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Study on the reduction of carbon emission，results from the vehicles in the Shanghai port's container collection and distribution system

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Study on the reduction of carbon emission， results from the vehicles in the Shanghai Port's Container Collection and Distribution System

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no materials are 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.

Supervised by

Professor Wang Xuefeng

Shanghai Maritime University

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Thanks to everyone I met in WMU and SMU.

And best regards to my parents and relatives.

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Abstract

Title of Research Paper: Study on the reduction of carbon emission，results from the vehicles in the Shanghai Port's Container Collection and Distribution System

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As a hub for global cargo transportation, the port has been continuously deepening and expanding its position and role. The facts show that as the demand for cargo transportation increases, the importance of the port is also rising. The greater the demand for goods, the more supportive role of the port. Therefore, competition between ports is not limited to cargo throughput. At the same time, it has gradually developed into a competition for port collection and distribution. Low-carbon transportation has become a trend in the development of the transportation industry. Therefore, it is necessary to study the carbon emissions of port collection and transportation.

Taking Shanghai Port as an example. Firstly, it summarizes the background of the container transportation in Shanghai Port and the traffic situation, and analyzes the inadequacies in the collection and transportation of Shanghai Port. Secondly, using the gray forecasting model to predict the future container throughput of Shanghai Port, and make judgments on the future trend of container transportation in Shanghai. Then, based on the formula for carbon emissions, the carbon emissions of Shanghai Port in the future are predicted. According to the development of the collection and transportation of Shanghai Port, the causes of carbon emissions are analyzed in many aspects. On this basis, through the data collection method, the carbon emission results of the Yangtze River multimodal transport strategy of Shanghai Port are summarized. Finally, from the economic, technical, and policy aspects, the annual average growth rate of Shanghai's carbon emissions will be analyzed and relevant conclusions will be drawn.

The optimization of the port distribution system based on the low-carbon theory and the owner's utility can not only provide support for the port's cargo handling capacity, but also improve the port operation efficiency. It can also make full use of the port resources, which is conducive to cultivating the port's core competitiveness and improving port competitiveness. The comprehensive strength of the port provides guidance for shippers to choose ports and provides reference for port planners.

Keywords: port throughput low-carbon

Chapter 1 Introduction

1.1 Research Background

With the declining air quality in China as well as the frequent fog and haze,reducing carbon emissions has become the subject of common interest of the whole society.Meanwhile, the global energy crisis also forced the community to being a conservation-minded society.

Energy conservation and emission reduction is the only way to achieve the low-emission and energy-efficient development.Transportation industry is the third most energy consumption sector of all the sectors in China, which has a huge volume of carbon dioxide emission. The container transportation between the port and its hinterland is the main source of carbon dioxide emissions.

Departure from the low-carbon perspective, this paper makes a research on the container transferring cities in multimodal transportation of Shanghai port, in order to improve the container multimodal transportation network and adopt more environmentally friendly container transportation.

1.2 Research Objectives

In various industries, transportation industry as an important carrier of logistics and driving force of social and economic activities. Quantity is the key industry of fossil fuel consumption. Statistics show that the carbon dioxide emissions of China's transportation industry increased from 35.3489 million tons in 1995 to 13.6881 million tons in 2008, with an average annual growth rate of 19.5%. In the same period, the annual average growth rate of the total carbon emissions of the whole society in China was 7.98%. The growth rate of carbon emissions in transportation industry is obviously higher than the overall growth rate of carbon dioxide emissions in China.

Implementing carbon policy in the transportation industry can directly reduce carbon dioxide emissions. It can also optimize the transport structure of our country, promote enterprises to optimize their own transport network layout and scale of the scale of the transport network, regulate transport demand, and promote innovation in transport organization and management. Realize the low-carbon development of transportation industry and improve the level of system informatization and means intellectualization. Taking European countries as an example, according to the EU carbon emission reduction plan, automobile carbon emissions will be reduced by 30% by 2020, which will rely on the application of information systems and communication technology to achieve 5% carbon emission reduction.

In summary, the carbon dioxide emissions of China's transport industry continue to grow, and the positive impact of carbon restriction policies on the control of carbon emissions in the transport industry has a common effect. It can be seen that the implementation of carbon restriction policies for the transport industry is a necessary and effective emission reduction measures.

1.3 Literature Review

In 2002, Zhang Jianyong established the allocation model for optimizing multimodal routes, whose aim was to obtain the lowest cost, and state detailed selections of routes and modes of transport, according to the network of multimodal transportation.Based on the detailed description of the multimodal transport network and the principle of minimizing the total cost, an optimal allocation model of the multimodal transport network is established, and the rational organization of the multimodal transport system is analyzed quantitatively.

In 2002, Zhang Dezhi established the optimization model of multimodal route, based on the lowest total cost, by building the virtual network of multimodal transportation in the case of time window constraints. According to the technical and economic characteristics of different vehicles, a model is established for selecting the optimal combination of traffic modes among multi-cities. The model is a multi-objective 0-1 programming model. By virtue of a transportation network, the original problem is transformed into a shortest path problem with time and capacity constraints, and the corresponding solving algorithm is given based on the shortest path (Dijk). The heuristic stra algorithm effectively solves the shortest path problem with time constraints and capacity constraints.

In 2006, Wei Zhong established the optimization model of routes based on the multimodal transportation and built the optimization model of total cost, according to the result from routes model, by taking account of time for transportation, transhipment, and delay in emergency.With the rapid development of economy, single mode of transportation can not meet the needs of agile manufacturing, rapid response to market and logistics supply chain management from customers. Multimodal transport provides a good solution to this problem. Multimodal transport network takes into account the transport time between nodes, the transit time of transport modes at nodes and possible freight delays. The shortest path time model under multimodal transport is proposed, and the corresponding transport cost model is provided according to the shortest path obtained, which provides a theoretical basis for the related research work of multimodal transport.

In 2008, Xiao Tianguo established the virtual network of multimodal, based on which they set the optimization models of the lowest total cost and time. And then they used practical data to validate the feasibility.With the rapid development of international trade, combined transport has become a hot issue. The optimization of transport routes in combined transportation is one of the key and difficult problems in combined transportation. This paper transforms the transportation route optimization problem of integrated transportation into a shortest path problem, establishes a model for selecting the optimal path with the objective of cost and time optimization, and designs a genetic algorithm as an example to solve the problem by applying the adaptive mechanism of crossover and mutation probability. The results show that the algorithm has good performance.

In 2008, Sun Huacan researched the transportation cost of multimodal transportation, with transferring time window constraints to penalty cost, and built the generalized path selection optimization model, which aimed to get the lowest cost.From the point of view of freight production practice, this paper puts forward the concept of reasonable route for combined transportation. Based on the realization process of combined transportation, it points out that besides maximizing transport benefits, reasonable replacement sequence and the limitation of replacement times are the other two important characteristics that must be taken into account in the selection and optimization of combined transportation routes. For general combined transportation, the composition of total transport cost, i.e. linear transportation cost, is studied. Utilization, node transit cost and overdue penalty cost. By constructing intuitive joint transportation network graph and taking the minimum total transportation cost as the optimization objective, the problem of reasonable route selection and Optimization for multi-modal combined transportation is transformed into a generalized shortest path model with overdue penalty factor. The assumptions and mathematical forms of the model are described in detail, and a brief solution idea and reference calculation are provided.

In 2010, Liu Yanan established the optimization model of multimodal routes, containing penalty cost for pollution, whose aim was to get the lowest cost on the base of multimodal transportation by adding constraints on environmental ecomony.Based on the theory of low-carbon economy, this paper studies the traditional multimodal transport model and elaborates the multimodal transport model based on low-carbon economy. The aim is to reduce the emission of pollutants from transportation fundamentally, so as to promote social, economic and environmental protection and achieve win-win situation.

In 2010, Jin Lingqin established the optimization model of transport routes, aimed at the lowest transport cost and the lowest emission of carbon on the base of multimodal transportation by taking account of the elements of carbon emission.Based on the in-depth study of cargo transport activities, this paper integrates carbon emission factors into multimodal transport, constructs a bi-objective model aiming at minimizing carbon emissions and transport operation costs, then uses carbon tax to transform the model, and finally applies the model to an example.

In 2012, Sun Renjie, from the perspective of environmental protection, by combining Quantitative Method with Qualitative Method, analyzed the difference between single transportation and multimodal transportation and used the measures of BP Neural

Network and Grey Prediction to compare each other.From the two aspects of energy saving and environmental protection, this paper uses the method of combining qualitative and quantitative analysis, compares and analyses the highway transport and railway transport, and concludes the advantages of container sea-rail intermodal transport, and points out that China should vigorously promote the development of container sea-rail intermodal transport, in order to accelerate the realization of the goal of energy saving and emission reduction in the whole society. In the prediction of port container sea-rail intermodal transport volume, the grey system combined with BP neural network prediction model is used. At the same time, the calculation formula of direct economic benefit of carbon emission reduction of port container sea-rail intermodal transport is obtained by comparing road transport with railway transport, and its huge social benefit is pointed out. Finally, taking Dalian Port as an example, this paper discusses the benefits of carbon emission reduction of container sea-rail intermodal transport in port, and puts forward some suggestions for the development of container sea-rail intermodal transport system in Northeast China.

In 2014, Teng Lan, by analyzing the the impact of carbon emission’s cost on container multimodal transportation, built the optimization model of multimodal routes, which took account of the cost of carbon emission,from the perspective of transport cost and time.From the perspective of multimodal transport operators, this paper takes the route selection of container multimodal transport as the research object, summarizes the research results at home and abroad, analyses the influence factors of carbon cost on the route selection of container multimodal transport, analyses the time and cost of container multimodal transport, analyses and calculates the composition of carbon cost of container multimodal transport, and establishes a container considering carbon cost. The multi-modal transport route selection model, taking Container Multi-modal Transport in Liaodong Peninsula as an example, carries on the empirical analysis to the model, and discusses and analyses the transport capacity limitation and the growth of carbon tax rate.

In 2014, Zhang Zhiyong, based on the analysis of carbon emission indices under different modes and routes of transport in the combined transport network, he built the optimization model of multimodal transport with lower carbon emission. Then he used Neural Network Optimized Genetic Algorithms to solve the model. In the process of vehicle transportation, the relationship between vehicle routing and carbon emissions is complex, and there is a non-linear relationship with the time, distance and cost of vehicle transportation. Traditional route selection methods need to introduce a large number of constraints to fully establish the relationship between them, which leads to the complexity of the path selection modeling process. A low carbon intermodal route selection method based on neural network optimization genetic algorithm is proposed. Carbon emission indices of vehicles under different routes in vehicle transportation network are analyzed to obtain transportation regions with different carbon emission levels. According to the above classification of carbon emission regions, a relationship model of carbon emission in low-carbon intermodal transportation route is constructed.

The genetic algorithm is optimized by using neural network to search the path with the least carbon emission. In the obtained route, the factors such as transportation time and transportation distance are fully considered. Low-carbon intermodal transport route selection in vehicle transport network. The experimental results show that the improved algorithm can shorten the transportation time and distance, and reduce the carbon emissions in the transportation process.

