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Research on Shanghai Port logistics collection and distribution network optimization

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Research on Shanghai Port Logistics Collection and Distribution Network Optimization

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DECLARATION

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

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

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(Gong Chaoyang)

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ABSTRACT

This thesis takes the fast development of Shanghai ’s economy and the operation of the Shanghai port as a background, the theory of comprehensive conveyance as a guide, the minimum logistic cost as an end target, establish a 0-1 integer programming model, the multiform transit channels as a research object, established in Shanghai, exerts the function of the container collection and distribution system .

The thesis is composed of 6 chapters. Chapter 1 narrates the background, target and significance of the research, and summarizes the traffic distribution principles that the thesis involves. Chapter 2 &3 summarizes the concept of Supply Chain, Port of Supply Chain, Collecting and Distributing network of port etc. It also describes the effects that ports' transfer node selection strategy and users' path selection strategy have made on structure of Collecting and Distributing network under the supply chain environment. Chapter 4 on the basis of Comparing with the other international shipping center ,elicit that the main collection and distribution system of Shanghai Port is highways, and described the reasons for this situation, then analysis the exist problems in highways, waterways and railways. Chapter 5 establishes the optimization model of collection and distribution system, using the model to Shanghai port and analyzing solutions. Chapter 6 bases some analysis of the problem of the collection and distribution system, and put forward the relevant policy recommendations to solve the problem

KEYWORDS: Supply Chain; Port Logistics; Collecting and Distributing Network; bi-level programming model

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Chapter I Introduction

1.1 The research background and significance

1.1.1 The research background

Since the 21st century, along with the deep development of economic globalization trend, ports as the global integrated transport network node, comprehensive logistics services will become an important direction of port development in the new century and new economic growth point, and at the same time also helps to promote the competitiveness of the port international logistics function. From the overall trend, the development trend of modern port is seeking to achieve with full integration of port logistics, port is mainly form a reasonable and efficient port logistics chain, which can realize the effective control of the entire supply chain and value.

Port trade logistics is an implementation of a variety of modes of transportation process of organic combination, mainly include three links maritime transport, port loading and unloading, and inland transportation (i.e., transportation system),among them the transportation is a very complicated and plays an important role in the transport links. In each link of port transportation, "set" refers to the export of the goods shipped to the port from consignor designated place, after waiting for packing centralized piled up near the wharf apron or terminal yard; "distribute " refers to the import goods are discharged from the ship and then centralized piled up near the rear yard at the dock or wharf yard outside the port, and then shipped to the consignee designated destination by any mode of transport. Transportation links including, wharf handling, mainland transport (including highway, railway, coastal and Inland River and pipeline transport), and information management, form a complete set of

technical equipment, operating management and regulation of the customs inspection, etc. From a certain extent, therefore, to realize the port logistics efficiency and rapid operation, there must be unobstructed transportation system. Improve the efficiency of port transportation system to improve the port throughput capacity, accelerate the transport turnover, shorten the time of flow of goods, to ensure that the goods delivered on all has the very vital significance.

In 2014, Shanghai finished 35.285 million TEU which still stands first in our country and the world container port. With the further growth of container throughput in Shanghai port, container transportation system will become an important factor of restricting the sustainable development of Shanghai international shipping center. Shanghai direct is the main river, Jiangsu, Zhejiang and Shanghai on economic hinterland of the Yangtze river delta region (hereinafter referred to as the Yangtze river delta, Yangtze river delta goods accounted for about 85% of the Shanghai import and export goods. From the perspective of transport economics, Yangtze River delta region belongs to the scope of highway transportation of container, so for a long time, the region's container quantity is mostly transported by the road to Shanghai port. Along with the completed and put into operation of Yangshan port , Shanghai port container throughput is constantly growing, focusing on road transportation of container transportation system has been unable to meet the demand for the development of Shanghai, the disadvantages of heavy highway container transportation is gradually revealed. Shanghai international shipping center in order to ensure scientific and sustainable development, how to carry on the system planning of Shanghai port container transportation system, improve the ability of Shanghai port container transportation system, the efficiency and quality is the core problem which should be considered.

1.1.2 The research significance

According to the above problems, this paper decided to study the problems of the Shanghai port logistics transportation system, in order to realize the following theoretical and practical function in four aspects:

(l)The systems analysis of port logistics transportation link related issues is of great significance to the development and improvement of port logistics of distribution theory system;

(2) Take Shanghai port logistics system transportation link as the specific research object, we will put forward the corresponding optimization measures while analyzing the problem and that will provide the case reference for analysis and optimization of our country main container port transportation system .

(3) The optimization of container transportation system helps to develop Shanghai port hinterland. Giving priority to highway container transportation system in Shanghai port due to the limited to the Yangtze river delta economy service area and the strategic target of Shanghai international shipping center include stimulating the economy and development of the Yangtze river valley, the Midwest. The realization of the international shipping, the elements of the strategic objectives must be accomplished through the optimization of container transportation system.

(4) To solve problems of Shanghai port transportation links is of great significance to multimodal transport, improving the business performance port logistics participant and reduce the logistics cost.

1.2 Related research status in domestic and abroad

1.2.1 The foreign research status

In the 1970s before the application limitation of regional freight transportation network optimization on fairly simple network, using some classic methods in operational research materials, optimization of transportation problem, the main methods on table method, the shortest route method and minimum cost maximum flow method [1] [2] [3] [4].These methods can't solve the problems of the comprehensive transportation will increase more, multimode, now commonly used in transportation planning principle of the network flow method, such as the short circuit allocation method, the capacity limit distribution model, the multipath probability distribution flow model and flow model and balance after application more is actually two [5].In the construction of container terminal, the connection between hub port and regional port transportation capacity planning rationality is directly related to the ports of the overall advantages [6].

Like other aspects of shipping industry in the production operation, port construction and development should follow a certain economic law, so when study of port transportation system, it will be built on solid economic foundation. literature [7] from the perspective of shipping development history, demonstrates the interaction of each related link of the shipping, which points out that to enhance the efficiency of port operations is of very significant influence to the ship operation efficiency, and good port facilities and transportation network is an important guarantee of port operations to improve efficiency; literature [8] Book analyzed the shipping economy from another Angle, which mainly focuses on the various technical and economic comparison between the mode of transportation. To improve the economic efficiency of the shipping industry, of course, especially port

profitability, the function as the goods distribution hub of the port will be given full play, which is visible to the importance of the transportation system to the port.

The major trading ports in all countries of the world attach great importance to research of port transportation system, such as literature [9] magazine each issue will list key production data of the European main ports, comprehensively use of modern advanced statistical method and the measuring software to measure the production data, a more scientific and comprehensive grasp of port development dynamic, with a particular focus on the transportation infrastructure system, the construction and utilization; Literature [10] for Asia's main port, such as Hong Kong, Singapore and other big ports' production data publish on a regular basis, focuses on the influence of the transportation cost to the port production, due to Hong Kong, Singapore, the special geographical position and important role in international trade, this part of the data statistics especially preferred by China's domestic shippers ,foreign shipping companies and large multinational companies; Literature [34] is the detailed analysis of the competition advantages and disadvantages for China's main transportation system. it is with international vision, to conducted a comprehensive, integrated review on China's major trading port, make the world more comprehensively understand the status quo of Chinese ports, at the same time, accelerate the development of the future for China ports itself ,especially the improvement of the port facilities itself and the external network construction.

1.2.2 Status quo of domestic research

There are many domestic scholars study of port transportation system, Shang guosheng, Dou Bin [6] discuss the Yangshan port to the Yangtze river port container transportation way, make use of the Yangtze river side benefit calculation model, put forward two ports such as Nanjing, Wuhan, Chongqing to Yangshan port routes of

transportation mode. Xiao Jin such as [7] from Dalian reality, objective analysis and economic development of Dalian port hinterland scope, predicts Dalian port container throughput of 2010, puts forward the development strategy of Dalian port container transportation system and implement the strategy of specific measures. Mr. Lei [8] is pointed out that our country should make container transportation way to reasonable direction, it shall recognize and give full play to the advantages of railway and inland water transport respectively, combined with the location of the port's own conditions, give full consideration to the future development of hinterland, the construction of infrastructure, improve relevant policies, make each mode of transportation do all it can, form the high efficiency and low energy consumption, less pollution of the container transportation system.

Fang Ran [9] is proposed based on negative exponent network optimization flow model of the port group of hinterland container transport system network optimization flow research, the pearl river delta container transportation system are analyzed with this model. Satisfied cream [10] port transportation system for physical description, definition, roads and network nodes, and using the methods of extension to describe and define, transshipment hub as the goal, to establish a optimum system based on the generalized cost will increase more comprehensive balance and multimode port transportation network optimization model, and to evaluate the model. Xiu-yuan zhang [11] on the basis of the theory of Fuzzy linear programming with Fuzzy goal programming port transportation Fuzzy network model is given, with a minimum cost maximum flow model of Fuzzy capacity limits, and with the center of Guangzhou port cargo transportation simulation analysis, transportation route optimization scheme is put forward.

However, for most of the port, port transportation is still a relatively weak link, efficient transportation network, has not been formed in the aspects of theory research is also relatively small. For a comprehensive transportation network

optimization research also does not see more.

1.3 Research ideas and research methods in this paper

1.3.1 Research thought

Followed from theory to practice, this paper analyses the research train of thought, the port logistics and port transportation system, this paper analyzes the development situation and the related theory, and then to Shanghai port transportation system development present situation has carried on the comprehensive and meticulous research, summarizes the main problems, and put forward various transportation subsystem on the basis of the overall planning, in the realization of the transportation of transportation systems and other infrastructure conditions improved, further optimization design was carried out in Shanghai port transportation system.

1.3.2 Research methods

(1) The method of combining the qualitative research and quantitative research. This article mainly adopted the quantitative prediction model

Analysts predict Shanghai port throughput in the next three years, using integer programming model planning transportation system node; At the same time combining the adopted qualitative research methods to analyze the modern container port comprehensive competitiveness factors.

