, D.W. (2007). *Asian Container Ports: Development, Competition and Co-operation*. Palgrave Macmillan, Basingstoke. ISBN: 978-0230001954
- Cullinane, K., Teng, Y., Wang, T.F. (2005). Port competition between Shanghai and Ningbo. *Maritime Policy & Management, Volume 32, 2005 - Issue 4*, 331-346. <https://doi.org/10.1080/03088830500300438>
- Dong, G., Zheng, S., Lee, P.T.W. (2018). The effects of regional port integration: The case of Ningbo-Zhoushan Port. *Transportation Research Part E: Logistics and Transportation Review, Volume 120, December 2018*, 1-15. <https://doi.org/10.1016/j.tre.2018.10.008>
- Fan, S., Xu, R. (2017). Evolution, problems and countermeasures of Ningbo-Zhoushan port integration. *Ningbo Economy (Sanjiang Forum), 2017 - Issue 10*, 16-18. ISSN: 1007-5259. <http://www.cnki.com.cn/Article/CJFDTotal-NBSJ201710005.htm>
- Feng, H., Grifoll, M., Zheng, p. (2019). From a feeder port to a hub port: The evolution pathways, dynamics and perspectives of Ningbo-Zhoushan port (China). *Transport Policy, Volume 76, April 2019*, 21-35. <https://doi.org/10.1016/j.tranpol.2019.01.013>
- Freeman, R. E. (1984). *Strategic management, a stakeholder approach*. ISBN: 0-273-01913-9. London: Pitman.
- Huo, W., Zhang, W., Chen, P.S.L. (2018). Recent development of Chinese port cooperation strategies. *Research in Transportation Business & Management, Volume 26, March 2018*, 67-75. <https://doi.org/10.1016/j.rtbm.2018.01.002>.
- Hwang, C. C., Chiang, C. H. (2010). Cooperation and competitiveness of intra-regional container ports. *Journal of the Eastern Asia Society for Transportation Studies, Vol. 8*, 2254-2269. <https://doi.org/10.11175/eastpro.2009.0.423.0>

- Kim, H.T. (2011). Prospect of Premier Port Competition in East Asian Region. *The Asian Journal of Shipping and Logistics*, Volume 27, Issue 2, August 2011, 191-215. [https://doi.org/10.1016/S2092-5212\(11\)80009-X](https://doi.org/10.1016/S2092-5212(11)80009-X).
- Lam, J. S. L., Ng, A. K. Y., Fu, X. (2013). Stakeholder management for establishing sustainable regional port governance. *Research in Transportation Business & Management*, Volume 8, 2013, 30–38. <https://doi.org/10.1016/j.rtbm.2013.06.001>.
- Li, J. and Oh, Y.S. (2010). A Research on Competition and Cooperation Between Shanghai Port and Ningbo-Zhoushan Port, *The Asian Journal of Shipping and Logistics*, Volume 26, Issue 1, June 2010, 67-91. [https://doi.org/10.1016/S2092-5212\(10\)80012-4](https://doi.org/10.1016/S2092-5212(10)80012-4).
- Li, X. (2015). Resources integration of Ningbo-Zhoushan port integration. *Journal of Hubei University of Economics (Humanities and Social Sciences)*, 2015 - Issue 2, 38-39. ISSN: 2095-8862. <https://doi.org/10.3969/j.issn.1671-0975.2015.02.015>
- Li, Z. (2004). Research on integration development of Ningbo-Zhoushan Port. *Zhejiang Academic Journal*, 2004 - Issue 3, 222 - 224. <https://doi.org/10.16235/j.cnki.33-1005/c.2004.03.040>.
- Liu, H. (1993). Shanghai Port Greeting the 21st Century. *Asia-Pacific Ports Symposium Proceeding 1993*, pp.239-247.
- Lu, C. and Yang, C. (2006). Comparison of investment preferences for international logistics zones in Kaohsiung, Hong Kong, and Shanghai ports from a Taiwanese manufacturer's perspective. *Transportation Journal* 45 (1), 30–51.
- Ng, A. K. Y. (2013). Port development in East Asia: From efficiency enhancement to regional competitiveness. *Port Technology International*, 57, 8–9.
- Notteboom, T., Ducruet, C., De Langen, P. (2009). Ports in proximity: Competition and coordination among adjacent seaports. *Journal of Transport Geography* Volume 18, Issue 3, May 2010, 492. <https://doi.org/10.1016/j.jtrangeo.2009.12.003>
- Notteboom, T. and Rodrigue, J.P. (2005). Port regionalization: towards a new phase in port development. *Maritime Policy & Management*, Volume 32, 2005 - Issue 3, 297–313. <https://doi.org/10.1080/03088830500139885>
- Notteboom, T., Yap, W. Y. (2012). Port competition and competitiveness. *The Blackwell companion to maritime economics*. pp. 549–570.
- Palmer, S. (1999). Current port trends in an historical perspective. *Journal for Maritime Research*