Chapter 2 Analysis of Shanghai Port's Container Collection and Distribution System

2.1 Overview of Shanghai Port

2.1.1 Geographical Conditions of Shanghai Port

The Shanghai Port is located on the forefront of the Yangtze River Delta, relying on the Yangtze River and the East China Sea. Therefore, it has the natural advantage of developing waterway traffic. Shanghai Port is only 18,000 kilometers away from the central part of China's mainland coastline (the Yangtze River estuary). It is located at the intersection of the east-west transport corridor of the Yangtze River and the north-south transport corridor. At this point, Shanghai Port is backed by Shanghai, backed by the Yangtze River, and has a very broad economic hinterland. Therefore, Shanghai Port is an important port for China's coastal opening up and participation in the international economic cycle. According to the "Shanghai 12th Five-Year Plan", in 2020, Shanghai's capital construction will become the development center of international economy, finance, trade and shipping. At the same time, strengthen the capacity allocation of international shipping centers, optimize the modern shipping collection and distribution system, promote the construction and function enhancement of Waigaoqiao Port Area, Yangshan Deepwater Port Area, accelerate the construction of inland waterway, improve the freight road network, and vigorously develop water and water transfer. And multimodal transport, strengthen the construction of integrated transportation hubs such as aviation, and accelerate the construction of international cruise home ports. While expanding the shipping aviation service industry chain, we will improve and develop various shipping services such as shipping economy, shipping finance, ship trading and maritime law. Promote the construction of a comprehensive pilot zone for international shipping development and accelerate the promotion of cargo, ships, enterprises and talents related to shipping.

2.1.2 Hinterlands of Shanghai Port（Yangtze River Delta Economic Circle）

Generally speaking, the hinterland of a port refers to an area where a certain amount of cargo throughput occurs and a certain number of passengers are distributed. The relationship between the port and the hinterland of the port is interdependent and mutually reinforcing. Therefore, the development and construction of the port must always refer to the scope of the hinterland and the economy of the hinterland. The hinterland of the port is an important aspect of the port's basic development. At the same time, the port's construction and development also promotes the economic development of the port hinterland.

For Shanghai Port, the Yangtze River Delta Economic Circle can serve as the direct economic hinterland of Shanghai Port, including Shanghai, Zhejiang, and Jiangsu. The construction and development of the Yangtze River Delta economic circle can be divided into two time periods. The first period began in 1978 and ended in 1991. In this stage, the economic development of the Yangtze River Delta is not rapid, and it is mainly divided into economic adjustment and steady growth. During this period, the Yangtze River Delta region effectively utilized its own economic background and enhanced its development potential and economic strength. The second stage began with Comrade Deng Xiaoping’s southern tour in 1992. In the second phase, with the opportunity of the country's development of Pudong and a series of preferential policies given by the state, the system has been actively promoted in the Yangtze River Delta region, and the economy has begun to leap forward. The economic growth rate has exceeded Pearl River Delta’s growth rate in the mid-to-late 1990s. The Yangtze River Delta Economic Circle has become a new bright spot for national economic growth.

With the gradual recovery of the global economy, the economic development rate in the Yangtze River Delta region has slowed down, and the industrial structure has entered the stage of “shuffle”. The industries with new, light and high-end industries have quickly become the pillars of economic development. As of now, the output value is in the top 10 The top ten industries are: electronic information equipment manufacturing, textiles, chemical raw materials and chemicals, ferrous and rolling processing, electrical machinery and equipment manufacturing, general machinery manufacturing, transportation equipment manufacturing, metals Products, petroleum processing and coking, clothing and other fiber products.

In terms of industry distribution, Shanghai focuses on the development of advanced manufacturing and high-tech industries, including new energy, civil aviation manufacturing, advanced equipment, biomedicine, electronic information manufacturing, new energy vehicles, offshore engineering equipment, new materials, software and information services. The nine major industries are the focus of the “Twelfth Five-Year Plan”. The two provinces, which are Jiangsu and Zhejiang pay close attention to “independent innovation” and vigorously develop the tertiary industry, with a focus on supporting the development of financial services, trade and circulation services, modern logistics and information services.

2.2 Shanghai Port’s Container Collection and Distribution System

2.2.1 Container road transport in Shanghai Port

The most important feature of road transport is its high degree of flexibility. Compared to water transport and rail transport, road transport networks cover a greater extent. Through different paths, you can also eventually reach the same destination.

Therefore, in the face of road accidents, the high adaptability of road transport is also reflected.

At the same time, in terms of vehicle scheduling, loading and unloading, due to the small size of the vehicle, the load is limited, shortening the connection time between various links. Benefiting from the small size of the car, the car does not need to carry out additional loading and unloading links during transportation, and the transportation time is short. Through a highly expanded road network, the scope of transportation can be directly from the port to the final destination, achieving a “door-to-door” transportation demand. This is unmatched by both water and road transport. Both modes of transport are recommended on the basis of road transport.

Road transport also has drawbacks. Because the vehicle is small in size, the carrying capacity is easily limited. Under the base of such a large container throughput, the unit cost is too high. At the same time, due to the upper limit of the transport, the car needs to go back and forth between the origin and the destination at a high frequency to meet the freight demand. This is also a challenge for the fuel consumption of cars, so the continuity of road transport is poor and not suitable for long-distance transportation. It is a heavier burden for the urban environment and road traffic conditions.

After many years of reconstruction, the Shanghai Port Highway Container Collection and Distributing Channel has basically become a collection and distribution channel with highways as the mainstay and auxiliary highways as the supplement. The container port area of Shanghai Port mainly includes the Yangtze River Port Area and Yangshan Deep Water Port Area. The Yangtze River Estuary Port Area mainly includes Zhanghuayu Wharf, Jungong Road Wharf, Baoshan Wharf and Waigaoqiao Phase I to Phase VI terminals. The Yangtze River estuary mainly passes through the east-west Gangcheng Road and Ganghua Road, the north-south Pudong Road, Puxing Road, Yanggao North Road and Yanggao North Road, as well as the S20 Outer Ring Road and the northern section of the G1501 Ring Expressway. The western section is connected to the outside, and then connected to Jiangsu and Zhejiang through the provincial highway. The Yangshan deep-water port area mainly passes the Donghai Bridge and the east-west Nanfeng Highway, Daye Highway and Yexin Highway, the north-south Nanlu Highway, the Nanliu Highway and the S20 Outer Ring Road, as well as the South-South and East-Western Hunan. The highway is connected to the G1501 by high-speed highway, and then connected to Jiangsu and Zhejiang through the provincial highway, or connected to the inner ring through the S20 outer ring.

However, the container collection and transportation of Shanghai Port mainly relies on road transportation, which is very different from other major ports in the world. This is also a typical representative of the container collection and distribution system in

China's ports. The development of this trend determines some characteristics of Shanghai's highway transportation.

(1) Excessive highway container collection and transportation not only increased the congestion of urban traffic, but also expanded the scope of congestion. The congestion of Shanghai highways has increased year by year.

(2) A single mode of transportation is also not conducive to the safety of the collection and distribution system. For example, the Donghai Bridge is the only channel for the collection and transportation of the Yangshan Port container road. In the event of an accident, the Yangshan Port container collection and distribution system will Facing a rampant crisis.

A large number of trucks destroy the city's scenery, roads and environment, and have a very serious impact on the quality of life of the citizens.

At the same time, through reading materials, Shanghai's major road collection and distribution channels were obtained, including Shanghai's container roads to other provinces, as well as road container collection and distribution channels in Shanghai and roads around the port area.

(1) Road collection and distribution channels in Shanghai and collection and distribution channels around the port area

1) Caohejing Economic and Technological Development Zone. To Waigaoqiao: S20-S20 West Section → S20 South Section → S20 East Section → G1501 East Section; to Yangshan Port: S20-S20 West Section → S20 South Section → S2.

2) Jinqiao Export Processing Zone. To Waigaoqiao: Jinhai Road → S20 East Section; to Yangshan Port: Jinhai Road → S20 East Section → S2.

(3) Songjiang Industrial Zone and Songjiang Export Processing Zone. To Waigaoqiao: G1501-G1501 West Section → A15 →East section of G1501; to Yangshan Port: G1501- G1501 West section → G1501 East section → S2.

4) Waigaoqiao Free Trade Zone. The main transportation direction is for Hong Kong transportation and does not need to be organized separately.

5) Minhang Economic and Technological Development Zone. To Waigaoqiao: S32→S2→S20; to Yangshan Port: S32→G15→G1501→S2.

6) Jiading municipal industrial zone and export processing zone. To Waigaoqiao: G1501→ North section of G1501 on the ramp of Huyi Highway→ East section of G1501; to Yangshan Port: G1501→ North section of G1501 on the ramp of Huyi

Highway→ S5→G1501 South section→S2.

7) Qingpu Industrial Park. To Waigaoqiao: Beiqing Highway→G1501 - North Section of G1501 on the North Road→G1501 North Section→S20 East Section→G1501 East Section; To Yangshan Port: Beiqing Highway→G1501→North Section of G1501 on Beiqing Highway ramp→G1501 South Section→S2.

The local sources of production in Shanghai are mainly concentrated in the export processing zones and industrial zones in various districts of Shanghai. Among them, the total import and export volume of Jinqiao Processing Zone and Waigaoqiao Free Trade Zone in Pudong New Area account for more than half of the total import and export volume of Shanghai. It is the most important source of container supply in Shanghai.

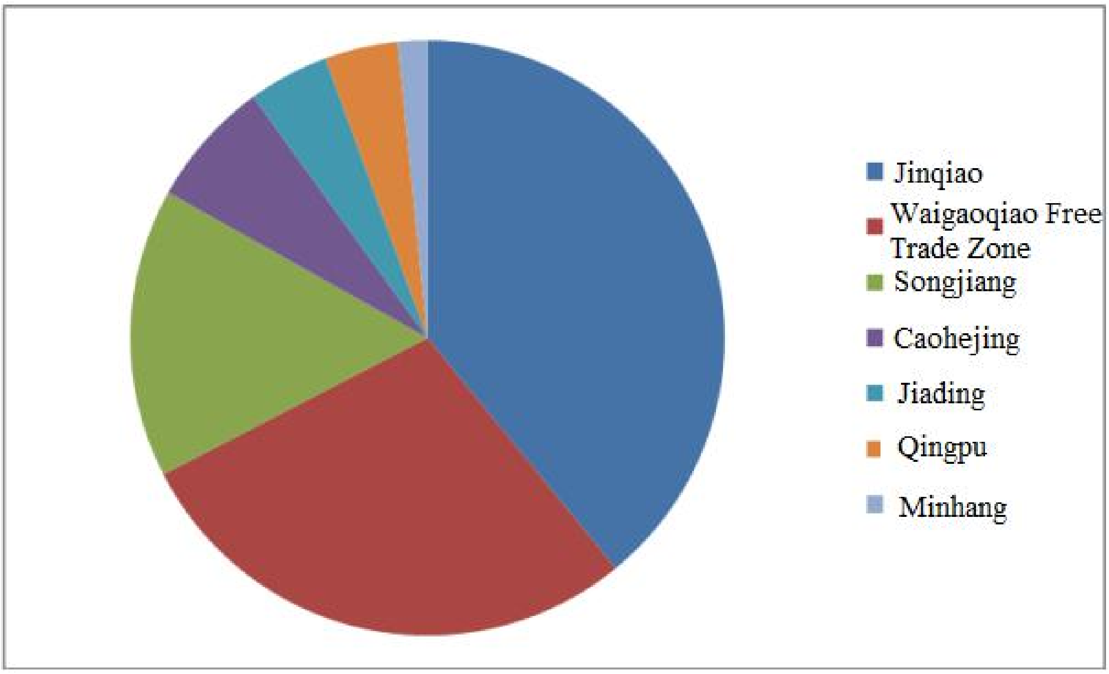

Figure 1 - The proportion of source of container supply in different districts in Shanghai

Source: Shanghai Statistical Yearbook

(2) Shanghai's container transportation to the province's road collection and distribution channels

According to the relevant contents of the “Port Overall Layout Plan” in the “Shanghai Port Master Plan Report”, the Shanghai Port Container Terminal will be concentrated in the Waigaoqiao Port Area and the Yangshan Deep water Port Area, so the roads around the port area will be distributed. The analysis will be carried out directly for the above two port areas.