(2) The method of combining the documentary research and field investigation. Shanghai port transportation system present situation mainly through on-the-spot investigation and interview, head of the relevant government authorities and ports. The port throughput prediction and transportation optimization model and method is mainly related to access to professional journals, academic monographs and so on

literature material

(3) The case analysis. Based on the analysis of the advantages and disadvantages of Shanghai port transportation system in the process of reviewing

A large number of the world's leading container port transportation system relevant information, through a lot of case analysis and comparison,

Finally determine the transportation system optimization idea of this article.

1.4 Framework Paper

Chapter I

Introduction

》A brief description of the status quo and distribution Shanghai collect, analyze current research, based on ascertaining title

》Research ideas and research methods "describes.

Chapter II

Literature review

》Describes Port Logistics related research

》Introduce related researches port logistics network

》Summed up domestic and foreign ports collection and distribution system research

Chapter III

Port Logistics collection and distribution optimization model under supply chain study

》Port Logistics Network Structure of Collecting and Distributing

》Port Logistics transportation network optimization factors

》Port Logistics transportation network optimization Model

Chapter IV

Status collection and distribution systems Shanghai analysis

》Situation Analysis of Shanghai collection and distribution transport system

》summarize the main problems of collecting and distributing system

Chapter V Shanghai port collection and distribution Network Optimization

》case of Shanghai port, network optimization model

》Empirical analysis, modeling and solving

Chapter V Conclusions and Recommendations

》Summed deficiency of this writing

》development proposals of Shanghai port on collection and distribution system

Chapter II Literature review

2.1 Related research on Port Logistics

Foreign research in the port logistics focused on the development of the port, port logistics functions, port logistics service evaluation. Specific literature: such as the United Nations Conference (UNCTAD) has proposed a "third generation port" (port cargo handling capabilities in addition to providing other than to strengthen ties with the city's harbor, in the service beyond the boundaries of the service increases information, services, distribution and other integrated services) and the concept of "fourth generation port" (geographical separation, but the same operation or management strategy to provide integrated logistics services, port and harbor Union) [12]. Harding and Juhd [16] By outlining the concept of general logistics services and value-added logistics services for port logistics services related to the evaluation made. Klin[17] Port is considered an important transportation junction in the course of international trade and transport of goods, which determines the logistics network

of maritime and inland transport can be effectively connected to the port core mission it is to achieve between the various modes of transport of goods or with the rational allocation of resources between the mode of transport. In addition, in many other literature, some scholars believe the port as a logistics center in the future there will be much room for development, maritime and intermodal transport system will be an important node in the in position, For example, Nottebooin[18] Systematic study of the port logistics involved in the development of intermodal systems, and the effects of multimodal brought to port. In China, scholars are very concerned about the study of port logistics, mainly to study the structure and function of port logistics, port logistics development strategy and evaluation, port logistics and other aspects of system planning and optimization. Specific literature like Wang Ling, Wei Ran[19] considered necessary from the interaction of port logistics infrastructure, logistics information, logistics operations, related industries, and coordinated support of five subsystems to study the problem of how to build the port function conversion and logistics systems. Tang Hailong, Hu Xia[20] think we should build a service from the chain, remodeling business system, providing full integration of marine cargo services and logistics services change other aspects of development of modern logistics, construct modern port logistics service system. Zhang Ming[21] believes port logistics system analysis is made in order to achieve economic port in time and space, and the use of systems theory and methods of port logistics system for analysis and research. Liu Lihui considered when building the port logistics chain make supply chain management concepts into port logistics, making the port companies and other related businesses integrated into the overall existing research literatures from the point of view, very few people from the perspective of supply chain to study the issue of port logistics, The limited few literature is mainly from the perspective of supply chain microscopic study of port logistics, Level covered include the use of supply chain management of port supply chain performance

analysis, using empirical analysis of the port in the supply chain management to analyze the role and Container Ports from the perspective of the logistics supply chain activities. Nevertheless, the integration of multimodal transport and organization associated with the port supply chain has attracted great attention of foreign scholars. Domestic academic research in this regard has also been involved in two, but most of the research in favor of substantive analysis and qualitative research, part of the literature of the intermodal itself theoretical research, For example, Wei jigang and Rong chaohe[28] mainly studied the issue of coordination of transport intermodal container transport system in the process; Zhu xiaoming, Bian yandong and Ma guizhen [29] mainly do analysis to the problems of Intermodal channel effectiveness evaluation.

In summary, the present study the theory of port logistics mainly qualitative analysis is still lacking in the study of the theory of comparative systems, In addition, port logistics research study only on local logistics port itself, no systematic consideration of global logistics network from the perspective of supply chain.

2.2 Related research on port logistics network

Port Logistics Network is a multi-level complex network of foreign scholars in port logistics networks mainly for logistics network planning and optimization of two aspects of the corresponding research. Research in port logistics networks can be attributed to foreign summarized in two situations:

Location-Routing problem;

Location-Allocation problem

In the research of Location-Routing problem, Laporte made both solving facility location and vehicle routing problem model; Laporte and Nobert Propose a single

station on Location-Routing problem and Exact algorithm; Laporte, Nobert, Laporte and Laporte on this basis, the issue raised more than LR stations and Its Solution.

In the research of Location-Allocation problem, Baumol and Wolfe proposed Nonlinear warehouse location problem. Heuristics, Erlebacher and Meller proposed further Nonlinear warehouse location problem on the basis of their analysis model, To achieve a fixed operating costs, warehouse goods holding costs, transportation costs (between manufacturers and warehouses as well as warehouses and retailers) and minimization of, and proposed heuristic algorithm to solve the model; Teo and Shu Mainly related to match, warehouses and retailers warehouse inventory replenishment policy decisions quantity and location, warehouse and retailers to achieve total costs (inventory costs, transportation costs and positioning costs) are minimized. Domestic research on port logistics network focused on logistics network optimization, Specific literature: Ding yizhong Mathematical demonstration and simulation method of combining the multi-level queuing network system and port logistics network design in an article on the theory and methods of multi-level queuing network system for a more in-depth study and applied to port logistics network design and reconstruction, the establishment of a port logistics network design model based on multi-level queuing network theory approach; Li ertao In the bi-level programming model for logistics network in an article from the perspective of the scale of logistics costs and logistics center location can be optimized to minimize the total cost of logistics as the objective function to establish a bi-level programming model and the model with a genetic algorithm solving; Lv lixin studied the Regional logistics systems and logistics planning methods, think that the regional logistics system design into network planning and network nodes planning two parts, and mathematical models of the systems involved in the introduction of network planning; Wang chuanxu based on the shaft - optimization of regional port cluster two stage logistics network spoke transportation system in an article in the collection

and distribution network area network ports and maritime transport and port economic hinterland between the research object, applicable to regional port cluster secondary nonlinear optimization model of the secondary logistics system logistics network optimization, to achieve a minimum total transportation costs, while optimizing the economic hinterland port, the transit hub and transport capacity between the ports of transit cargo; Pang Ming Bao proposed Regional Logistics Network Planning in the double-level programming model, the use of systems analysis and game theory, government logistics route network planning from a macro perspective, construction and transport and logistics companies logistics line from the perspective of micro-enterprises optimization goal and game scheduling process were studied to establish the upper governments to pursue generalized minimal logistics costs, lower business pursuit Stackelberg model to minimize the cost of their own enterprises balanced Flow.

2.3 Related research on port logistics collection and distribution system

Study abroad in terms of collection and distribution is mainly for study or collection and distribution of a port at the core of the collection and distribution for regional port cluster study, and study abroad in terms of collection and distribution is not just for the collection and distribution hardware facilities and a single mode of transport, but from the port of intelligent transport systems and port logistics systems, study of the overall perspective of port transport, port and intermodal issues were discussed for analysis. The main theoretical research abroad in terms of collection and distribution Port Logistics: Beuthe in a certain area, for example, different kinds of goods for ten categories of transport, based on a comprehensive consideration of

multimodal combinatorial problems during transport all modes of transport on all available paths and transport routes, build traffic demand distribution model, obtained railways, highways, waterways are three modes of transport in transit direct and cross-elasticity of demand. Peter and Nikamp Using the discrete model and neuron model for optimization and predictive capacity cargo transport network a comparative analysis, the method for coordination between the various subsystems collection and distribution system gives a good research ideas. Kenneth J.Butto Mainly on economic and technical similarities between the various modes of transport do comparison, transport and port-related economic benefits not only its own advantages and mode of transport in the port for more can give full play to the role of its cargo hub related. Domestic research collection and distribution logistics in the port areas mainly in the port collection and distribution logistics management, collection and distribution methods, collection and distribution networks, collection and distribution construction and other transit nodes. Main research: Zhang Yun Peng think that the layout of the building management system of collection and distribution, inland transit nodes, providing professional services for the collection and distribution fleet efficiency and so has an important role to make recommendations for the development of ports must be built to rationalize collection and distribution system; Xiao dusheng the actual status of Heihe, in order to improve the collection and distribution capacity of Heihe port, gives to the development of road transport, construction of roads transit hub, while improving port transportation network building capacity to improve the collection and distribution of recommendations; Dalian Port Container Co., Ltd. It focuses on the development pattern Dalian Port inland collection and distribution system that Dalian Port should be for the development of the concept of supply chain integration to inland ports, information systems for the two wings, enhancing port and transport companies, customers, shipping companies cooperate , vigorously develop the trains based

collection and distribution system. Collection and distribution in port logistics optimization, Huang fang and Tao jie specifically for port transport network, from the perspective of the port network assignment, a 0-1 integer programming model to optimize the port transportation network; Wang chuan xu and Jiang liang kui Optimization decisions are based on double Programming Regional Port Inland Transportation Network in an article for Regional Port Inland transportation network optimization decisions, constructed choose two levels inland port logistics system construction and distribution center based on the user's path level programming model, in order to reduce port coordination of the upper and lower logistics costs.