- 1 (1), 99–111. <https://doi.org/10.1080/21533369.1999.9668302>
- Parker, M. (2013). Containerisation: moving things and boxing ideas. *Mobilities* 8 (3), 368–387.
- Peter W. de Langen (2006). Chapter 20 Stakeholders, Conflicting Interests and Governance in Port Clusters. *Research in Transportation Economics, Volume 17, 2006*, 457-477. [https://doi.org/10.1016/S0739-8859\(06\)17020-1](https://doi.org/10.1016/S0739-8859(06)17020-1)
- Ruan, X., Feng, X., Pang K. (2018). Development of port service network in OBOR via capacity sharing: an idea from Zhejiang province in China. *Maritime Policy & Management, Volume 45, 2018 - Issue 1*, 105-124. <https://doi.org/10.1080/03088839.2017.1391412>
- Rodrigue, J.P. and Notteboom, T. (2010). Foreland-based regionalization: integrating intermediate hubs with port hinterlands. *Research in Transportation Economics* 27 (1), 19–29. <https://doi.org/10.1016/j.retrec.2009.12.004>
- Shi, X., Jiang, H., Li, H., Wang, Y. (2020). Upgrading port-originated maritime clusters: Insights from Shanghai's experience. *Transport Policy, Volume 87, March 2020*, 19-32. <https://doi.org/10.1016/j.tranpol.2019.11.002>
- Song, B. (2018). The world's first one-billion-ton port could become a model for domestic port integration. *Maritime China, 2018 - Issue 1*, 20-21. ISSN : 2096-3890. <https://doi.org/10.3969/j.issn.1673-6664.2018.01.008>
- Song, D. (2003). Port co-opetition in concept and practice. *Maritime Policy and Management, Vol.30, No.1*, pp.29-44. <http://doi.org/10.1080/0308883032000051612>
- Song, D. W., Panayides, P. M. (2008). Global supply chain and port/terminal: Integration and competitiveness. *Maritime Policy & Management, Volume 35, 2008 - Issue 1*, 73–87. <https://doi.org/10.1080/03088830701848953>
- Tang, O. (2010). Ports in Proximity – Competition and Coordination among Adjacent Seaports, edited by Theo Notteboom, Cesar Ducruet, and Peter de Langen. *Maritime Policy & Management, Volume 37, 2010 - Issue 5*, 541-542. <https://doi.org/10.1080/03088839.2010.509051>
- Wang, C., Ducruet, C. (2012). New port development and global city making emergence of the Shanghai–Yangshan multilayered gateway hub. *Journal of Transport Geography, Volume 25, November 2012*, 58-69. <https://doi.org/10.1016/j.jtrangeo.2012.07.008>
- Wang, C., Ducruet, C., Wang, W. (2015). Port integration in China: Temporal pathways, spatial patterns and dynamics. *Chinese Geographical Science, 25(5)*, 612–628.