1) Waigaoqiao Port

The Waigaoqiao area used to be the largest cargo distribution center in the world (before the Yangshan Wharf was not built). The construction of its container collection and distribution channel also has important reasons. The container transportation and transportation to the traffic conditions in Shanghai and the increase The container throughput of Shanghai Port has great strategic significance.

It can be seen from the table that the road network of Jiangsu Province that arrived in Waigaoqiao Port Area has entered Shanghai with a relatively developed road network. It is mainly transported through the northern half of the outer ring line S20 in Shanghai. The route from Zhejiang Province to Waigaoqiao Port Area is mainly transported through the southern half of the outer ring line S20 in Shanghai.

<table>
<tr><th></th><th colspan="4">Channels in Waigaooqiao Port</th></tr>
<tr><td rowspan="9">From Waigaoqiao Port to Jiangsu Province</td><td rowspan="9">S20(North)</td><td colspan="2">S5(A12)</td><td rowspan="9">Jiangsu Province</td></tr>
<tr><td colspan="2">204</td></tr>
<tr><td>312</td><td>G1501</td></tr>
<tr><td>G2</td><td>G1501</td></tr>
<tr><td>Beiqing Road</td><td>G1501</td></tr>
<tr><td colspan="2">G2</td></tr>
<tr><td>312</td><td></td></tr>
<tr><td>318</td><td></td></tr>
<tr><td colspan="2">G50</td></tr>
<tr><td rowspan="5">Waigaoqiao Port to Zhejiang Province</td><td rowspan="5">S20(South)</td><td colspan="2">A4(G15)</td><td rowspan="5">Zhejiang Province</td></tr>
<tr><td colspan="2">A8(G60)</td></tr>
<tr><td colspan="2">320</td></tr>
<tr><td colspan="2">318</td></tr>
<tr><td colspan="2">G50</td></tr>
</table>

Table 1 - The channels in Waigaoqiao port

Source: Own composition

2) Yangshan Deepwater Port

Yangshan Port has brought the core position of Shanghai International Shipping Center, and it has also brought great challenges to Yangshan Port. The capacity of road container collection and transportation has a great impact on the future development of Yangshan Port.

<table>
<tr><td></td><td colspan="8">Channels in Yangshan Port</td></tr>
<tr><td rowspan="5">From Yangshan Port to Jiangsu Province</td><td rowspan="5">Donghai Bridge</td><td>Lianggang Avenue</td><td>S1</td><td>S20</td><td>Xupu Bridge</td><td>S20(North)</td><td rowspan="5">G2 312
318
G50</td><td rowspan="5">Jiangsu Province</td></tr>
<tr><td>Nanlu Road</td><td>S1</td><td>S20</td><td>Xupu Bridge</td><td>S20(North)</td></tr>
<tr><td colspan="2">S20</td><td>Xupu Bridge</td><td colspan="2">S20(North)</td></tr>
<tr><td colspan="2">Nanlu Road</td><td>Daye Road</td><td colspan="2">A5(G15)</td></tr>
<tr><td colspan="3">G1501</td><td colspan="2">A5(G15)</td></tr>
<tr><td rowspan="3">From Yangshan Port to Zhejiang</td><td rowspan="3">Donghai Bridge</td><td>A2</td><td>S20</td><td>Xupu Bridge</td><td colspan="2">S20(North)</td><td rowspan="3">318
G50</td><td rowspan="3">Zhejiang Province</td></tr>
<tr><td colspan="2">G1501</td><td>A4(G15)</td><td colspan="2">320</td></tr>
<tr><td>Nanlu Road</td><td>S1</td><td>S20</td><td>Xupu Bridge</td><td>S20(North)</td></tr>
</table>

Table 2 - The channels in Yangshan port

Source: Own composition

It can be seen from the table that the Jiangsu Province container cargo arriving at Yangshan Port has more roads to enter Shanghai. It is mainly transported through the southern half of the outer ring line S20 in Shanghai. The land passage from Luchao Port to Yangshan Wharf is only One - Donghai Bridge. The Zhejiang container arriving at Yangshan Port is mainly transported through G1501, G320, A4 (G15) and the ground road Yexin Highway, Daye Highway and South Road.

2.2.2 Container waterway transportation in Shanghai Port

The biggest feature of waterway transportation is its strong carrying capacity. Compared to road transport, a container ship has at least a thousand times the load of a car. Therefore, in China's container transportation, the proportion of waterway transportation is second only to road transportation. Rivers are a natural advantage of channel development compared to highway construction. Therefore, the construction cost of waterway transportation is much less than that of roads and railways. In terms of the environment, ships have less energy consumption and a wider development.

However, the large volume of waterways also limits the speed of the ship, which greatly lengthens the transportation time, resulting in an increase in time costs and increasing the operational risks of both buyers and sellers. Moreover, the route of water transport is fixed compared to road transport. Therefore, once trapped in the seasons and climate changes, the ship has only the option of suspension, which is a devastating blow to goods of time value. Similarly, a large number of goods also need to be matched with the loading and unloading capabilities. Therefore, the loading and unloading costs of the goods are also relatively high. Therefore, in general, waterway transportation is more suitable for areas with natural waterways and stable climate.

The inland river channel in Shanghai is rich in resources and has good connectivity. There are 210 waterways with a navigation distance of 2,100 kilometers. It connects the main areas of Shanghai Port and the major towns and industrial areas of the counties (districts) and connects with the Jiangnan Waterway Network. Among them, the six channels of Sushen Outer Port Line, Hangshen Line, Taipu River, Zhaojiagou, Dalu Line and Dapu Line have been included in the main channel of national water transport, and are connected to the Yangtze River water transport network through the Beijing-Hangzhou Grand Canal. The fast-moving and transportation of water containers in Shanghai and surrounding areas.

During the “Eleventh Five-Year Plan” period, Shanghai has basically completed the three-level roadway through the completion of the 174.6km waterway improvement project. The Waigaoqiao and Yangshan Port Containers will be able to reach the Huangpu River and other rivers more smoothly. At the same time, the inland river will be connected to the Jinghang Canal and will be connected to the high-grade waterways of Jiangsu and Zhejiang. In January 2010, the Sushen Outer Port Line Waterway Project was completed and put into use. This is the first channel used in the construction of the Shanghai Inland River Route. The completed Sushen Outer Port Line is the first channel used in Shanghai's “One Ring and Ten Shots” trunk route planning. The channel is connected to the Beijing-Hangzhou Canal in the west and the Huangpu River in the east. It is 65.7km long. The Shanghai section is located in the boundary between Shanghai Qingpu District and Songjiang District. The navigation channel is 35.5km long and is constructed according to the three-level navigation standard. It can pass 1000t container barges. The Sushen Outer Port Line is a high-grade waterway leading to Shanghai from Jiangsu and an integral part of the inland river channel network in the Yangtze River Delta. According to the relevant development plan, Shanghai plans to basically build a “one ring and ten shots” inland waterway network in 2020. “One Ring” refers to Huangpu River – Dazhi River – Pudong Canal – Zhaojiagou – Yunzao – Youdun Port – Huangpu Jiang; “Ten Shooting” refers to Taipu River, Hangshen Line, Sushen Outer Port Line, Sushen Inner Port Line, Jinhui Port, Pingshen Line, Luoyun River, Chuanyang River, Longquan Port and Dalu Line.

The container inland river transportation routes in Zhejiang and Jiangsu provinces, which are currently the main economic hinterland of Shanghai Port, are as follows: Suzhou, Wuxi and Changzhou in Jiangsu Province enter Shanghai via Sushen Inner Harbor Line, arrive at Huangpu River, and pass Zhaojiagou in the north. Entering Waigaoqiao Port Area, the south side enters Luchao Port via Dalu Line; the Huzhou area of Zhejiang Province enters Shanghai through Changhu Shenxian, Sushen Foreign Port Line and Hangshen Line, and Jiaxing and Hangzhou enter through Hangshen Line. Within the territory of Shanghai, the Pinghu area entered the territory of Shanghai through the Pingshen Line. After arriving at the Huangpu River, it entered the Waigaoqiao Port Area through Zhaojiagou in the north and entered the Luchao Port via the Dalu Line in the south. The table shows the main inland river grades in

Shanghai.

Inland river(canal)	Level
Jiangsu to Shanghai(in)	III、V、VI (46.69km)
Huangpu River	III (23.39km)
Zhaojiagou	VII (10.54km)
Jiangsu to Shanghai(out)	IV (35.50km)
Hangzhou to Shanghai	IV (17.24km)

Table 3 - The level of inland canals in Shanghai

Source: Own composition

The guiding ideology for the development of Shanghai's inland navigation is to build a container network connecting the Beijing-Hangzhou Canal water system and the entire Yangtze River basin to build and improve the international container transportation system in the Yangtze River Delta region around the construction of the Shanghai International Shipping Center and the Yangshan Deepwater Port. As of December 2017, Shanghai's inland ports have completed an annual cumulative cargo throughput of 566 million tons. Shanghai Inland Navigation mainly undertakes bulk cargo transportation such as coal and building materials in Shanghai and the Yangtze River Delta. In addition, it also undertakes all domestic garbage transportation in Shanghai. The existing inland waterway transportation volume is equivalent to the total transportation volume of the two Shanghai-Nanjing Railway and the Yangtze River Channel. It is an important infrastructure to promote urban economic and social development and maintain people's livelihood security.

2.2.3 Container rail transportation in Shanghai Port

Rail transport is highly adaptable to any natural conditions, so trains are very regular in terms of frequency of departure. Compared to short-distance transportation of cars, railways are basically long-distance transportation. Therefore, the load of railway transportation is also large, and usually a single-layer container train can transport about 100 standard boxes. According to relevant information, the unit transportation cost of the railway is 10% of the road transportation, the fuel consumption is 5% of the automobile, and the energy consumption is low. At the same time, railway transportation is safe and reliable, and the risk is smaller than that of water transportation. Therefore, railway transportation has great potential for mining.

However, the biggest shortcoming of railway transportation is the lag in information exchange. Because the equipment on the entire railway line is owned by the same organization, it is only for its own use. This has led to the monopoly of the entire railway line. At the same time, the construction project is more complicated and requires a lot of manpower and material resources. Usually the assumption of a railway trunk line takes more than 5 years, which invisibly increases the fixed cost of railway construction.