Chapter III Research on the optimization model of transportation network in Port Logistics under the supply chain

This chapter is intended by the port, transit nodes (especially inland freight stations, goods distribution centers), origin of goods as the node to connect each node transport route for the arc established transportation network, the port as the supply chain a node, considering the port and transport logistics enterprises joint decision-making, from the transit node (cargo hub, a transit point) layout, size and path selection at two levels the network structure for the collection and distribution of the total cost under different modes of transport based on the smallest angle optimization.

3.1 port logistics transportation network structure analysis

Port Logistics transportation network by port, transit node, port economic hinterland as the nodes involved in a variety of modes of transportation and transportation routes of each node connected to the network configuration, which is a port logistics supply chain management is an important carrier, in order to OK port logistics transportation network optimization study supply chain environment, it is essential to transportation network port logistics research and analysis.

In the port logistics activities, due to multiple nodes enterprises involved in a variety of transportation modes,

At this point the various modes of transportation and port interrelated, forming a centralized and evacuation port cargo throughput of collection and distribution system

Systems: Port Logistics collection and distribution system is comprised of inland transportation networks, coastal branch, terminals, operations organization and management,

Collection and distribution of information systems and customs control and examination, etc.,

Port transportation system is to do the entire carriage for passengers and goods and provide infrastructure and cohesion of the place, and the contact of the port and the port around the vast hinterland is an important channel and inland transportation network is a set of effective carrier to transport the efficient operation of the system, all the goods transportation needs in the inland transportation network as a carrier. In the port and transportation system network structure and transport through capacity determines the port logistics system scale, efficiency and quality of service, is in the port and an important guarantee for the efficient operation of the transport system, so it is necessary to set and distributing system of collecting and distributing network

(including freight station and transit node, means of transportation, the supply of goods to the) related research, through the effective convergence of various modes of transport to achieve physical and logical "zero distance transfer" and "seamless connection".

3.2 port logistics transportation network optimization factors

On port logistics transportation network optimization and influence in the port and transportation system optimization factors into quantitative and qualitative factors, details are as follows:

1) Quantitative factors

(1) Transport costs

Transportation is the port collecting and distributing system of the logistics activities, transportation costs and customer requirements of freight, transport distance and customers and port selection mode of transport has a direct relationship. Port collecting and distributing system is mainly used in waterway transport, rail transport, road transport and other modes of transportation, the transportation cost should include goods from shippers supply transport to the transit node sections of transportation costs, from transit transportation node to the port of transportation costs.

(2) Operating costs of transport vessels

Transit transport vessel operating costs, including the human cost of ship management personnel costs, operating the ship, power cost and port management costs, and transport routes, cargo, and transport routes start and finish, etc. factors has a direct correlation. Most of the ports in the carriage of goods do generally the

transport to the shipping company, so the transportation network structure optimization does not consider the cost.

(3) Port cargo handling costs

In cargo ships arriving at the port, the port will be according to the goods, shipment plan and conveyor belts distribution and other factors, the use of professional facilities for cargo handling, loading and unloading cost is determined by the types of goods, loading and unloading tool, the volume of cargo and other.

(4) Inventory costs

Inventory costs are those due to port of transportation conditions can not be timely shipment, port available transportation resources are limited, destination is not ready to receive goods led to the goods in the port stay, product occupancy expenses paid in the process of storage space, the residence time and has a direct relationship.

The expenses paid in the space process have a direct relationship with the residence time.

(5) Investment construction costs

Port of transshipment nodes for investment and construction of the loss of cost is the cost of investment and construction, mainly including the variable cost and fixed cost. Port of transshipment nodes construction investment, consumption of fixed cost including staff salaries, construction costs, infrastructure and equipment purchase costs, installation costs etc., variable cost is mainly refers to vary with changes in the environment loss cost, including maintenance and new equipment costs, water and electricity costs, accident emergency caused by fee, vehicle, office and living consumption costs, materials costs due to turn according to the environment change and the variable cost is the variable cost, and not one classification.

2) Qualitative factors

(1) Transport conditions

The transportation conditions (railways, ports, highways, waterways and other

transportation line traffic and transportation infrastructure) directly affect the port transportation system in freight transport activities of the logistics cost, operation efficiency also have influence.

(2) customer demand distribution

Is the main port for the large enterprises of cargo transportation services, in the port and transportation efficiency will directly affect the customer demand distribution. Customers choose to serve the port not only to consider the distance, but also to consider the efficiency of service and transportation costs. If the port from the customer is far away, then transit time will be increased, the more important is produced in the process of transportation of goods increased the risk. Therefore, customers will be according to its need to deliver goods quantity characteristics of reasonable choice to provide transport services of the port.

(3) economic environment and related institutional factors

Port and enterprise policy environment and economic environment will affect the port transportation development, the enterprises in the port selection for providing services to the need analysis of the environmental factors [38]. The transportation network optimization research purpose is to make the port set and distributing system total cost minimum, so the model in the construction should consider using quantitative factors to quantify in port set port and customers in transportation costs. So of supply chain under the environment of port logistics in transportation network optimization model is constructed, for port selection construction costs to quantify the port transit node construction cost and investment cost of construction including the variable cost and fixed cost, establish suitable model for analysis and decision making, also should choose transportation costs, cost of inventory and reproduced to quantify in the process of transportation costs. In consideration of the quantitative factors must also consider some qualitative factors, such as transportation, in the construction of models should consideration of the various modes of transport

transportation condition is good, can not do in traffic on the way to the seamless connection.

3.3Transportation network optimization problem of Port Logistics

For a have been identified in the collecting and distributing system [41]. Each port set mode of transportation, port supply chain logistics nodes, logistics network and transport path are generally have been identified, namely in the collecting and distributing network constitute the logistics chain. Therefore, on port logistics set and distributing network structure optimization is to have formed the port logistics chain network structure optimization, in potential relay node location of construction investment in the construction of some logistics transit node, in order to optimize the allocation of logistics resources, improve the efficiency of port logistics, reduce the cost of port logistics service. Under the supply chain mode, port logistics set and distributing network structure optimization is not simple transit freight station node location problem, from the point view of two levels of considering port decision makers (government) and the enterprises or users, on the basis of minimum cost flow and all kinds of transportation modes based on the rational distribution of by the port transit node layout, scale, path selection and volume distribution layer against transportation network structure optimization. The construction should achieve the following goal optimization model of transportation network in port logistics under the environment of supply chain.

to optimize the model should be able to used by a plurality of the supply of goods to the way multiple intermediate nodes shipped at least a port of destination set transport network system;

(2) The model should be able to achieve port hinterland to the port cargo supply problem, identify the node between the hinterland and port transit construction site at the optimal total cost of the premise, size and volume in the collection and distribution of goods transport networks ;

(3) The model should be the establishment of a customer engagement, to seek customer path selection policy based on the best transit node construction site and scale, so that the system of minimum total cost of collection and distribution systems;

(4) The model should be able to react influence decisions on port transport and logistics companies as well as transport and logistics business impact of the port routing decisions.

3.4 port transportation network optimization Model

Port transport system network architecture optimization problems related to two different target function decision makers, namely port decision makers (government) and logistics, transport companies or users. The path to a more accurate analysis of the decision-making of port logistics, transport companies selected path impacts and transportation and logistics companies choose to change the decision-making influence decision makers on the port, the use of double-planning ideas here and port transport network optimization analysis.

(1) Optimization of decision options

Port, port hinterland, port and port hinterland between transit node and collecting and distributing way constitute the port logistics transportation network, port transit node construction investment decision, transportation network is affecting the port transportation network are two important factors. From the port decision point of view, the port by changing the structure of the transportation network construction

investment transfer node is changed; from the perspective of users or to transport, logistics enterprises, the choice of transportation network reflects the goods in the transport process in transit node and the set of sparse transport line of traffic assignment model, so the port transit node construction investment decision, user path selection decision can be used as is port transportation network optimization to consider two important decisions. In order to determine the port logistics in transportation network optimization of the upper and lower specific decision makers, the port of transshipment decision nodes and user path selection decision of correlation analysis, as follows:

In the port logistics collecting and distributing process, port through investment in the construction of different transit nodes set the network structure of the transportation network, thereby affecting the transportation, logistics or (user) at the relay node and port traffic assignment. At the same time, the user of transit node, port and transport route choice of port transit nodes decision.

(2) Under normal circumstances, port operators and managers first of all to make decision on transit node, which changes the structure of collecting and distributing network, transportation, logistics enterprises or users in the existing transit nodes make of freight transport route choice decisions, and the freight transportation route choice decision feedback to the port enterprise and influence the transit node of investment and construction.