<https://doi.org/10.1007/s11769-015-0752-3>

- Wang, J. J. (1998). A Container Load Center with a Developing Hinterland: A Case Study of Hong Kong. *Journal of Transport Geography*, Vol. 6, No. 3, 187-201. [https://doi.org/10.1016/S0966-6923\(98\)00011-8](https://doi.org/10.1016/S0966-6923(98)00011-8)
- Wang, J.J., Brian S. (2004). Regional governance of port development in China: a case study of Shanghai International Shipping Center. *Maritime Policy & Management*, Volume 31, 2004 - Issue 4, 357-373. <https://doi.org/10.1080/0308883042000304467>
- Wang, R. (2008). Resource integration strategy in China's port integration -- a case study of Ningbo-Zhoushan port. *Economic Geography*, 2008 - Issue 5, 872-875. <https://doi.org/10.15957/j.cnki.jjdl.2008.05.028>
- Wang, S. (1993). Regional perspective on port development. *Economic Geography*, 1993 - Issue 1, 33-37. <https://doi.org/10.15957/j.cnki.jjdl.1993.01.005>
- Xing, W., Liu, Q., Chen, G. (2018). Pricing strategies for port competition and cooperation. *Maritime Policy & Management*, Volume 45, 2018 - Issue 2, 260-277. <https://doi.org/10.1080/03088839.2017.1405290>
- Xu, G., Xu, M., Xu, C., Shang, Q. (2003). The rising port of Suzhou. *China Water Transport*, 2003 - Issue 12. <https://doi.org/10.13646/j.cnki.42-1395/u.2003.12.018>
- Yan, H. (2012). Development status and prospect of Suzhou port. *China Water Transport*, 2002 - Issue 1, 20-21. <https://doi.org/10.13646/j.cnki.42-1395/u.2012.01.008>
- Yan, Y. and Hou, J. (2018) Research on port competitiveness in Yangtze river delta region under the strategy of Yangtze river economic zone. *Marine Economy*, Vol. 8, 2018 – Issue 1, 24-29. <https://doi.org/10.19426/j.cnki.cn12-1424/p.2018.01.003>
- Yoon Mi-Sun. (2006). Port Competition and Co-operation as a Strategy of Busan Port. *International Journal of Navigation and Port Research*, Vol.30, No.7, pp.749-752. <https://doi.org/10.5394/KINPR.2006.30.9.749>
- Yue, Y., Li, L. (2004). The Suzhou port three armies to present strong. *Sunan Sci-Tech. Devel*, 2004 – Issue 11, 14-15. ISSN : 1004-888X. <http://www.cnki.com.cn/Article/CJFDTotal-SNKJ200411010.htm>
- Zhang, H. (2004). The Yangshan Deepwater Harbor: Shanghai's Emerging International Shipping Center. *City Management*, 2004 - Issue 6, 4-8. ISSN : 1008-4959. <https://doi.org/10.3969/j.issn.1674-7739.2004.06.001>

- Zhang, X. and Liu, W. (2008). Integration modes of port resources in Yangtze river delta. *Shipping Management*, 2008 - Issue 2, 14-16. ISSN : 1000-8799. <https://doi.org/10.3969/j.issn.1000-8799.2008.02.006>
- Zhen, H. (2009). *Port Management (2nd Edition)*. People's communications press, October 2009, ISBN: 9787114080180.
- Zhou, X. (2015). Competition or cooperation: a simulation of the price strategy of ports. *International Journal of Simulation Modelling*, 14 (3), 463–474. [https://doi.org/10.2507/IJSIMM14\(3\)8.303](https://doi.org/10.2507/IJSIMM14(3)8.303)
- Zhou, X., Chen, X., Shao, L. (2017). Study on The Optimization of Collection and Distribution System of Freight Hub Ports: Illustrated by The Case of Shanghai International Shipping Center, China. *Transportation Research Procedia*, Volume 25, 2017, 1126-1136. <https://doi.org/10.1016/j.trpro.2017.05.125>
- Zhuang, P., Song, D. W. (2017). Discussing port governance issues at the regional level: A tale of Zhejiang province in China. *The International Association of Maritime Economists Conference, Kyoto, Japan, 27–30 June 2017*.

## Appendices

### Appendix A: Establishment of the judgment matrix

Establish the judgment matrix  $A = (a_{ij})_{n \times n}$ . Where  $A$  represents the importance of pairwise comparisons between elements  $B_i$  and  $B_j$  in the same layer, which takes 17 values from 1 to 9 and  $\frac{1}{2}, \frac{1}{3}, \dots, \frac{1}{9}$ . Its meanings are shown in **Table 23**. The judgment matrix has the following properties:  $a_{ii} = 1$ ,  $a_{ij} * a_{ji} = 1$ .