Although Shanghai Port has a relatively fast growth in sea-rail combined transport business, its share of container throughput in Hong Kong is still small. The reason is that at present, Shanghai Port basically does not have the conditions for collecting and distributing railway containers, so railway container transportation is very backward. This is mainly limited by the railway transportation capacity and operation mechanism, and it is difficult to meet the needs of customers in terms of scheduled transportation and price. At present, in the Shanghai-based container land-to-collection and transportation mode, the traffic volume of the highway is more than 53%, and the transportation volume of the railway is less than 1%. In addition to being affected by the above factors, the most prominent problem is that container-only terminals occupy too few railway lines. At Shanghai Port, there are only two container berths at the front of the Jungong Road Wharf. There are 16 railway container berths and 6 branch berths in the Waigaoqiao Port Area. There are no direct railway connections. In recent years, the newly built Yangshan deep water Large container berths in the port area are also not connected by rail. The construction of the Pudong Railway lags behind, and it is not synchronized with the development of the Shanghai Port Container Terminal. Therefore, a short fee is required, resulting in a higher total cost than the domestic ports. The current situation of the separation of Shanghai Port Railway and the terminal objectively also caused the increase in the import and export cost of the sea-rail combined transport box in Shanghai Port, which weakened the advantage of competing with other ports.

Chapter 3 Prediction of container throughput of Shanghai Port in 2019

3.1 Model Description (Grey Prediction)

3.1.1 Selection of Grey Prediction Model

The forecast of port throughput is an important link in port planning, which is related to the rationality of the future development of the port. Especially for the development direction of the port, investment scale, business strategy, cargo transportation and other aspects of the layout planning, there will be important reference value.

The port container throughput system is essentially a gray system, which contains many factors that have been identified, social and natural factors such as the economic development trend of the country or region, the development level of the port, and many studies and The factors of recognition, such as the Belt and Road Initiative, will bring about an improvement in the economy of the entire region of Shanghai.

In recent years, the throughput of Shanghai Port has shown a continuous growth trend. For such forecasting objects with obvious upward trend, gray prediction is a reliable forecasting method. The level of port throughput development depends on uncertainties such as the development of the hinterland economy, port facilities, and port collection and distribution. These factors are not directly linked to throughput and have the essential characteristics of a gray system. Therefore, this paper selects the GM (1,1) prediction model to predict the container throughput of Shanghai Port.

3.1.2 Description of the grey prediction model

Gray model GM(n,h), where n is the order of the differential equation and h is the number of variables. The paper establishes the GM(1,1) model. The modeling process is as follows:
Set the original series， $X^{(0)} = \{(X^{(0)}(1), X^{(0)}(2), \ldots, X^{(0)}(n))\}$， as the Non-negative sequence. It has n observations.Transform it to generate a first-order cumulative sequence，when it makes changes.

Then it forms a new time series by accumulating,
$X^{(1)} = \{(X^{(1)}(1), X^{(1)}(2), \ldots, X^{(1)}(n))\}$,

$$X^{(1)}(k) = \sum_{m=1}^{k} X^{(0)}(m)$$

The equation, $X_k^{(0)} + aZ_k^{(1)} = b$, is the Grey equation, which is also called GM(1,1) model.

In this equation, a and b are called pending parameters.

The sequence $Z^{(1)} = (Z_1^{(1)}, Z_2^{(1)}, \cdots, Z_n^{(1)})$ is another sequence, which results from another equation, $Z_k^{(1)} = \dfrac{X_{k-1}^{(1)} + X_k^1}{2}$.

According to the least-squares method, we can get the differential equation, which is subject to the gray prediction model. We identify it as $X_k^{(0)} + aZ_k^{(1)} = b$. From the new equation, we can evaluate these two estimated values of parameter a' and parameter b' .

Then we set:

$$Y = \begin{pmatrix} X_2^{(0)} \\ X_3^{(0)} \\ \cdots \\ X_n^{(0)} \end{pmatrix}, \quad B = \begin{pmatrix} -Z_2^{(1)} & 1 \\ -Z_3^{(1)} & 1 \\ \cdots & \cdots \\ -Z_n^{(1)} & 1 \end{pmatrix}, \quad \text{parameter } A = \begin{pmatrix} a \\ b \end{pmatrix}$$

$X_k^{(0)} + aZ_k^{(1)} = b$,

$Y = BA$

By using the least-squares method, we can get the estimated value of parameter A, which is called A's.

$$A' = \begin{pmatrix} a' \\ b' \end{pmatrix} = (B^T B)^{-1} B^T Y$$

Then we can get the differential equation:

$$\frac{dX^{(1)}}{dt} + aX^{(1)} = b$$

For this differential equation, the solution of $\begin{pmatrix} a \\ b \end{pmatrix} = (B^T B)^{-1} B^T Y$ is:

$$X_{k+1}^{(1)} = \left(X_1^{(0)} - \frac{b}{a}\right)e^{-ak} + \frac{b}{a}$$

This function is also called a time response function. The sequence $X^{(1)}$ is the accumulated sequence of $X^{(0)}$. And the value of $X^{(0)}$ can be calculated by subtracting consecutively.

3.1.3 The methodology for checking the accuracy of GM(1,1) model

To check the accuracy of GM(1,1) model, we usually use three testing methods. One is residual size test, another is correlation test and the other is post-test difference test.

Correlation test is to test the approximation between the built model and pointing functions. Post-test difference test is to test the statistical characteristics of residual distribution. Residual size test is an intuitive point-by-point comparison of arithmetic test methods, which compares the predicted data with the actual data and then observes whether their relative errors meet the particular conditions.
In this module, we mainly introduce the residual size test and the post-test difference test. The specific inspection steps are as follows：

(1) Residual size test

First, set an sequence: e = (e(1)，e(2)，…，e(n)).
In this sequence, e(k)= X(0)(k)－X(0)'(k) , k = 2,3，…，N

Then we can set the relative residual as Ψ **(k)** = $\frac{e(k)}{X^{(0)}(k)}$ ×100%

And we also set the average error as $\overline{\Psi}$ (k) = $\frac{1}{n}\sum_{k=1}^{n}\left|\Psi(k)\right|$

Then we can get the accuracy of this model: P = (1－$\overline{\Psi}$)×100%

(2) Post-test difference test

First, we need to calculate the average value of $X^{(0)}$

The equation is as follow, $\overline{X}^{(0)}$ = $\frac{1}{n}\sum_{k=1}^{n}X^{(0)}(k)$ ；

Then we need to calculate the average value of e

The equation is as follow, $\bar{e}$ = $\frac{1}{n}\sum_{k=1}^{n}$ e(k)

The we can get two variances, which are S_1^2 and S_2^2

$$S_1^2 = \frac{1}{n}\sum_{k=1}^{n}(X^{(0)}(k) - \overline{X}^{(0)})^2$$

$$S_2^2 = \frac{1}{n}\sum_{k=1}^{n}(e(k)-\bar{e})^2$$

The last step is to set C,

$$C = \frac{S_2}{S_1}$$

If the value of C is less than or equal to 0.35, then the accuracy of this model is reliable.

Accuracy	p	c
Excellent	p≥0.95	0.35≥c
Good	0.95>p≥0.8	0.5≥c>0.35
OK	0.80>p≥0.7	0.65≥c>0.5
Failed	0.7>p	c>0.65

Table 4 - The accuracy of GM(1,1) model

Source: Own composition

The table above has shown how to judge the accuracy of this model.

3.2 Model operational process

Year	Throughput (10000TEU)	Year	Throughput (10000TEU)
2013	3361.7	2016	3713.3
2014	3528.5	2017	4023.3
2015	3653.7	2018	4201

Table 5 - The container throughput of Shanghai Port from 2013 to 2018

Source: http://wap.sh.gov.cn. Own composition

This table has shown the throughput of Shanghai Port from 2013 to 2018.

First, we build the GM(1,1) model，and set an original sequence:

$X^{(0)} = (X_1^{(0)} , X_2^{(0)} , X_3^{(0)} , X_4^{(0)} , X_5^{(0)} , X_6^{(0)})$

$X^{(0)} = (3361.7 , 3528.5 , 3653.7 , 3713.3 , 4023.3 , 4201)$

Then we can get a new sequence by accumulating $X^{(0)}$:

$X^{(1)} = (X_1^{(1)} , X_2^{(1)} , X_3^{(1)} , X_4^{(1)} , X_5^{(1)} , X_6^{(1)})$

$X^{(1)} = (3361.7 , 6890.2 , 10543.9 , 14257.2 , 18280.5 , 22481.5)$

At last, we can set another new sequence by calculating the average value of $X^{(1)}$:

$Z^{(1)} = (Z_2^{(1)} , Z_3^{(1)} , Z_4^{(1)} , Z_5^{(1)} , Z_6^{(1)})$

$Z^{(1)} = (5125.95 , 8717.05 , 12400.55 , 16268.85 , 20381)$

According to the equation ($X_k^{(0)} + aZ_k^{(1)} = b$), we can set the matrix model.

Y =	3528.5		B =	-5125.95	1		A =	a	
	3653.7			-8717.05	1				
	3713.3			-12400.55	1				
	4023.3			-16268.85	1			b	
	4201			-20381	1				

With the help of data above, we can calculate the model by using least squares.

B^T =	-5125.95	-8717.05	-12400.55	-16268.85	-20381		B^TB =	936096605.7	-62893.4
	1	1	1	1	1			-62893.4	5
$(B^TB)^{-1}$ =	6.89747E-09	8.67611E-05					B^TY =	-247058407.7	
	8.67611E-05	1.291340032						19119.8	
$(B^TB)^{-1}B^TY$ =	-0.045223702		a =	-0.045223702		b/a =	-71977.86556		
	3255.105527		b =	3255.105527					

The final equation for $X_{k+1}^{(1)} = (X_1^{(0)} - \frac{b}{a})e^{-ak} + \frac{b}{a}$:

$X_{k+1}^{(1)}$ = 75339.56556 * $e^{0.045223702k}$ - 71977.86556

The final result of prediction is shown as follows:

Year	Throughput (10000TEU)	Year	Throughput (10000TEU)
2013	3361.7	2016	3815.3
2014	3485.4	2017	3991.8
2015	3646.6	2018	4176.5
2019	4369.7	2020	4571.8
2021	4783.3	2022	5004.6
2023	5236.1	2024	5478.4

Table 6 - The container throughput prediction results of Shanghai Port from 2013 to 2024

Source: Own composition

3.3 Model Validation

3.3.1 Residual size test

First, we need set an sequence: e = (e(1)，e(2)，⋯，e(n)).

In this sequence, e(k)= X(0)(k)－X(0)’(k) , k = 2,3，⋯，N

e = (0 , 43.14972894 , 7.110857688 , -101.9872276 , 31.51039582 , 24.54268669)

Then we can set the relative residual as Ψ **(k)** = $\frac{e(k)}{X^{(0)}(k)}$ ×100%

Ψ **(k)** = (0.00% , 1.22% , 0.19% , -2.75% , 0.78% , 0.58%)

And we also set the average error as $\overline{\Psi}$ (k) = $\frac{1}{n}\sum_{k=1}^{n}|\Psi(k)|$

$\overline{\Psi}$ (k) = $\frac{1}{n}\sum_{k=1}^{n}|\Psi(k)|$ = 0.92%

Then we can get the accuracy of this model: P = (1－$\overline{\Psi}$)×100%

P = (1－$\overline{\Psi}$)×100% = 99.08%

3.3.2 Post-test difference test

First, we need to calculate the average value of $X^{(0)}$

The equation is as follow, $\overline{X}^{(0)} = \frac{1}{n}\sum_{k=1}^{n}X^{(0)}(k)$ ；

$\overline{X}^{(0)} = \frac{1}{n}\sum_{k=1}^{n}X^{(0)}(k)$ = 3746.916667

Then we need to calculate the average value of e

The equation is as follow, $\bar{e} = \frac{1}{n}\sum_{k=1}^{n} e(k)$

$\bar{e} = \frac{1}{n}\sum_{k=1}^{n} e(k)$ = 0.721073593

The we can get two variances, which are S_1^2 and S_2^2

$$S_1^2 = \frac{1}{n}\sum_{k=1}^{n}(X^{(0)}(k) - \overline{X}^{(0)})^2 = 81416.09472$$

$$S_2^2 = \frac{1}{n}\sum_{k=1}^{n}(e(k) - \overline{e})^2 = 2317.664471$$

The last step is to set C,

$$C = \frac{S_2}{S_1} = 0.168721391$$

According to the table below, We can guarantee the availability of the model.