(3) The decision of the port investment in the construction of the transfer node can only affect the choice of the path of the user, and the two kinds of decisions are independent of each other. Through to the port logistics in port transportation decision node and user path selection strategies were analyzed, select the investment decision making of construction of port transit nodes as in the port and transportation network optimization of the upper level decision model, path of transportation and logistics enterprises selection decision as port logistics set transportation network

optimization of the lower level decision model

Chapter IV Shanghai port collection and distribution system analysis

4.1The status of Shanghai port transportation system

4.1.1 Highway subsystem

The road transport in Shanghai port container container throughput accounted for more than 80%, Shanghai port container port area are mainly distributed in the Yangtze River Estuary and East China Sea on the Yangshan Deepwater Port. The mouth of the Yangtze River port mainly includes Zhang Huabang pier, wharf, wharf and military road Baoshan Waigaoqiao phase 1-5. The Yangtze River port mainly through (outer ring

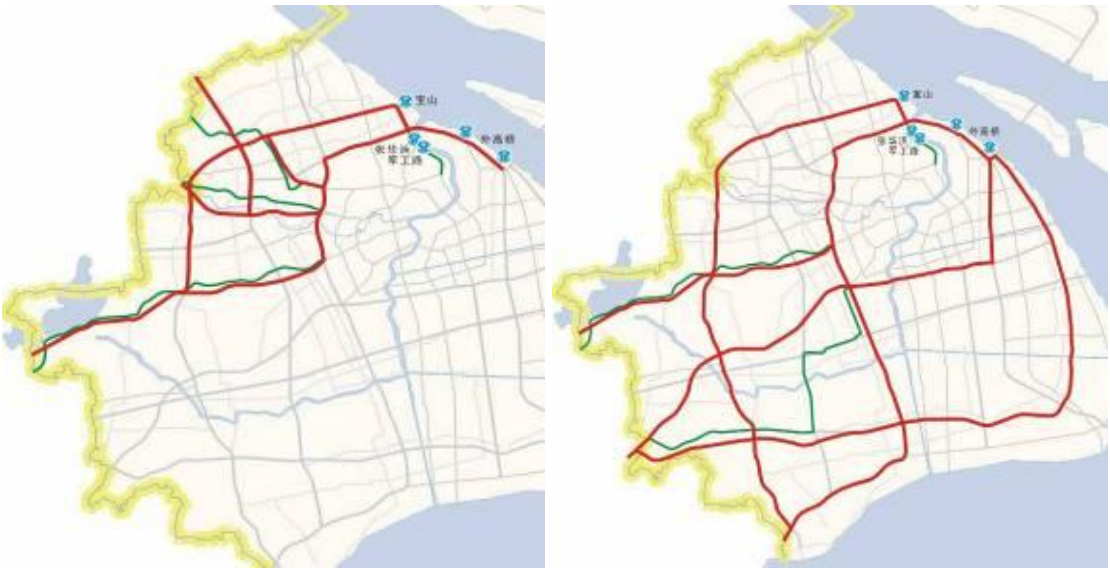

Figure 4-1 Yangtze Delta Port Container Delivery Channel

road) A20, A30 (Rural Link) from the northern and western part of the external connected, through inter provincial highway and Jiangsu, Zhejiang docking. Yangshan Deepwater Port mainly through Donghai Bridge channel and A30, A20 is connected, through the provincial highway and Jiangsu, Zhejiang docking, or by A2 and the inner ring is connected.

Yangshan Port road collection and distribution where the main road is now the only major collection and distribution channel - the East China Sea Bridge, the bridge will link up the harbor.

Yangshan Deepwater Port Donghai Bridge A2 vehicle through the road, entered the Shanghai highway network, suburban Link, Outer Ring Road, Inner Ring Road, Accessible State Road 204, the 312, 318, 320 and other Yangtze River Delta region and the formation of the collection and distribution network. From the northern end of the East China Sea Bridge, about 4 km east of Shanghai Luchaogang old levee, the new embankment across the Hangzhou Bay, the southern tip of the island by the large turtle hill beyond the small town of Zhejiang Shengsi Xiaoyangshan. A total length of 32.5 km, with a total width of 31.5 meters, six lanes, design speed of 80 km / h [15]. A2 highway (Hulu Expressway) leading to the central city of Shanghai Lingang New high-capacity fast-track and Shanghai

International Shipping Center Yangshan Deepwater Port backbone supporting a total length of 42.3 kilometers of traffic engineering, with a total investment of about 2.4 billion yuan. After the northern section of the A2 highway (Hulu Expressway) was opened to traffic, making the city the center of the city to traffic Harbor City to shorten the time from 90 minutes to less than 30 minutes, to the development of the Yangshan Deepwater Port, Lingang zone to greatly facilitate transportation on. In addition, the connection A4, A30 (South Central) and A30 (East South Central) three highways important transport hub --- Xinfengjin major interchange on the official

opening, into Shanghai expressway network operation.

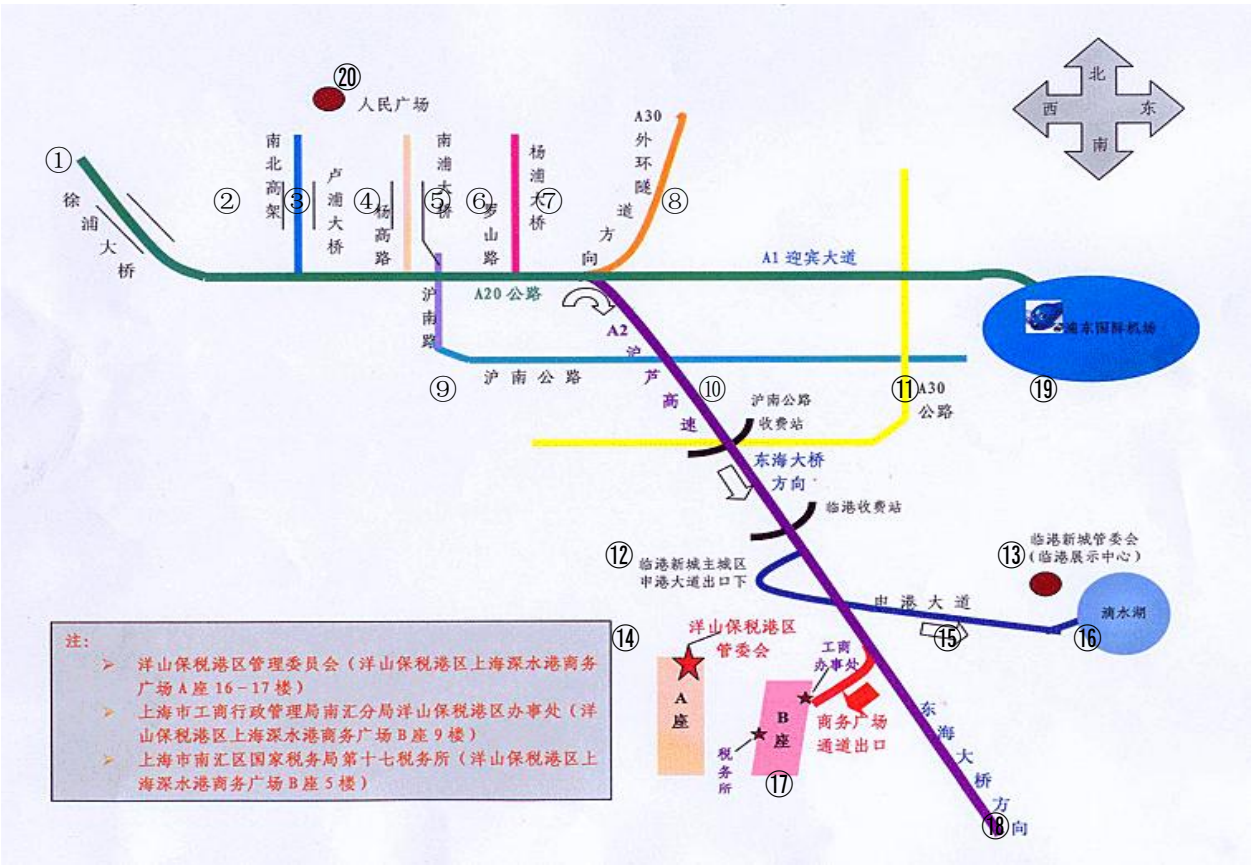

Figure 4-2 Yangshan Port Outer collection and distribution road Figure

Source: Shanghai Yangshan Deepwater Integrated Information Service

①：Xu Pu Bridge

②：North and South Express

③：Lu Pu Brideg

④：Yanggao Road

⑤：Nan Pu Brideg

⑥：Luoshan Road

⑦：Yang Pu Brideg

⑧：A30Outer Ring Tunnel direction

⑨：Hunan Road

⑩：A2 Luwei highway

⑪：A30 Road

⑫：Shengang Avenue exit in Lingang New City

⑬：Lingang New Town Management Committee

⑭：Yangshan Bonded Area Administrative Committee

⑮：Shengang Avenue

⑯：Dripping Lake

⑰：Business Plaza channel exit

⑱：Donghai Bridge direction

⑲：Pudong International Airport

⑳：People's Square

4.1.2 Waterway Subsystem

Shanghai Port Container Delivery waterway system includes the following ways:

1). the import and export of container land transport set Port, dock completed in Yangshan mention delivery box.

2). coastal feeder, feeder vessels within Jianghai direct carrier transit box, direct transport dock in Yangshan.

3). the Yangtze River in the regional carrier transit box, the "shuttle bus" to complete the lightering Yangshan Port and Waigaoqiao port area.

4). the international shipping routes conversion, the country round transit system conversion box, the "shuttle bus" to complete the lightering between Yangshan Port and Waigaoqiao Port Area in Yangshan wharf or direct transfer.

These four Container Delivery ways to form a Shanghai existing transit services.

It encompasses the coastal water of the transit, the Yangtze River in the regional transit, international transit and domestic transit. Strictly speaking coastal Shanghai, the Yangtze River in the regional transit, water of international transit transport infrastructure and transit constituted domestic equivalent to Hong Kong, Singapore single international transit mode.

(1). along the coast, the Yangtze River in the regional transit situation:

Coastal feeder service within Shanghai Yangshan Port include a total coverage of the 14 ports, mainly in Tianjin, Qingdao, Dalian and Lianyungang and other northern ports based. Coastal management is now a total of seven people, his ship 23, the loading capacity 11669TEU.

Yangtze inside leg total covering all major ports of the Yangtze River and its tributaries, the Xiangjiang River, Gan River and other watersheds, from Sichuan Luzhou, next to Taicang in Jiangsu Province, more than 30 ports, mainly in the Yangtze River in Nanjing, Zhangjiagang and Nantong port is the Lord. Now a total of 25 operators Yangtze, his ship 295, the loading capacity is 40078TEU.