**Table 23.** The definition of judgement matrix.

Value of $a_{ij}$	Meaning of $a_{ij}$ (The degree of importance of $B_i$ compared with $B_j$ )
1	$B_i$ is as important as $B_j$
3	$B_i$ is a little more important than $B_j$
5	$B_i$ is obviously more important than $B_j$
7	$B_i$ is strongly more important than $B_j$
9	$B_i$ is absolutely more important than $B_j$
2, 4, 6, 8	between the degree of importance above
Reciprocal ( $\frac{1}{2}, \frac{1}{3}, \dots$ )	$a_{ij} = 1/a_{ji}$

Source: Compiled by the author.

## Appendix B: The indicator weights and consistency test in AHP

**Table 24.** Result of judgment matrix of comprehensive competitiveness of port cluster

Pairwise comparisons among objectives Matrix					Normalized matrix				Weights ( $W_0$ )	Product Ratios ( $\lambda$ )	
	C <sub>1</sub> Regional economy	C <sub>2</sub> Scale of port cluster	C <sub>3</sub> Throughput of port cluster	C <sub>4</sub> Core port(s) competitiveness							
C <sub>1</sub>	1	1/2	1/3	2	0.1538	0.1333	0.1667	0.1538	0.15	0.61	4.0046
C <sub>2</sub>	2	1	1/2	4	0.3077	0.2667	0.2500	0.3077	0.28	1.14	4.0113
C <sub>3</sub>	3	2	1	6	0.4615	0.5333	0.5000	0.4615	0.49	1.97	4.0210
C <sub>4</sub>	1/2	1/4	1/6	1	0.0769	0.0667	0.0833	0.0769	0.08	0.30	4.0046
$\lambda_{\max} = 4.0210$ ; CR = 0.0038 < 0.1, satisfy the consistency test										CI	0.0035
										CR	0.0038

**Table 25.** Result of judgment matrix of regional economy (C<sub>1</sub>)

Pairwise comparisons on regional economy (C <sub>1</sub> )			Normalized matrix		Weights ( $W_1$ )	Product Ratios ( $\lambda$ )	
	C <sub>11</sub> Economic aggregate	export-import volume					
C <sub>11</sub>	1	1/2	0.3333	0.3333	0.33	0.67	2.0000
C <sub>12</sub>	2	1	0.6667	0.6667	0.67	1.33	2.0000
$\lambda_{\max} = 2.0000$ ; i = 2 < 3, no need to do the consistency test							

**Table 26.** Result of judgment matrix of scale of port cluster (C<sub>2</sub>)

Pairwise comparisons on Scale of port cluster (C <sub>2</sub> )					Normalized matrix				Weights ( $W_2$ )	Product Ratios ( $\lambda$ )	
	C <sub>21</sub> Total number of berths	number of deep-water berths	C <sub>23</sub> Total port cargo throughput capacity	C <sub>24</sub> Total port container throughput capacity							
C <sub>21</sub>	1	1/2	1/3	1/3	0.1111	0.0909	0.0870	0.1429	0.11	0.44	4.0433
C <sub>22</sub>	2	1	1/2	1/2	0.2222	0.1818	0.1304	0.2143	0.19	0.76	4.0362
C <sub>23</sub>	3	2	1	1/2	0.3333	0.3636	0.2609	0.2143	0.29	1.20	4.0856
C <sub>24</sub>	3	2	2	1	0.3333	0.3636	0.5217	0.4286	0.41	1.70	4.1186
$\lambda_{\max} = 4.1186$ ; CR = 0.0263 < 0.1, satisfy the consistency test										CI	0.0236
										CR	0.0263

**Table 27.** Result of judgment matrix of throughput of port cluster (C<sub>3</sub>)

Pairwise comparisons on Throughput of port cluster (C <sub>3</sub> )				Normalized matrix				Weights ( $W_3$ )	Product Ratios ( $\lambda$ )		
	C <sub>31</sub> Total cargo throughput	C <sub>32</sub> Total container throughput	C <sub>33</sub> Proportion of foreign trade goods								
C <sub>31</sub>	1	1/2	2	0.2857	0.2500	0.4000	0.31	0.9524	3.0534		
C <sub>32</sub>	2	1	2	0.5714	0.5000	0.4000	0.49	1.5095	3.0777		
C <sub>33</sub>	1/2	1/2	1	0.1429	0.2500	0.2000	0.20	0.5988	3.0301		
$\lambda_{\max} = 3.0777$ ; CR = 0.0463 < 0.1, satisfy the consistency test										CI	0.0269
										CR	0.0463