Accuracy	p	c
Excellent	p≥0.95	0.35≥c
Good	0.95>p≥0.8	0.5≥c>0.35
OK	0.80>p≥0.7	0.65≥c>0.5
Failed	0.7>p	c>0.65

Table 7 - The accuracy of GM(1,1) model

Source: Own composition

Chapter 4 Analysis of carbon emission and feasibility of optimizing seaway and railway transportation

4.1 The definition and the calculation of Carbon emission cost

When calculating the carbon emissions, it requires two factors: the energy consumption and emissions factors. The carbon emission factor refers to the unit energy quality of mining, processing and use. The amount of greenhouse gases emitted at each link is converted to the sum of the amount of carbon dioxide. It is an important parameter for characterizing the emission characteristics of a certain energy greenhouse gas. It will be linked to activity data of greenhouse gas emissions. Greenhouse gas activity data is a quantitative indicator of greenhouse gas emissions activities, about the amount of greenhouse gases emitted by energy, expressed in terms of carbon dioxide and related activity units.

The greenhouse gas emissions generated by energy activities mainly include fixed combustion sources and mobile combustion sources. The estimated gas comprises carbon dioxide and methane. These two gases are the main mobile combustion sources in the collection and transportation transport network. According to "IPCC 2006 Guidelines for National Greenhouse Gas Inventories," Accounting for carbon dioxide emissions from mobile sources can be divided into two categories. One approach is top-down, statistical data based on vehicle fuel consumption. Another approach is based on data of different types of vehicles, such as the vehicle type, number, mileage, driving unit, mileage, fuel consumption, calculated from the fuel consumption to the to calculate carbon dioxide emissions. In the collection and distribution system, different approaches of collection and distribution are involved, including roads, railways and waterways. Therefore, in this dissertation, approach 2 is selected for calculation, because approach 2 can be used to calculate carbon emissions in more detail.

Different energy consumption coefficient of carbon emissions	
Types	**consumption coefficient**
Heavy oil	2.991kg/L
Diesel oil	2.778kg/L
Gasoline	2.361kg/L

Table 8 - Different energy consumption coefficient of carbon emissions

Source: http://www.itdzs.org. Own composition

This table above has shown different carbon emissions, result from different energy consumption. One is caused by the heavy oil, which has been consumed. Another is caused by the diesel oil, and the other one is caused by gasoline.

4.1.1 carbon emission, results from trucks

Vehicle unit energy consumption of road transport	
Types	**consumption coefficient**
Diesel oil	0.0689L/ton·km
Gasoline	0.0606L/ton·km

Table 9 - Vehicle unit energy consumption of road transport

Source: http://www.itdzs.org. Own composition

Trucks, which need different resources to start up will cause different pollution to varying degrees. This table above has shown the energy consumption, results from different types of trucks. In China's container road transport, diesel fuel is mostly used, and the amount of diesel consumed per kilometer for each ton of cargo is 0.0606 liters. In general cases, a container truck can hold a 40-foot container (FEU) or two 20-foot containers (TEU). This article assumes that the cargoes carried are all standard containers, and then a container truck unit loads 2 TEU boxes. The limitation of weight for carrying one standard container is 22 tons, so the largest stowage for one truck is 44 tons.

As is known to us, the coefficient of carbon emission, which is caused by diesel oil, is 2.778 kilogram per liter (2.778 kg/L). Then on this basis, we can calculate how much carbon emission per kilometer it will be for a standard truck.

$C_1 = 44 * 0.0606 * 2.778 = 7.4073$ kg/km·2 TEU

4.1.2 carbon emission, results from trains

Vehicle unit energy consumption of railway transport	
Types	**consumption coefficient**
Diesel oil	0.0689kg/ton·km
Electricy	0.01108kwh/ton·km

Table 10 - Vehicle unit energy consumption of railway transport

Source: http://www.itdzs.org. Own composition

This table above has shown the energy consumption of railway transport when different types of trains. In this paper, we choose the diesel oil as object.

In the transportation of railway containers, people mainly use internal combustion models, and the consumption of energy is diesel oil. Commonly speaking, 0.00259 kilogram of diesel oil will be consumed per kilometer to carry one ton of cargo. For one rail car, generally speaking, two 20-foot containers (TEU) can be carried. For a whole train, it has 70 cars. This indicates that a whole train can carry 140 20-foot containers (TEU). And for one container, its weight is about 22 tons, so the stowage of one whole train is about 3080 tons.

As is known to us, the coefficient of carbon emission, which is caused by diesel oil, is 2.778 kilogram per liter (2.778 kg/L). Then on this basis, we can calculate how much carbon emission per kilometer it will be for a whole train.

C_2 = 3080 * 0.00259 * 2.778 = 22.1606 kg/km·140 TEU

4.1.3 carbon emission, results from vessels

The fuel consumption of ships is more complicated than that of trucks and trains, because more factors need to be taken into consideration. So its function needs more data.

Generally speaking, container ships used for inland water transport are small vessels. The stowage of a vessel is about 1000 TEU. For a 1000 TEU vessel, its rated weight is about 2427 tons. The speed in still water is 18.5 kilometers per hour (18.5 km/h). The monitor rate of its engine is about 562 kw, and its fuel consumption rate is about 202 g/kw·h. The auxiliary machine power is about 27 kw, and its fuel consumption rate is also about 202 g/kw·h. For the machine of a vessel, its fuel consumption coefficient is 0.80, which means the primal fuel consumption is 96.17 kilogram per hour (96.17 kg/h). Then on this basis, we can calculate how much fuel consumption it will be for a 1000 TEU vessel in one voyage.

Q_3 = 96.17 * t_1 .

In this function, t1 means the time spent in one voyage.
So for total routes, the total amount of carbon emission will be the below function.

C_3 = 96.17 * (R_3 / 18.5) * 2.778 kg/km·1000 TEU

According to the above research ideas and methods，we can calculate and estimate the annual emissions of carbon dioxide gas in Shanghai Port Collection and Transportation, which is shown in the following table.

	Weight(ton)	Increasing Rate
2013	4288422.103	
2014	4544684.203	5.98%
2015	4868135.157	7.12%
2016	4846880.088	-0.44%
2017	5243475.255	8.18%
2018	5372623.736	1.77%
2019	5621131.749	4.63%
2020	5766311.3	2.58%
2021	6014819.314	4.31%
2022	6159998.865	2.41%
2023	6408506.879	4.03%
2024	6553686.429	2.27%

Table 11 - Annual prediction emissions of carbon dioxide gas from 2013 to 2024

Source: Own composition

4.2 Comparison and analysis of carbon emissions in the past few years

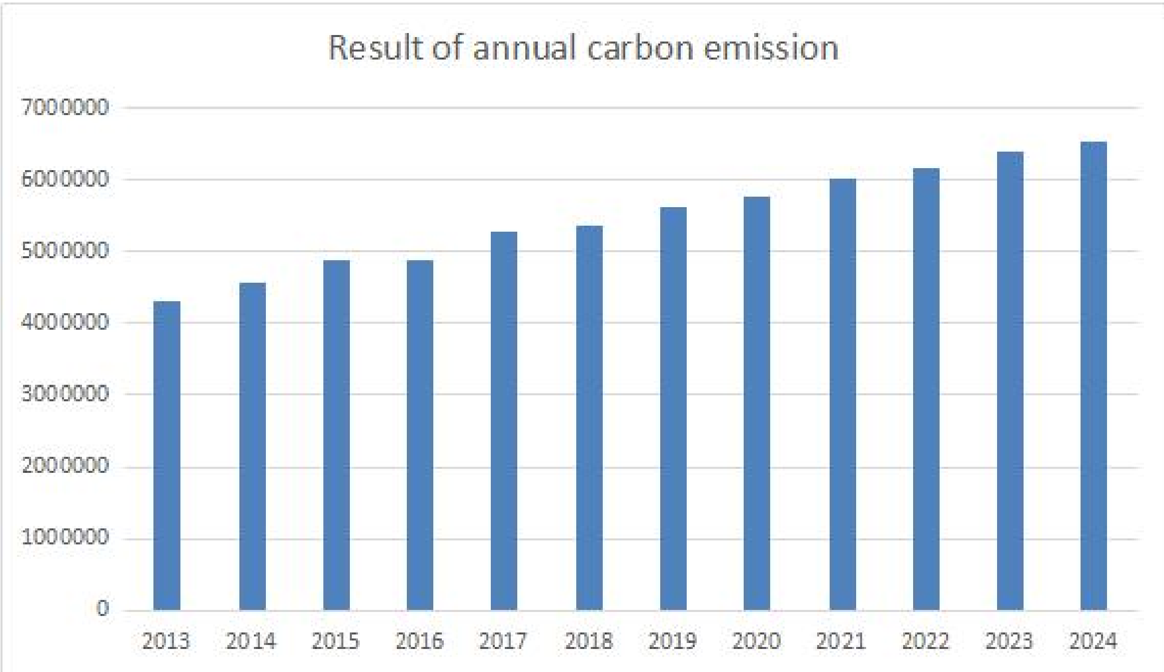

Figure 2- Annual prediction emissions of carbon dioxide gas from 2013 to 2024

Source: Own composition

From this table, it is easy to find the emission of carbon is increasing stably from 2013 to 2017. However, for 2016, its increasing rate is negative, but this ratio is very little, and it may not influence the trend of carbon emission in the future.

In fact, carbon emission is only part of pollution sources. In the process of collecting and distributing goods, the energy consumption generated by vehicles is the main influencing factor of pollutant emissions. The main pollutants emitted include: CO, CO_2, SOx, NOx, PM, HC and CH_4.

According to statistics, the energy consumption coefficient of goods transported by highway is 23.1 times that of railways and 10 times that of waterways. For Shanghai Port, the proportion of goods transported by roads is too high, and the proportion of waterways and railways is low. The container throughput of Shanghai Port and its continuous growth trend and the excessive proportion of highway collection and distribution will inevitably cause serious energy waste and air pollution in the city. Therefore, for a super-large port like Shanghai Port, the problem of pollutant emissions caused by the collection and distribution system cannot be ignored.

Take 2015 as an example. The table below has shown the summary of Pollution Gas Emission in Shanghai Port Container Collection and Distributing System.

Pollution Gas of Shanghai Port Collection and Distributing System				
Types of gas	**Emission from road (Ton)**	**Emission from railway (Ton)**	**Total**	**Proportion of road emission**
CO	8201.90	16.70	8218.60	99.80%
CO_2	4913701.50	10002.08	4923703.58	99.80%
SO_X	24.74	0.05	24.79	99.80%
NO_X	41102.50	83.67	41186.17	99.80%
PM	920.62	1.87	922.49	99.80%
HC	1934.24	3.94	1938.18	99.80%
CH_4	46.68	0.10	46.78	99.79%

Table 12 - Pollution Gas of Shanghai Port Collection and Distributing System

Source: http://www.chinaports.com.