(2). international transit situation:

Shanghai international transit as a key development target in the policy-oriented and rates have made absolute support, optimizing the environment for the port customs clearance mode, using imported a declaration, after the filing of the export shipment monitoring processes, greatly simplifies the international transfer clearance mode, so that the proportion of the annual international transit are gradually increasing. 2006 3.6% of the total in 2007 is expected to reach 5%.

(3). domestic transit situation:

Domestic transit mainly between inland and coastal ports Yangtze convert domestic demand items, in order to attract such containers to Shanghai transit, Shanghai on the basis of such containers carried on preferential rates, simplifying the

domestic transit in Hong Kong operating procedures, through a series of measures to improve the confidence of customers in Shanghai which relays promote the increase of such cargo tank.

Due to a series of policies and measures to make Shanghai an increasing proportion of transit boxes, rose steadily each year, from 16.7% in 1999 has increased to 36.3% in the first half of 2007, it showed a good momentum of development. As the world's third-ranked container port, Shanghai has formed a clear division of the three container terminals [22]: Yangshan Port, Waigaoqiao Port, Wusong Port. Work Division Yangshan Port is: the water of the main transit hub for Northeast Asian container transit port area; the division is positioned Waigaoqiao Port: direct hinterland container sources to support transit hub port area; Wusong Port the division position is: the domestic-based Container Port.

4.1.3 Railway subsystem

Shanghai is one of the country's main rail hub, is also an important railway transportation hub in eastern China, in the possession of the Shanghai Railway Beijing-Shanghai, Shanghai-Hangzhou two lines are connected with the national railway lines. Shanghai rail transport over the years, the railway transport of containers amounted to less than 1% of the total throughput of the port, Table 4-3:

Year	Railway set of sparse amount	Port Throughput	Throughput proportion accounted for
1998	2.05	306	0.67%
1999	3.56	422	0.84%
2000	4.41	561	0.79%

2001	4.39	634	0.69%
2002	5.98	861	0.69%
2003	7.49	1428	0.52%
2004	6.44	1455	0.44%
2005	5.31	1808	0.29%
2006	8.4	2171	0.39%
2007	10.32	2615	0.39%

Table 4-3 1999-2007 Shanghai Port Container rail set of sparse amount and proportion accounted for Port Throughput (Unit: ten thousand TEU)

Source: Shanghai Port Business

In conclusion

Situation container collection Shanghai international shipping center and distribution system are: recent road container collection and distribution system is still the whole container collection and distribution system in a large proportion, but the development trend, growth is slowing down, in Container Delivery system proportion has declined; railway container transportation and distribution system set to rise slowly in the box, the proportion of container collection and distribution system is still low, less than 0.5%; waterway container collection and distribution system, because promote the rapid development along the Yangtze River waterway transit container collection and distribution system in the proportion of the whole container collection and distribution system in the marked increase in the Yangshan Deepwater Port has also led to the development of international transit, transshipment and stable development of coastal areas, but the Yangtze River Delta region small IWT development lags behind.

4.2 The problems in Shanghai port collection and distribution system

4.2.1 the collection and distribution structure is irrational way

Shanghai Port Container Delivery System prevalent mode of transport structure is irrational, poor transport substitutability and other issues. Similar foreign ports, such as Rotterdam, Hamburg, Antwerp, Long Beach, etc, their roads, railways, waterways container transport generally in proportion 60:20:20. Currently, Shanghai Yangshan Port container throughput, road collection and distribution volume of more than about 85% of the total, the amount of water collection and distribution account for about 15% of the total, set sparse amount of less than 1% of the railway.

This over-reliance on a certain way of transport structure integrated transport system caused stability weakened, especially in the Yangshan Harbor Bridge as the only land passage for, if too dependent on car transport, once the bridge occurred emergency, will greatly affect the normal operation of Yangshan Port.

4.2.2 The problems in Shanghai collection and distribution of the subsystems

A. Highway Subsystem

(1) At present, Shanghai's entire road transport system has reached the point where crowded. To Waigaoqiao Port, for example, the number of daily collection and distribution of more than 5,000 motorcycles were set card. Way Inner Ring Elevated Road Zhoujiazui ramp-card access to about 500 per hour, resulting in a blockage of the Yangpu Bridge. After the outer opening of the tunnel, take the

Yangpu Bridge and the former East toro ferry massive transfer of card sets, card sets one hour through about 200 vehicles, opening only five days on a serious traffic jam.

(2) The annual traffic volume communicating Yangshan Port Donghai Bridge was 5,000,000 TEU, even by means of computer reservation, and other annual throughput of Yangshan Port of more than 10 million TEU, bottlenecks Donghai Bridge immediately evident. Due to the special nature of the location of the East China Sea Bridge, the climatic conditions and the general city bridges are very different, vulnerable to bad weather, the probability of occurrence of large fog, wind power is particularly large. Capacity Donghai Bridge is designed in accordance with the throughput of Yangshan Port on one side, while the long-term with the development Dayangshan Port, container berth will be further expanded, subject to the geographical conditions of the island, Yangshan road access capacity expansion is limited, they can not meet the needs of a large number of container collection and distribution.

B. sub-sea

(1) With the increase of water-water transit container volume of Shanghai Waigaoqiao dock capacity constraints, resulting in Shanghai and other barge feeder vessel takes a long time, increasing the number of berthing, directly affect the entire Shanghai transit collection and distribution, to become Hong Shui transit operation outstanding issues. In 2006, Shanghai water-water transit container volume increased by 1.92 million TEU, 53% of the total increment of such a large incremental shuttle bus transfer port brought great pressure, and the shuttle bus terminal operations branch occupies more leading to dock even more crowded.

(2) But there is disconnect between Shanghai and Shanghai inland shipping container hub port. River level is low, the structure is irrational, poor patency, navigation guaranteed rate is not high, no longer meet the needs of large ships and economic development. Inland container terminal construction is lagging behind,

container berth layout imperfect, docks scattered distribution, small-scale, handling technology, inadequate capacity is difficult to adapt to the container throughput growth.

C. railway subsystem

(1)Railway facilities with respect, international container rail transport technology and equipment level is not high. Less container transport special vehicles, the use of ordinary gondola, flatbed car on behalf of the widespread. Handling equipment behind, the lack of international container handling machinery. Container transport information systems to be developed. Major transportation corridor capacity is insufficient, the main channel of Shanghai Port International Container Railway collection and distribution of - capacity utilization Shanghai, the Longhai, Zhejiang-Jiangxi railway and other major long-term saturation, in restrictive state transportation.

(2)Currently Shanghai Port Container Terminal, mainly Terminals Waigaoqiao port (Yangpu Port Terminals and Military Road Station) and the recent completion of Yangshan Harbor pier no rail links, rail container trains can not go directly to port, and therefore sea Rail transport container via Shanghai port and out, must shuttle between the station to port. Such container transit in Shanghai than in Hong Kong, Qingdao, Shenzhen and other transit increased twice handling car and a lightering operation, not only the price is high cost, mainly reflected in rail freight, container truck drayage costs in terms of both goods was extended Hong Kong time, and increased rail transport convergence uncertainty.

Chapter V Shanghai port collection and distribution Network Optimization

5.1 Network optimization model

Port collection and distribution network based on port and freight transit station (especially inland freight station) is the node to connect ports and freight transport route network stations arc established. Therefore, optimizing the structure of the collection and distribution networks, on the one hand through the study of the freight station layout issues, a reasonable choice of building sites (this study does not involve the sitting of this section, so I will not elaborate); on the other hand, through the collection and distribution lines with flow studies to strengthen the collection and distribution network capacity.

(1) collection and distribution network planning model

Container transportation network planning level programming model can be used, according to the definition Kolstad (1985) and Boyce and Kim (1987), the bi-level programming model has the following form: UP Min F(x, y) （Top model） 5-1

S .t G(x, y)≤0

Where: y (x) calculated by the following formula （Lower model） 5-2

LOW Min f(x,y)

s.t g(x,y)≤0

The above model, set the value of the decision by the top decision-makers of the impact of lower variable x makers, therefore, the lower limit of the feasible constraint set makers, top decision-makers through lower policymakers policymakers

interact with the underlying objective function. Variable y is a function of the lower top makers decision variables x, i.e., y = (x).

Goal is to make the top model of the total cost of the collection and distribution network and investment costs are minimized; and the lower model is based on the collection and distribution network user equilibrium assignment model, allowing users to lower the top decision-makers in a given node and link the case of the ability to do their needs in line with the path selection behavior. Model established in this paper is for the top model, the underlying model is in the road network has been optimized for optimal route selection.

（2）Unity between ports, cargo terminals and transportation network with flow

Shanghai Port transportation network planning, comparing with Node (connections between ports and freight stations, warehouses and freight shippers transport routes between stations) restrictions on the collection and distribution network, limiting the node's performance more prominent. Collection and distribution network node that is the port and cargo terminal restrictions on collection and distribution, the performance of coordination of port and cargo terminal operations and management of cargo capacity, which is the collection and distribution of the relatively weak link, which is reflected in the handling jobs, job entry boxes, storage, inspection, etc. can practice time requirements and timely allocation of heat supply.

Collection and distribution lines, that is, from the beginning to the end O n D have transportation routes to choose from, each line has a certain amount of traffic that may be assigned, in a certain period of time, when all shippers have selected transport routes and transport modes, on the realization of the assignment of collection and distribution networks. Assignment may result in the collection and distribution network capacity to the extent permitted, may transport a mode of transport in one direction of flow can not meet the demand. When transport capacity

can not meet the traffic demand, the emergence of obstruction, on the one hand caused by redistribution of traffic on the collection and distribution network, so that certain traffic transferred to other alternative route; on the other hand, proposed restrictions strengthening the capacity of the road; to achieve volume distribution of homeostasis.

Port, cargo terminal and transportation network with a unified flow relationship, shown in Figure 5-1:

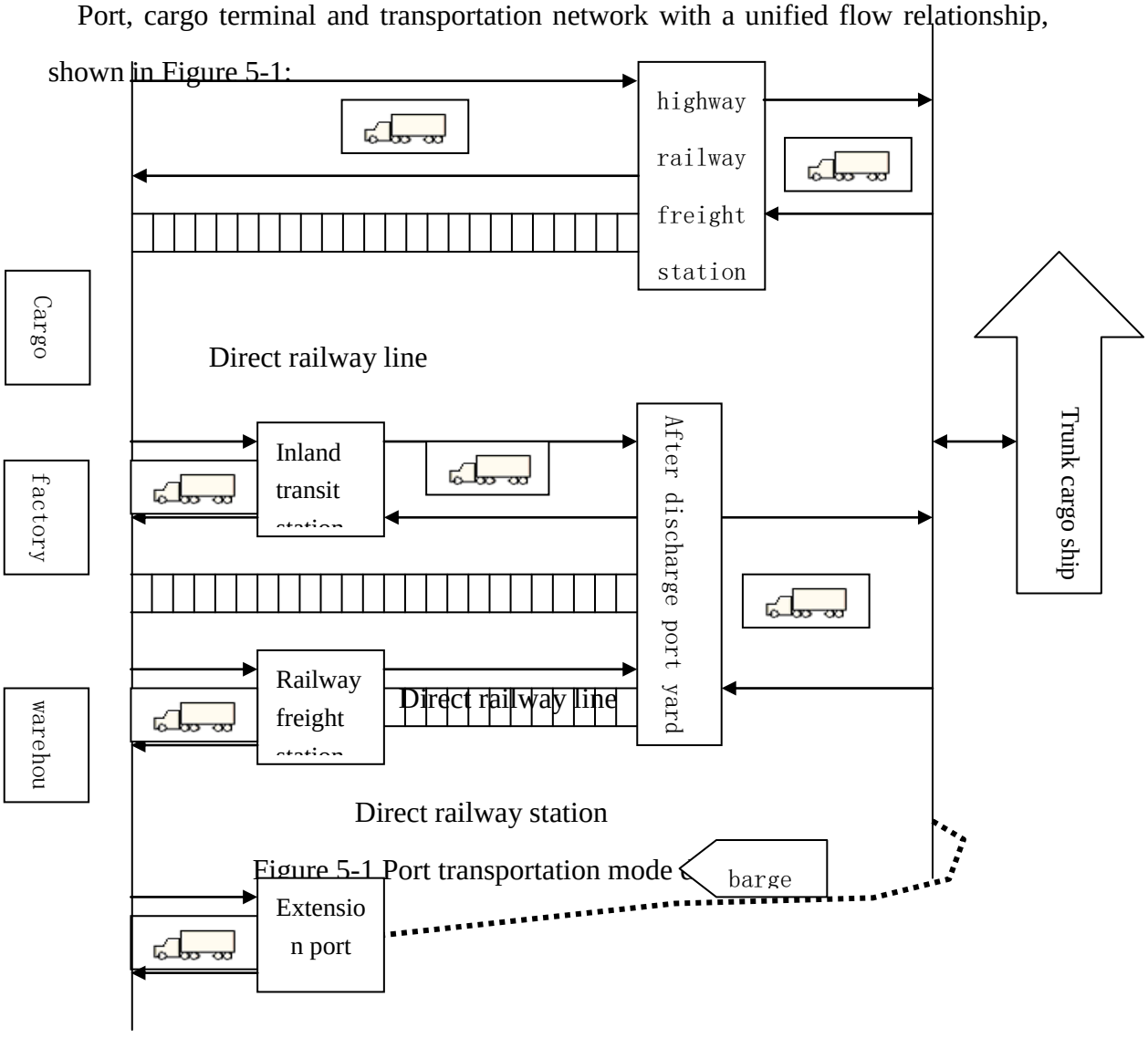

Figure 5-1 Port transportation mode

5.2 Case of Shanghai port

5.2.1 Identify assumptions

(1)Cargo terminal, transit and transport route choice and use unified consideration and analysis.

(2)Supposing Terminal layout has been identified, regardless of location.

(3)Generated from the transportation of the goods to the destination port of the main road, rail and water transport over short distances of three transportation modes.

(4) If railway and highway transportation volume within the design capacity of the selected line.

5.2.2 Optimization model for construction of container transportation system

According to ports, terminals and transportation network flow assignment of Unity (as shown in Figure 5-1), as well as assumptions, taking into account the actual situation, you can set up relay stations, lines costs, and cargo transport for minimum total cost optimization model, generates the best transportation system.

(1) physical description of Shanghai port container transportation system network

Port transportation system network nodes between two nodes on each one composed of multiple lines or parallel. Where each line represents a mode of transport, defining a connection for

(i,j,m) iN, jN, m M

Among them, I means start node; j means the end node; m between the i, j means a certain mode of transport available; n represents a collection of all nodes in the network; m represents a collection of all modes of transport in the network.

Assuming a transport network by x, y, and z of the 3 nodes, there are 3 available modes of transport: road, rail and inland waterway. X, y-3 way between the two

nodes available, x, z two transport between road, rail, and y, z Highway between modes of transport. Description of the network takes the form of Figure 5-2. Directional parallel straight line connecting two adjacent nodes, each line represents one possible mode of transportation.

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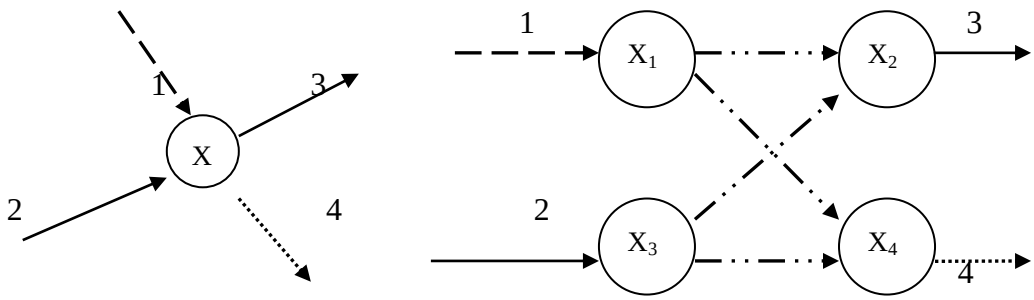
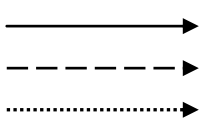
Above basic networking task separately for each mode of transport to complete its transport, that is, where no transport can be well described, but for those who must carry out multimodal transport, this network is not appropriate. The description and definition of the network use the extension.

Assume that any mode of transport between cohesion can only happen in transit hub, you can through the expansion of the transshipment point to solve this problem, as shown in figure 5-3. The basic approach is to change will occur the transshipment point (x), according to its inflow flow (1, 2) and flow (3, 4), split into two flows into the node flow (x1, x2) and two nodes (x3 and x4), and connected with the change in line, To form a nodes by inflow or outflow of cross-dressing extension node of the two parts.





highway

railway

waterway

change(multiplication)line： [1， 3] [2， 3] [1，4] [2，4]

figure 5-2 Node expansion diagram

5.3 Empirical Analysis

First, the relevant symbol appears in chapter V :(unified description of them)

① subscript

i----cargo generation, the owner of the factory or warehouse;；

j----inland freight station, transit station or branch in Hong Kong;

k----port of destination;

m----port cargo generating set to i;

n----collection and distribution network in mainland freight station set (hub or branch in Hong Kong) j of, nm;

y----numbers of ports k in collection and distribution network.

②decision variables

cgij----cargoes from i to j unit cost of road transport;

ctij----transport from i to j railway cargo transport unit costs

cgjk----cargoes from j to k unit cost of road transport;

ctjk----cargoes from j to k unit costs of rail transport;

csjk----cargoes from j to k of waterway transportation unit costs;

cgik----cargoes from i to k unit cost of road transport;

ctik----cargoes from i to k unit costs of rail transport;

Qi----Port cargo builds I may build, it consists of two parts,

Qij may need to be transported to inland freight station (transfer stations, feeder port)

of cargo;

Qik for cargo from shippers warehouse loading docks;

Qk----K cargo are transported to port terminals, consists of two parts: Qjk needs from inland freight station (transfer stations, feeder port) transport to the port freight volume, Qik for cargo fromport) transport to the port freight volume, Qik for cargo from shippers warehouse loading docks.

Aj----Inland freight station (transfer or extension Hong Kong) transit expenses;

QFS j max----Inland freight station (transfer station or branch in Hong Kong) FS maximum operational capability or capacity;;

QFSj----Inland freight station (transfer station) the amount of work FS breakeven point, that is the minimum amount of work;

The decision variables: If the goods from generation to transportation to the destination port terminals i k through inland freight terminal (or hub, Hong Kong branch) j, then xjik = 1, otherwise, xjik = 0; this is the objective function for solving the minimum of 0 -1 integer programming problem.