As is shown in the table above, In 2015, Shanghai Port Containers produced 82,186,000 tons of CO, 4,923,037.58 tons of CO_2, 24.79 tons of SO_x, 41,186.17 tons of NO_x, 922.49 tons of PM, 1938.18 tons of HC, and 46.78 tons of CH4. Almost all emissions of polluting gases come from road collection and distribution.

Proportion of different pollutants in Shanghai Port			
Area	**SO_X**	**NO_X**	**Dust**
A:total emission in Shanghai (10000t)	17.08	30.06	12.07
B:total emission in Shanghai Port (10000t)	0.002479	4.118617	0.092249
B/A	0.01%	13.70%	0.76%

Table 13- Proportion of different pollutants in Shanghai Port

Source: http://www.chinaports.com.

What's more, according to the polluted gas emissions in Shanghai Port Collection and Distributing System in 2015, the NOx emissions generated during the Shanghai Port's highway and railway collection and transportation account for 13.70% of Shanghai's total NOx emissions, and the port collection and distribution system is a very large source of nitrogen oxides in Shanghai.

The PM emissions from roads and railways collected and distributed accounted for 0.76% of the total smoke (dust) dust emissions in Shanghai, and the SOx emissions accounted for 0.01% of the total sulfur dioxide emissions in Shanghai.

CO_2 is an important part of greenhouse gases, and its large-scale emissions are enough to cause changes in the global climate, which in turn affects the ecological environment. Port collection and transportation are closely related to urban development, and the discharge of a large amount of polluting gases will seriously affect the living environment of the citizens.

4.3 Analysis of the structure evolution of Shanghai Port's Container Collection and Distribution System according to carbon emissions

The emission factor decomposition analysis method has always been an important method to study the energy problem. It can qualitatively and quantitatively analyze the contribution of each influencing factor to the pollution gas emissions in a certain field, so as to infer the main influencing factors. This is of great significance in exploring the factors affecting emissions.

According to the basic model of pollutant emission, combined with the development of the transportation industry and the analogy analysis of the current situation of the collection and discharge of Shanghai Port, it can be inferred that the main factors affecting the emission of pollutants from the Shanghai Port Collection and Transportation System include: , energy structure factors, port development level factors and distribution and distribution ratio structure factors, emission control standard factors of transportation vehicles, traffic congestion factors and other factors.

4.3.1 Energy Consumption Factor of Unit Transportation

The unit transportation energy consumption refers to the energy consumed by the unit weight product moving unit distance. From the perspective of the consumption intensity of transportation energy units, among the various methods of port collection and distribution, consumption in road is the highest, followed by consumption in railway, and the energy consumption of waterway is low.

Coal consumption in different kinds of transport			
Year	Railway (kg/100ton·km)	Road (kg/100ton·km)	Seaway (kg/100ton·km)
2011	0.472	2.2	0.378
2012	0.468	1.7	0.335
2013	0.466	1.9	0.319
2014	0.451	2	0.275
2015	0.468	1.9	0.281

Table 14 - Coal consumption in different kinds of transport

Source: (2012 -2017) Statistical bulletin on the development of transportation industry

In the past six years, the Statistical Bulletin of the Development of the Transportation Industry shows that, except for the large-scale decline in the energy consumption of China's highway professional freight transport enterprises in 2012, there have been rises and falls in other years. In general, the energy consumption of road freight units in China has declined or the growth rate has narrowed.

Increasing rate of energy consumption from 2012 to 2017	
Year	**Rate**
2012	-2.34%
2013	10.00%
2014	6.70%
2015	-6.90%
2016	-4.00%
2017	3.50%

Table 15 - Increasing rate of energy consumption from 2012 to 2017

Source: (2012 -2017) Statistical bulletin on the development of transportation industry

In terms of railway transportation, in 2017, the comprehensive energy consumption of China's railway unit transportation workload was 4.33 tons of standard coal per million ton-km, which was 0.39 tons less than the standard coal per million ton-kilometer. The unit transportation workload is mainly for comprehensive energy consumption of 3.96 tons of standard coal per million conversion tons, which is a decrease of 0.20 tons of standard coal/million ton-kilometers compared with 2016, a decrease of 4.8%.

According to the 2017 Railway Statistics Bulletin of the National Railway Administration, in the past six years, the comprehensive energy consumption of China's railway unit transportation workload has declined in general except for 2015 and 2016; the main unit consumption is higher in 2015 and 2016, and the rest The year is generally stable.

The "Shanghai Green Transport Development Annual Report (2017 Edition)" shows that in 2017, the city's transportation industry consumed 26.171 million tons of standard coal, an increase of about 2.097 million tons, a decrease from 2016. Among them, the energy consumption of waterway transportation has increased rapidly and the unit consumption has rebounded. The energy consumption of railway transportation decreased and the unit consumption decreased slightly. In 2017, the railway industry's overall energy consumption was 380,000 tons of standard coal, up 2.8% year-on-year, and unit consumption fell by 4.0% year-on-year. Road and other transportation energy consumption is reduced, and unit consumption is basically stable. In 2017, road and other transportation energy reached 4.48 million tons of standard coal, down 1.1% year-on-year. Due to the decline in freight load factor, unit consumption increased by 0.8% year-on-year.

4.3.2 Energy structure factors

Under the same mode of transport, the energy structure used by the means of transport will also largely determine the amount of pollutants emitted. For example, most of the trucks used in road transport are diesel vehicles. The pollutants emitted are mainly nitrogen oxides and particulate matter (PM10). The particulate matter discharged by diesel vehicles is larger than the amount discharged by gasoline vehicles, and the damage to the environment is also Bigger. Nitrogen oxides react with water and other compounds in the air to form nitrates and fine particles. Chemical reactions with hydrocarbons also form ozone near the ground, and other pollutants can produce photochemical smog pollution under certain conditions.

According to estimates, the pollutants emitted by a truck are equivalent to the sum of the emissions of 30 cars. If the truck is powered by electric drive or LNG, it can greatly reduce the emission of polluted gases. Therefore, the type of energy used by the vehicle determines how much is emitted.

4.3.3 Standard factors for emission control of transport vehicles

Emission control standards for different grades of transportation vehicles also have a large impact on emissions. The higher the standard, the stricter the pollution, and the better the pollution emissions can be controlled.

In June 2018, the Ministry of Ecology and Environment and the State Administration of Market Supervision jointly issued the “Limited Limits and Measurement Methods for Heavy Duty Diesel Vehicles (China Stage 6)”. This standard will be implemented on July 1, 2019 and will be divided into three phases. This means that in the future, heavy-duty diesel vehicles will all implement the national six emission standards within the specified time points. This is a major positive for the emission control of port collection and distribution.

4.3.4 Factors of Port Development Level

There is a close relationship between port development level and port cargo throughput. As the economic level continues to increase, transportation demand is also growing, bringing more freight to the port. The process of transporting goods to their destinations by means of vehicles is the process of consuming energy to achieve their goals and is the most direct emission factor.

Shanghai Port has always maintained a high cargo and container throughput, ranking the world's forefront. High throughput means high energy consumption in the process of collection and distribution. With the improvement of port development level, port transshipment, loading and unloading, etc. are more efficient, the port radiation range is wider, the cargo collection and transportation turnover is accelerated, and the turnover volume is increased. As a result, a large amount of polluting energy sources such as coal and petroleum are consumed, resulting in an increase in emissions of carbon dioxide and other polluting gases. Therefore, the increase in port logistics volume caused by the improvement of port development level is a major factor in the emission of pollutants from Shanghai Port.

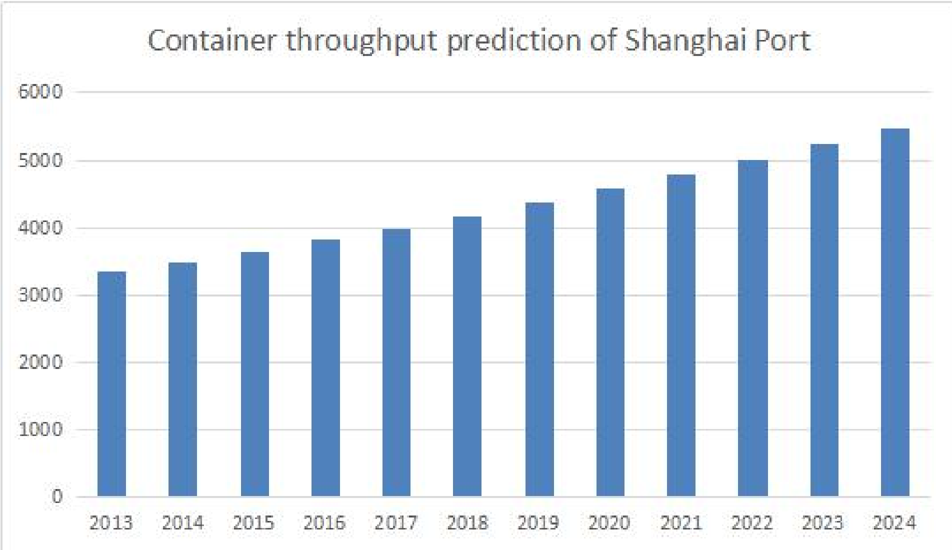

Figure 3 - Container throughput prediction of Shanghai Port

Source: Own composition

4.3.5 Proportional Structural Factors of Collection and Distribution Transportation

The imbalance of the distribution structure of Shanghai Port has always been one of the main factors restricting the development of Shanghai Port into a low-carbon, green port. Shanghai Port's throughput has been among the highest in the world for many years, and more than 50% of the goods have been transported and transported by road transport, while the unit's energy consumption per unit of transportation is about five times that of the railway. The single-use transportation of the trucks used for road transportation is small. For Shanghai Port, which has a large throughput, it is necessary to make up for the collection and transportation of goods, which is necessary to make up for the increase in the frequency of trucks. A large number of trucks enter and leave the port area, which has brought a series of negative effects to the surrounding area of the port area and the urban air environment.

According to the calculation of the Shanghai Environmental Protection Bureau: Shanghai's motor vehicles are less than Beijing's, but the total emissions of motor vehicles are not less than that of Beijing. The main reason is that the proportion of Shanghai's card collection is relatively high, and the pollution problem of Shanghai Port card collection cannot be ignored.

4.3.6 Traffic congestion factor

Traffic bottlenecks are an important factor in traffic congestion. The idling of vehicles while waiting for traffic will also cause pollution. Therefore, the consumption of transportation energy and the pollution caused by congestion in the vicinity of traffic bottlenecks have been highly concerned.

The Waigaoqiao area is concentrated in Waigaoqiao port area, bonded area, logistics company, etc. It is the main source and destination of traffic flow, resulting in serious road congestion such as Pudong North Road and Zhangyang North Road near the port area. The Donghai Bridge is the only channel for foreign traffic in Yangshan Port Area. Once an accident occurs, traffic jams are very likely to occur. Therefore, attention should also be paid to congestion factors.

In addition, overloading of vehicles can also cause an increase in pollutant emissions. For example, severe overloading of dry bulk collection and distribution systems can greatly increase vehicle load and increase fuel consumption, thereby increasing emissions of greenhouse gases and other atmospheric pollutants.

4.4 Utility analysis of Shanggang Group Yangtze River Strategy

According to relevant statistics, 8.02% of China's annual consumption of petroleum energy is generated by the transportation industry. Due to different organizational methods and operating methods, the unit energy consumption of different modes of transportation is also different, and the carbon dioxide emissions generated are also different. The energy consumption coefficient of road freight transportation in China is 0.01505 kg/ton km, the energy consumption coefficient of inland water transport is 0.00544 kg/ton km, and the energy consumption coefficient of railway transportation is 0.00264 kg/ton. The unit energy consumption of inland water transport is only 1/3 of the energy consumption of road freight. The unit energy consumption of railway transportation is only 1/7 of the energy consumption of road freight.

In terms of carbon dioxide emissions, road freight CO_2 emissions are 0.04795 kg/ton km, inland water transport CO_2 emissions are 0.01733 kg/ton km, and rail transport CO_2 emissions are 0.0081 kg/ton km. The unit carbon emissions of inland water transport are only one-third of the energy consumption of road freight. The unit carbon emissions of railway transportation are only 1/6 of the energy consumption of road freight.

Therefore, the construction of port multimodal transport system can replace part of road transport with lower carbon and environmentally friendly inland river and rail transport, thus achieving the goal of energy saving and emission reduction.

The Yangtze River Delta region (including Shanghai, Jiangsu and Zhejiang) is the direct hinterland of Shanghai Port. Nearly 70% of Shanghai Port's annual export containers come from the Yangtze River Delta region. The Yangtze River Delta region has not yet reached the economic transportation distance of the railway to Shanghai Port; the inland waterway resources in the Yangtze River Delta region have not been fully utilized, and the functions of many inland river ports have not been fully developed; therefore, the export sources of the Yangtze River Delta region mainly rely on direct transportation to Shanghai port. A large amount of road transportation not only aggravates the congestion of Shanghai urban roads, but also generates a lot of carbon emissions and seriously pollutes the air environment of Shanghai cities. This runs counter to the current theme of sustainable development and is not conducive to Shanghai's development towards a low-carbon, green international shipping center. In 2014, Shanghai Port cooperated with Taicang Port in Jiangsu Province and Anji Port in Zhejiang Province, and opened the quantitative, scheduled and designated inland river barge transportation routes of Taicang Port-Yangshan Port and Anji Port-Waigaoqiao Port. However, at present, the cooperation between Shanghai Port and the river ports in Jiangsu and Zhejiang has just begun, and the inland river barge route is not yet mature.

4.4.1 Taicang Port-Yangshan Port

At the beginning of 2014, Taicang Port and Shanghai Port successfully signed a strategic cooperation framework agreement, and the two parties cooperated to operate two berths downstream of the third phase of the Taicang Port Container Terminal. In 2014, Taicang Port opened a barge service every 8 hours to Yangshan Port. Mainly engaged in Chongqing, Wuhan and other middle and upper reaches of the Yangtze River and Jiangsu Sunan region foreign trade container transfer business. This is also a typical case of Shanghai Port actively using the Yangtze River internal branch to expand the water-water transfer business.

According to relevant research, we can get , for one TEU container from Suzhou to Yangshan Port, using the direct transportation and highway - water multimodal transport its transportation costs, transportation time, transportation carbon emissions and market share, as shown in the following table.

Transport from Taicang Port to Yangshan Port				
Proposal	Cost(yuan)	Time(hour)	Carbon emission(kg)	Marker share
Roadway	1274	9.3	205.5	46.80%
Highway - water	1035	16.6	163.3	53.20%

Table 16 - Transport from Taicang Port to Yangshan Port

Source: Own composition

It can be seen from the table that compared with the direct transportation scheme of inland water, the inland water-water transfer scheme has a longer transportation time, but the transportation cost can be 200 yuan per standard box, and the cheap ratio is 16%. This is very attractive for ocean-going cargo owners who are not very sensitive to transit time. According to the table, it can be concluded that the market share of the highway - water transport scheme is 53.2%. According to relevant research, the volume of foreign trade containers exported by Yangshan Port in Suzhou is 910,000 TEU. That is to say, for the 910,000 TEU export box source of Suzhou to Yangshan Port, theoretically, nearly 500,000 TEUs can choose highway - water transport scheme. Considering the actual operational capacity of the Taicang Port and the operational capacity of the barge, it can only digest about 160,000 TEU export boxes from Suzhou in the year.

After the barge business of Taicang Port-Yangshan Port is put into operation, Suzhou City expects to have 160,000 TEU export containers each year to use the inland water-water transfer mode to Yangshan Port. The economic and social benefits of the inland water-water transfer model can be calculated, as shown in the table below.

Benefits in transport from Taicang Port to Yangshan Port		
Index	Reduction amounts	Propotion of reduction
Total Cost / Year	38238500 yuan	3.30%
Carbon emission / Year	6756 ton	3.60%
Trucks / day	754 trucks	6.80%

Table 17 - Benefits in transport from Taicang Port to Yangshan Port

Source: Own composition

It can be seen from the table that the economic and social benefits brought by the inland water-water transfer mode of Taicang Port are enormous. It can reduce the total logistics cost by 3.3% and reduce carbon emissions by 3.6% per year. In addition, the inland water-water transfer mode reduces the flow of roads directly to Yangshan Port, resulting in a daily reduction of 7.8% of the total flow, and significant relief to the congestion of S20 and G15 sections around Yangshan Port.

4.4.2 Anji Port-Waigaoqiao Port

In 2014, Anji Shanghai International Port Co., Ltd., a joint venture between Anji Port and Shanghai Port Group, was officially listed. Anji Port currently has seven 36TEU vessels and 16 48TEU vessels, which have been opened. They operate the inland barge transport business, 4 shifts a day, between Anji Port and Waigaoqiao Port.

According to relevant research, the total export volume of Anji Port to Shanghai Port is 132,000 TEU. According to the ratio of 6 (Waigaoqiao Port) : 4 (Yangshan Port), the volume of foreign trade containers exported to Waigaoqiao Port is 80,000 TEU, and the volume of foreign trade containers exported to Yangshan Port is 52,000 TEU.

According to the relevant calculations, the transportation cost, transportation time, transportation carbon emissions and market share of one TEU container from Anji Port to Waigaoqiao Port can be obtained, with two different transport modes, as shown in the following table.

Transport from Anji Port to Waigaoqiao Port				
Proposal	Cost(yuan)	Time(hour)	Carbon emission(kg)	Marker share
Roadway	1465	10	240.8	25.20%
Highway - water	677	24	103.1	74.80%

Table 18 - Different transport proposals from Anji Port to Waigaoqiao Port

Source: Own composition

According to the table, where the highway - water transport scheme is compared with the highway direct transport scheme, although the transportation time is longer, the transportation cost can be as low as 765 yuan per standard box, and the cheap ratio is 52.2%.

In the meantime, according to the relevant calculations, the transportation cost, transportation time, transportation carbon emissions and market share of one TEU container from Anji Port to Yangshan Port can be obtained, with two different transport modes, as shown in the following table.

Transport from Anji Port to Yangshan Port				
Proposal	Cost(yuan)	Time(hour)	Carbon emission(kg)	Marker share
Roadway	1842	11.5	310.1	24.80%
Highway - water	1079	39.2	154.5	75.20%

Table 19 - Different transport proposals from Anji Port to Yangshan Port

Source: Own composition

According to the table, where the highway - water transport scheme is compared with the highway direct transport scheme, although the transportation time is longer, the transportation cost can be as low as 763 yuan per standard box, and the cheap ratio is 41.4%.

Totally speaking, according to Table 16 and Table 17, in the 80,000 containers exported from Anji Port to Waigaoqiao Port, theoretically there can be nearly 59,800 TEU to choose inland water-water transfer. And in the 52,000 containers exported from Anji Port to Yangshan Port, theoretically there can be nearly 39,100 TEU to choose inland water-water transfer.

Taking into account the actual operational capacity of of Anji Port and the operational capacity limits of the inland barge, Anji Port can only digest about 70,000 TEU of export containers per year. According to the relevant calculations, the economic and social benefits brought by the inland water-water transfer model are obtained, as shown in the following table.

Benefits in transport from Anji Port to Shanghai Port		
Index	**Reduction amounts**	**Propotion of reduction**
Total Cost / Year	57547700 yuan	25.13%
Carbon emission / Year	10139 ton	28.60%
Trucks / day (to Waigaoqiao)	197.9 trucks	1.00%
Trucks / day (to Yangshan)	131.9 trucks	1.20%

Table 20 - Total benefits in different transport proposals from Anji Port to Shanghai Port

Source: Own composition

It can be seen from the table that the economic and social benefits brought by the inland water-water transfer mode of Anji Port are huge. Each year, it can reduce the total logistics cost of local cargo owners by 25.13% and reduce carbon emissions by 28.6%.

In addition, the inland water-water transfer mode reduces the flow of road transport directly to Waigaoqiao Port. The daily card traffic reduction of the total traffic flow reached 1%, which can alleviate the congestion of S20 and other sections around Waigaoqiao Port.

And the inland water-water transfer mode reduces the flow of road transport directly to Yangshan Port. The daily card traffic reduction of the total traffic flow reached 1.2%, which can alleviate the congestion of G15 and other sections around Donghai Bridge.

4.4.3 Summary of highway - water transport scheme

(1) An important role in reducing the total cost of social logistics

According to the result, the inland river highway - water multimodal transport business from Taicang Port to Shanghai Port can save 3.3% of the total logistics cost every year, and the inland river-water multimodal transport business in Anji Port can save 25.13% of logistics costs annually. This is a win-win result for the cargo owners and the whole society.

(2) An important role in reducing the carbon emissions of social logistics

According to the result, the inland river highway - water multimodal transport business from Taicang Port to Shanghai Port can save 3.3% of the carbon emissions of social logistics every year, and the inland river-water multimodal transport business in Anji Port can save 28.6% of the carbon emissions of social logistics annually. This is a win-win result for the port operators and the whole society.

The highway - water transport scheme brings important economic and social value to Shanghai Port. Shanghai Port should continue its existing strategy and actively build an inland water-water transshipment network that efficiently connects Shanghai with other Yangtze River Delta River Ports, in order to maximize the role of Shanghai Port as an international hub port and exert its greatest value in the national “Belt and Road”strategy and the“Yangtze River Economic Belt”strategy.

4.5 Analysis of feasibility in carbon emission reduction

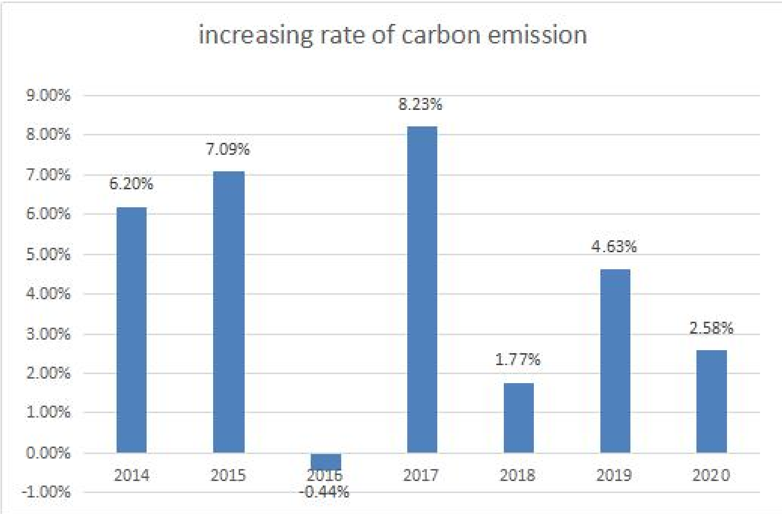

Figure 4 - Increasing rate of carbon emission from 2014 to 2020

Source: Own composition

According to relevant forecasts, by 2020, the increasing rate of emission will be reduced to 2.58%. When we compare the it with other numerical values from 2014 to 2017, we can find it has been decreased to a great extent and we can see some facts from its back.