The objective function is

$$\min Z(x) = \sum_{i\in m}\sum_{k\in y}\sum_{j\in n}(((Q_{ij}^{g}c_{ij}^{g} + Q_{ij}^{t}c_{ij}^{t} + Q_{ij}^{s}c_{ij}^{s}) + (Q_{jk}^{g}c_{jk}^{g} + Q_{jk}^{t}c_{jk}^{t} + Q_{jk}^{s}c_{jk}^{s}))x_{ik}^{j}$$
$$+ (Q_{ik}^{g}c_{ik}^{g} + Q_{ik}^{t}c_{ik}^{t} + Q_{ik}^{s}c_{ik}^{s})) + \sum_{j\in n}\theta A_{j}(F(Q_{j}) \qquad 5\text{-}3$$

Constraints

$$\text{s.t} \sum_{j\in n} x_{ik}^{j} = 1 \qquad \forall i \in m, \forall k \in y \qquad 5\text{-}4$$

Freight Station opt transportation network by:

$$\theta = \begin{cases} 1 & F(Q_j) \geq Q_j^{FS} \\ M & F(Q_j) \prec Q_j^{FS} \end{cases} \qquad \forall j \in m \qquad 5\text{-}5$$

$$F(Q_j) = \sum_{i\in m}\sum_{j\in n}(Q_{ij} + Q_{jk})x_{ik}^{j} \qquad \forall k \in y \quad \text{M infinity} \qquad 5\text{-}6$$

Freight station (transfer station or branch in Hong Kong) has a maximum operating capacity or capacity restriction:

$$\sum_{i\in m}\sum_{j\in n}(Q_{ij}+Q_{jk})x_{ik}^{j} \le Q_{j\max}^{FS} \qquad \forall k \in y \qquad 5\text{-}7$$

Balanced by the number of supply and generation amount received port cargo volume

$$\sum_{k\in y}\sum_{j\in n}(Q_{ij}^{g}+Q_{ij}^{t}+Q_{ij}^{s})x_{ik}^{j}=Q_{ij} \qquad 5\text{-}8$$

$$\sum_{k\in y}\sum_{j\in n}(Q_{ik}^{g}+Q_{ik}^{t}+Q_{ik}^{s})=Q_{ik} \qquad 5\text{-}9$$

$$\sum_{k\in y}\sum_{j\in n}(Q_{jk}^{g}+Q_{jk}^{t}+Q_{jk}^{s})x_{ik}^{j}=Q_{jk} \qquad 5\text{-}10$$

$$Q_{ij}+Q_{ik}=Q_{i} \qquad Q_{ik}+Q_{jk}=Q_{k} \qquad 5\text{-}11$$

$$x_{ik}^{j}=(0,1) \qquad \forall i\in m \quad j\in n \quad k\in y \qquad 5\text{-}12$$

Shanghai has long been based on the supply structure of the Yangtze River Delta, accounting for more than 80% of the supply of Shanghai, where 30 percent of Shanghai Municipality; Jiangsu, 30%; 21% of Zhejiang Province; the Yangtze River region of 6.4%. Research for the sake of convenience, this paper select a few representative supply Shanghai port as a network node. Supply port: Chongqing, Hong Kong, Hong Kong and Wuhan, Nanjing, Hong Kong, Suzhou Port, Hangzhou, Jiaxing port; port of destination for the Shanghai Yangshan Port. As shown in Figure 5-4.

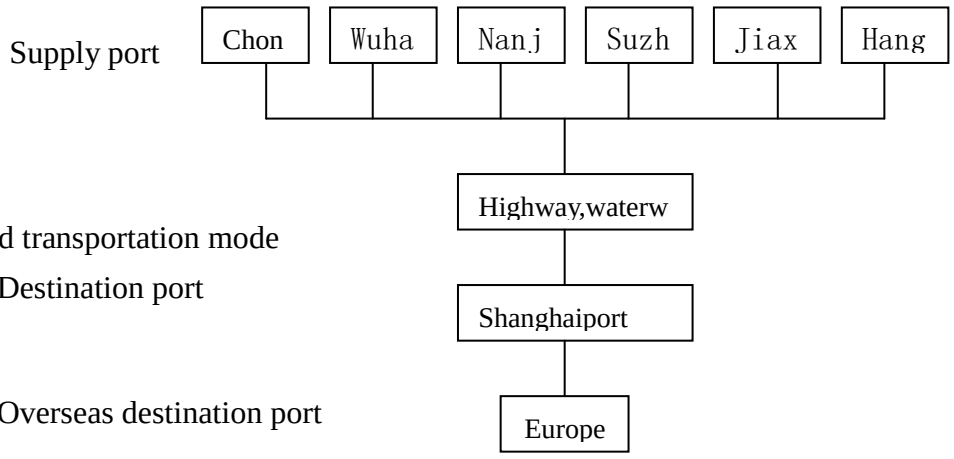


Figure 5-3 Shanghai port container transportation network structure

5.4 solution and analysis

5.4.1 basic data collection and collation

Table 5-1 Freight between the ports (unit: Yuan/box)

port	Yangshan			Nanjing			Chongqing		
	highway	waterway	railway	highway	waterway	railway	highway	waterway	railway
Yangshan	0	0	0	2500	600	800	20000	2500	3000
Nanjing	2500	600	800	0	0	0	11000	2200	2700
Chongqing	20000	2500	3000	11000	2530	2700	0	0	0
Wuhan	8700	1150	2700	5000	1100	800	9200	2100	1500
Hangzhou	1900	1300	600	2500	650	450	20000	4600	3200
Suzhou	1550	350	500	1500	500	290	22000	5000	3000
Jiaxing	1600	1100	520	2300	480	400	19200	4500	3000

port	Wuhan			Hangzhou			Suzhou			Jiaxing		
	highway	waterway	railway	highway	waterway	railway	highway	waterway	railway	highway	waterway	railway
Yangshan	8700	1150	2700	1900	475	350	1550	350	200	1600	1100	230
Nanjing	5000	1100	800	2500	650	450	1500	500	290	2300	480	400
Chongqing	9200	2100	1500	12000	4600	3200	22000	5000	3000	19200	4500	3000
Wuhan	0	0	0	5800	1300	900	8000	1800	1300	6500	1400	1000
Hangzhou	5800	1300	900	0	0	0	1000	200	220	400	100	120
Suzhou	8000	1800	1300	1000	200	220	0	0	0	380	110	120
Jiaxing	6500	1400	1000	400	100	120	380	110	120	0	0	0

Data sources: Speed railway container freight spreadsheet, the Ministry of Communications on the adjustment of the Yangtze River cargo freight (Note data 2007)

Table 5-2 The distance from the Waigaoqiao and Yangshan Port(Unit: nautical mile)

Port name	The distance from the Waigaoqiao	The distance from the Yangshan
Chongqing	1337	1405
Wuhan	605	673
Nanjing	214	282
Hangzhou	108	178
Suzhou	90	210
Jiaxing	122	53

Table 5-3 Each port container throughput in 2007（Million TEU）

Nanjing	Suzhou	Hangzhou	Jiaxing	Chongqing	Wuhan	Yangshan
105.6	189.55	5	3.72	33.8	26	610.8

Data sources：《Shanghai Port Statistical Yearbook 2007》

5.4.2 Modeling and solving

Based on the above data, the establishment of Shanghai Port Container Delivery Optimization Model:

$$\min Z(x) = \sum_{i=1}^{6} \sum_{j=1}^{5} \sum_{k=1} (((Q_{ij}^{g} c_{ij}^{g} + Q_{ij}^{t} c_{ij}^{t} + Q_{ij}^{s} c_{ij}^{s}) + (Q_{jk}^{g} c_{jk}^{g} + Q_{jk}^{t} c_{jk}^{t} + Q_{jk}^{s} c_{jk}^{s})) x_{ik}^{j}$$

$$+ (Q_{ik}^{g} c_{ik}^{g} + Q_{ik}^{t} c_{ik}^{t} + Q_{ik}^{s} c_{ik}^{s})) + \theta \sum_{j=1}^{5} A_j (F(Q_j) \qquad 5\text{-}13$$

In order to reduce the running time of LINGO program , taking into account the practical problems, here artificial make a rough optimization, such as Chongqing, Hong Kong as a transshipment port of discharge preferably queue program.

Different modes of transport determines the different transit costs Aj, in addition to the black point of different modes of transport and minimum volume of different, but also determines whether the j-point transit network can be introduced, but because the relevant data is not available, so the modelIt adopted a uniform transit fee, while the minimum volume and profitability from the point unified as a limit.

Finally using LINGO8.0 to solve(solving process, see Appendix I) the result are as follows:

Results from the optimization of data, from Chongqing to Yangshan select waterway and transit in Nanjing; Wuhan, Nanjing Yangshan is Jianghai direct; Hangzhou, Suzhou and Jiaxing by sea, accounting for about 60%, the rest to road transport to Yangshan. Highway Percentage from 86.2% (2007) down to about 40%,

the proportion of water from 13.3 percent to around 60 percent, due to the choice of supply in Hong Kong are more representative, the advantage of the railway could not very well reflected, but in the long term, should develop rail transport, especially in Chengdu, Zhengzhou, Xi'an and other places, sea and railway transport expanded by conducting the hinterland of Shanghai, to promote sustainable development of Shanghai international shipping center.

Analysis of the above optimization results, at an elevated ratio of water transport to reduce road traffic, improve rail transport in the case, the objective function has been optimized. It showed water-water transit, sea transit and other collection and distribution of iron way to have an important role in energy conservation.

In addition, Shanghai and Hangzhou Bay Bridge should also consider the impact of its collection and distribution mode after the completion of Sutong Bridge. Change will bring changes haul logistics costs, will affect the flow of the corresponding economic hinterland container supply further bring readjust stream channel.

Chapter VI Conclusions and Prospects

6.1 conclusions

In this paper, after reading a lot of literature, on the basis of previous studies, to cargo total transportation cost minimum as the goal, to explore port container in transportation system optimization method, and to Shanghai port container in transportation system were optimized.

Firstly to Shanghai port container set transportation system makes a comprehensive summary of, analysis of the Shanghai port container set transport

system present situation and the existing problems, through and the world famous shipping container center set transportation system of comparative analysis, obtained in recent years highway container in transportation system still in the container set system of transportation occupies a large proportion, collecting and distributing system of serious imbalance, the imbalance of the transportation system is not conducive to the sustainable development of Shanghai international shipping center, must optimize the Shanghai Port collecting and distributing system. And the optimization theory is applied to the container port collecting and distributing system, to cargo total transportation costs minimum established container port transportation system optimization model set, through the optimization model of Shanghai port set and distributing system for empirical analysis, it is concluded that the Shanghai port container transportation should pay attention to develop Jianghai direct, the Haihe river reach and the conclusion of rail sea intermodal transport.