4.5.1 The aspect of economy

In 2018, IMO has announced that new sulfur emission restrictions will be implemented in 2020. Currently, the three main alternative compliance options for reducing sulphur emissions from shipping activities are switching to high-quality, low-sulphur fuel, installing a ship's exhaust gas desulfurization unit, or retrofitting existing ships to make them a LNG-powered ship. The evaluation of each program is mainly based on its environmental benefits, economics and other factors that cannot be quantified, while shipping companies are most concerned about its economics.

The switch to low-sulfur fuels as a fuel restricts the emission of sulfur oxides from the source, and is considered by many shipping companies as the preferred method for dealing with sulfur-restricting orders. From the content of the IMO 2020 Sulfur Limits, the intention of the regulation is to hope that shipping companies will use more low-sulfur fuels to reduce shipping sulphur emissions, and the desulfurization unit is in some ways an alternative reduction. Method of sulfur oxide emissions. Of course, this needs to be based on the assurance that the quality of the oil is guaranteed. The shipping company's use of qualified low-sulphur fuel for ships can certainly comply with the regulations and effectively reduce the atmospheric pollution caused by the emission of sulfur oxides.

At present, low-sulfur fuels with a sulfur content of less than 0.5% have not been widely used in the shipping industry. As a result, IMO2020 sulfur limit will lead to a significant increase in marine fuel standards in the short term, resulting in short-term marine low-sulfur fuel supply and demand imbalance. It is predicted that by 2020, the global demand for marine low-sulfur fuel will reach 320 million tons. The low-sulfur fuel market will have a serious oil shortage, which will push its prices further up. Similarly, for carbon dioxide emissions, it is similar to the source of sulfur emissions. If shipping companies use greener, more environmentally friendly energy sources as fuel for ships, carbon dioxide emissions will be equally controlled. In other words, the demand for green energy will rise in the short term. At the same time, rising demand will drive up the price of green energy. When supply is less than demand, unit cost will become a more sensitive topic.

After all, fuel consumption and cost are factors that shipping companies must consider, which will cause the operators still prefer and choose to use the truck to transport the container rather than use the barge or the feeder.

4.5.2 The aspect of technology

The installation of desulfurization equipment has also been used by many shipping companies as a measure to deal with sulfur restrictions. Typically, desulfurization units are permitted to treat sulfur-containing exhaust gases emitted from ships. There are many kinds of exhaust gas desulfurization technologies in the world, so it is technically feasible to use a desulfurization device to treat sulfur oxides.

However, the use of exhaust gas desulfurization devices generally increases fuel consumption, resulting in an increase in carbon dioxide emissions. This means that conflicting with the goal of reducing the energy used for unit transportation, the increasingly stringent requirements for reducing greenhouse gas emissions are not met.

Another measure is to put LNG natural gas driven trucks into operation. Natural gas vehicles emit much less pollution than gasoline and diesel-fueled vehicles, and the exhaust gas contains no sulfides or lead. In this way, Carbon dioxide is reduced by 20%, carbon monoxide is reduced by 90%, and hydrocarbons are reduced by 70%.

However, it is difficult to build a gas supply system. The promotion and application of natural gas vehicles in large cities in China must establish corresponding gas stations, which involve many factors such as urban construction planning and environmental safety. And the cost of building a gas station is quite high, it needs 5-10 million yuan, or even more. Therefore, gas supply manufacturers generally do not build large-scale natural gas stations before they can ensure economic benefits. To a certain extent, this problem has become an obstacle to the development of natural gas trucks in ports.

4.5.3 The aspect of policy

Compared with foreign countries, China's carbon emission control degree started relatively late. For the first time in the 13th Five-Year Plan, China has incorporated “green” into its economic development concept. In order to reduce greenhouse gas emissions and build a green low-carbon recycling economy, seven regional carbon emissions trading markets have been piloted for many years, and on December 19, 2017, the national carbon emissions trading system was launched. China has made many commitments to the greenhouse gas emission reduction targets at the International Climate Conference. Building a green, low-carbon, and circular economic system has become an important strategy for China's economic development, and insists on using the carbon trading market as a low-carbon emission reduction. Effective tool. China is currently the world's largest carbon market, and will lead the global carbon trading trend in the future and provide experience in carbon trading operations.

But to this day, there is still a lot of controversy about whether China will levy a carbon tax. Or if it is levied, how to formulate a carbon tax policy that is in line with China's national conditions, is relatively fair, and can promote carbon emission reduction without greatly increasing the burden on enterprises and thus damaging market enthusiasm, is worth studying and discussing.

Chapter 5 Suggestions and prospects

5.1 Optimization analysis of Shanghai Port

The Yangtze River Basin, which is the hinterland of Shanghai's direct supply, is the foundation for the development of Shanghai's home port and the core area for maintaining Shanghai's existing growth capacity. Maintaining and improving the market share of the container market in the Yangtze River Basin, both at this stage and in the future, is the cornerstone of the development of the Shanghai Group. The core of the Yangtze River strategy is to lead the flow of goods in the Yangtze River basin, enhance Shanghai's ability to gather and radiate in the Yangtze River basin, and achieve sustainable development of the Shanghai Group.

5.1.1 Optimize port terminal operations and provide port integration services

Integrate the dry branch dispatching center to improve the overall operational efficiency of the port berth. By integrating port production information resources, a unified production scheduling information platform will be established to realize integrated and coordinated dispatching of Shanghai Port dry and feeder ships, strengthen the unified allocation of terminal resources, and improve customer service level and comprehensive port competitiveness.

Develop better barge or feeder service to optimize the Yangshan collection and distribution system. With the opening of the Yangshan Deepwater Port, the Shanghai Port Group has opened a barge service, which means that fixed-time, fixed-shift shipping routes will be opened in the Waigaoqiao Port Area and Yangshan Port Area, providing a range of fast-forward container transiting services. The mutual operation function of the transit box in the port area. Barge as an important means for the port, has become an efficient collection and distribution channel for Shanghai Port to connect with dispersed port areas.

Promote the development of “two ports linkage” and reduce customer export costs. The two-port linkage refers to the export container that was originally transported by land to the Yangshan Bonded Port Area for shipment. It was first transferred to the Waigaoqiao Port Area by land, and then delivered to the Yangshan Bonded Port Area by the barge or feeder. The advantages of the distribution organization of the Waigaoqiao Port Area and the advantages of the route resources of Yangshan Deepwater Port are combined to effectively reduce the cost of transportation logistics for customers and enhance the service capacity of Yangshan Port.

The automation of the terminal transfer box “mutually dragging” accelerates service response and saves energy and reduces emissions. With the increasing number of transit businesses in Shanghai, there has been a large number of docking operations between docks. Shanghai Port should optimize its intelligent information platform, make use of RFID intelligent crossing and wireless positioning technology to automatically dispatch transfer boxes between terminals, improve the overall operation efficiency of container transfer business, and achieve "re-entry and re-entry" of trucks, with remarkable energy saving and emission reduction results.

5.1.2 Improve logistics resource allocation, provide high-end and value-added logistics services

Give full play to the advantages of port logistics resources and provide integrated logistics services. The logistics service organizations under the Shanghai Port Group have spread throughout the country's central cities, covering international freight forwarding, shipping, storage, land transportation, multimodal transport, dangerous goods storage and transportation, shipment of major cargo, container assembly and unpacking. , ship supply and other comprehensive logistics business. The next step should focus on developing a well-developed port service chain, focusing on the development of third-party logistics and value-added services. Focusing on “big customers, big projects, and big platforms”, focusing on platform logistics, engineering logistics, and including automotive, chemical, and electronic In the field of product logistics services, integrating port logistics advantages, establishing long-term business relationships with large cargo owners, and promoting a series of high-end logistics such as multimodal transport, export secondary assembly, and “bonded-clearance-distribution” integrated operation project.

Meet the business needs of customers and build a professional logistics infrastructure. With the expansion of the logistics market, the demand for customer-specific logistics services continues to increase. The Shanghai-Hong Kong Group should increase its investment and strive to build professional infrastructure that leads the development of the industry, such as the roll-to-roll warehouse for commodity vehicles, regional distribution centers and cold. Chain logistics base, etc. Continuously strengthen the ability of Shanghai Port Logistics Center to provide value-added professional logistics services and enhance the competitiveness of port logistics.

5.1.3 Improve logistics service level and strengthen logistics path advantage

Promote the rotation of regional transportation, and encourage operators to improve the efficiency of branch transportation by swapping or sharing the space. On the one hand, it supports the Yangtze River branch transportation liner, and provides standardized services for timing, port and line to meet the supply chain service needs of production enterprises. The Shanghai Port Group should coordinate the riverside port, the internal branch dispatching center, and the Shanghai Port to work closely with the operators of each branch to provide customers with timely and efficient feeder transportation services. On the other hand, it encourages branch operators to exchange or share the space, and has formed a good shared space situation in terms of exports, reducing the situation of the original feeder ships repeatedly relying on Hong Kong, improving the ship turnover efficiency, and achieving the cooperation and win-win situation of the branch operators. Provide customers with faster service. Through the adjustment of a series of feeder transportation services, we will gradually establish a stable, fast, efficient and excellent waterway transportation system, actively respond to the competition of roads and railways, and establish a green, convenient and efficient service brand for the Yangtze River trunk logistics channel.

Develop regional outlets in the Yangtze River to achieve deep radiation of the logistics network. First, based on the business layout of the Yangtze River trunk line, we will develop service stations along the Yangtze River according to customer needs and market conditions, extend 150 kilometers to the north and south of the Yangtze River, establish a horizontally extended logistics distribution system, and expand the radiation surface of integrated logistics business. Secondly, strengthen the layout advantages of the Yangtze River network, establish partnerships with professional logistics service providers in various fields, and jointly provide customers with all-round high-quality integrated logistics services to realize the deep radiation of integrated logistics services in the Yangtze River Basin.

Integrate the logistics information system to realize the full visualization of port logistics. It is necessary to make full use of the advantages of existing information systems and information resources to provide efficient and convenient services to customers; it is also necessary to plan in the long run, unify standards, and build an open information service platform. Create a complete port logistics information platform, provide business information docking services for customers, and realize the full visualization of port logistics.

5.2 Shanghai Port's development prospects

In recent years, China and Shanghai have issued a number of policies for green port collection and distribution, mainly from the aspects of energy conservation and emission reduction, the use of new energy technologies, etc., and have achieved relatively remarkable results. However, due to the strong mobility of vehicles, ships, roads, ports and other factors in the port collection and distribution system, the carbon emission sources of the whole area are numerous and mixed, and there is no obvious boundary, which reduces the port collection and transportation. The cost of emissions is higher.

At present, the policies and measures for the carbon emission system of port collection and distribution are relatively limited. For example, the key aspects of the control and scope of the carbon emission system of the port collection and distribution, accounting methods, quota allocation, and verification agencies are not supported by a clear framework system. In the future development and construction, we should fully combine the characteristics of the transportation industry, actively design the top-level plan for the carbon trading of port collection and distribution, study the carbon emission verification method system of the port collection and distribution, and actively organize the pilot project of the carbon trading of the port collection and distribution. To play the supporting role of the competent authorities and strengthen the capacity building of carbon trading in Shanghai Port.

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