Due to limitations of time and the research condition, we in the empirical analysis of Shanghai port and selects only the several representative source port has carried on the preliminary discussion, no analytical advantages for the development of rail sea intermodal transport of Chengdu, Anhui and other places, need to be more in-depth study in the future work and study.

In addition, this study only for Shanghai port set transportation system study and didn't give consideration to both the multiple port adjacent and a region. Only ports integration can play its overall competitiveness, and the integration of the port collecting and distributing system is one of the key points. Will all the ports in the region as a whole is optimized, comprehensive prediction set of transportation demand, a comprehensive analysis of the set and distributing network, considering transportation cost, can fully reflect the port cluster particularity of transportation system integration.

6.2 Development recommendations on collection and distribution of Shanghai port

6.2.1 Speed up the construction of Shanghai inland waterway, to develop Shanghai Inland Container Transportation

WT has well-known advantages, in a limited capacity on Shanghai's urban road traffic, the development of Shanghai inland container transport is very important. Although Shanghai has a dense inland waterways, and through inland river network in Jiangsu, Zhejiang and the Yangtze golden waterway connecting the Beijing-Hangzhou Grand Canal, constituting over Yangtze River Delta, Yangtze River Delta constitute waterway transport network extending in all directions. But the current low level of Shanghai inland waterways, navigation-building many poor port facilities along the river, inland container ships are not standardized, Shanghai inland container transport lagged behind demand, there is no Shanghai collection and distribution system in one mode of transport. After the Yangshan Port Operations, Shanghai attracted the attention of inland container transport in the port sector, this is because, to carry out inland container transport Shanghai Shanghai city can not only ease urban traffic pressure, but also by river transport to the Yangtze River and Shanghai reasonable diversion between some goods that inland shipping container hub port collection and distribution has become an indispensable party

Type, therefore, accelerate the construction of Shanghai inland waterway. Shanghai inland container transport has been carried out is to improve the Shanghai International

The objective needs of container hub port collection and distribution network.

6.2.2 rapid development of a sea container rail transport, expanding the Shanghai hinterland

Collection and distribution of land in Shanghai are becoming nervous at the same time, as a vital waterway railway collection and distribution methods, the proportion is very small. Central and western China development, built in Shanghai's Yangshan Port, Shanghai Port ambitious future development in the 21st century to change the status quo of Shanghai Port Container rail transport to create the conditions. This is because the first, large open central and western China in the ascendant strategy, Yangshan Port to attract sources Midwest, expanding the port hinterland, improve competitiveness of the port, sea and railway transport must be developed. Second, the port capacity with the construction of Shanghai Yangshan Port and continuous improvement to meet the greater amount of container imports and exports; hence the need to expand the economic hinterland, that is, except the Yangtze River Delta, but also extends to Hubei, Hunan, Chongqing and Sichuan Yangtze River region, while rail transport is a high volume, ideal for long-distance transport of goods; and third, the development of Yangshan Port and rail transport in these areas, we can improve the way integrated collection and distribution of Yangshan Port, more split hinterland container, reduce road collection and distribution of dependence; fourth, and the completion of the construction of Shanghai Pudong railway construction along the railway to Shanghai to carry out sea and railway transport to create the preconditions.

6.2.3 Improve the Yangshan policy, expanding the proportion of water-water transit Yangshan Port

To build an international hub port, Yangshan port must effectively increase the proportion of water of international container transit tank. In the current international container port in the highly competitive market situation, the key to improve the proportion of Yangshan Port international container transit port is a policy to achieve liberalization. Although the central government has approved the Port of Yangshan Bonded Port, but the openness policy follows the "Hong Kong-Zone Interaction" model that still exist with the international free port policy compared to the gap. In order to adapt to the international port competition, early completion of the Shanghai international shipping center, the new Yangshan Port needs to break the policy, the use of international standards and the Freeport mode, first create a new model for the new century, the development of ports in China. For this reason, it is recommended to further deepen the bonded port policy to improve the openness of Yangshan Port, comprising: a first bonded port area expanded to cover Yangshan Port berths, to reduce international container into

6.2.4 Rational division of labor and coordinated development of an integrated transportation system to achieve various modes of transport

Basic features integrated transport system is the mode of transport in accordance with its unique technical and economic characteristics, the division of labor and cooperation of both organic whole. On the one hand, various modes of transport has

its own advantages, objects and services are also different. For example, water is characterized by the railway transport capacity, low transport costs, road with fast, flexible, mobile, door to door transport characteristics. On the other hand, various modes of transport at the same time there is competition and complementary features. As long as it closely, you can make the transportation system more advanced, create better conditions for economic take-off base support, so that the product was reduced transaction costs, and enhance the potential for economic development. To this end, we must strengthen the system of consciousness, noting that various modes of transport differences and complementarity, so that what they want, the exhibition director, eventually forming a high overall efficiency of the national transportation system.

6.2.5 Establishing a sustainable transport system

From a sustainable development point of view, due to external conditions, environment and resources, social transport demand is unlikely to grow indefinitely. When supply exceeds the growth of the transport capacity of the environment in the region, the conflict between mobility objectives and environmental objectives into transport on the main contradiction transport activities, after transport followed them into the transportation stage. After first developing countries of the old ways of governance to our lesson is that we must be more conscious of protecting natural resources and the environment at the same time achieve economic development. Adhere to the ideological transport sustainability, it is for Shanghai's economic and social sustainable, rapid, healthy and coordinated development of material foundation. Therefore, the government should adopt some of the rational means to guide people to consciously adjust consumer attitudes and travel behavior ways: First, with the actual situation to establish an integrated transport system to adapt and

optimize traffic patterns to achieve in the structure; the second is to create the conditions and encourage people to use less resource-intensive modes of transport, such as rail, sea transport; third is to continuously promote technological advances in transportation industry.

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Appendix 1

```
model:
title Route Optimization, Cost minimization;

!================;
Here is the definition of a collection;
!================;
sets:

Source / NJ,CQ,WH,HZ,SZ,JX /:QS,QS_Jmax;           ! QS for each possible source of goods production, the maximum throughput for F_Sita oriented around yangshan;

Middle / NJ,CQ,WH,HZ,SZ,JX /:QM, QM_Jmax, Q_Jmin, F_Sita, A_Cost,Sita,X;    ! QM for each transfer station of the goods, X value for the decision-making variables (0, 1), A_Cost transfer unit standard box fee;

! Q_Jmax maximum transport capacity. Q_Jmin minimum amount of shipment (or turnaround point), the maximum throughput for F_Sita oriented around yangshan; Destination / YS /:QD;        ! QD for the purpose of port acceptance of goods;

CommA(Source,Middle):Q_sm,Fee_GL0,Fee_SL0,Fee_TL0,Q_GL0,Q_SL0,Q_TL0;        ! Establish supply to the transfer station set, Q_sm defined as the amount of delivery to the transit station
CommB(Middle,Destination):Q_md,Fee_GL1,Fee_SL1,Fee_TL1,Q_GL1,Q_SL1,Q_TL1;   Set up a transfer station to the destination port;
CommC(Source,Destination):Q_sd,Fee_GL2,Fee_SL2,Fee_TL2,Q_GL2,Q_SL2,Q_TL2;   ! A collection of goods to the destination;
Comm_ALL(Source,Middle,Destination)
/
 NJ,NJ,YS   NJ,CQ,YS   NJ,WH,YS   NJ,HZ,YS   NJ,SZ,YS   NJ,JX,YS
 CQ,NJ,YS   CQ,CQ,YS   CQ,WH,YS   CQ,HZ,YS   CQ,SZ,YS   CQ,JX,YS
 WH,NJ,YS   WH,CQ,YS   WH,WH,YS   WH,HZ,YS   WH,SZ,YS   WH,JX,YS
 HZ,NJ,YS   HZ,CQ,YS   HZ,WH,YS   HZ,HZ,YS   HZ,SZ,YS   HZ,JX,YS
 SZ,NJ,YS   SZ,CQ,YS   SZ,WH,YS   SZ,HZ,YS   SZ,SZ,YS   SZ,JX,YS
 JX,NJ,YS   JX,CQ,YS   JX,WH,YS   JX,HZ,YS   JX,SZ,YS   JX,JX,YS
/
:Q_Gonglu,Q_Shuilu,Q_Tielu,Fee_G,Fee_S,Fee_T;
endsets

!================;
! The following is the data assignment;
!================;
```

```
data:
Fee_GL0 = 0       11000 5000 2500  1500  2300
          11000   0     9200 12000 22000 19200
          5000    9200  0    5800  8000  6500
          2500    12000 5800 0     1000  400
          1500    22000 8000 1000  0     380
          2300    19200 6500 400   380   0;

Fee_SL0 = 0       2530  1100 650   500   480
          2200    0     2100 4600  5000  4500
          1100    2100  0    1300  1800  1400
          650     4600  1300 0     200   100
          500     5000  1800 200   0     110
          480     4500  1400 100   110   0;

Fee_TL0 = 0       2700  800  450   290   400
          2700    0     1500 3200  3000  3000
          800     1500  0    900   1300  1000
          450     3200  900  0     220   120
          290     3000  1300 220   0     120
          400     3000  1000 120   120   0;

Fee_GL1 = 2500    20000 8700 1900  1550 1600;

Fee_SL1 = 600     2500  1150 1300  350 1100;

Fee_TL1 = 800     3000  2700  600  500  520;

Fee_GL2 = 2500    20000 8700 1900  1550 1600;

Fee_SL2 = 600     2500  1150 1300  350 1100;

Fee_TL2 = 800     3000  2700  600  500  520;


Fee_G = 2500  31000 13700 4400  3050  3900
        13500 20000 17900 13900 23550 20800
        7500  29200 8700  7700  9550  8100
        5000  40000 14500 1900  2550  2000
        4000  42000 16700 2900  1550  1980
        4800  39200 15200 2300  1930  1600;

Fee_S = 600   4700  2150 1125 850  1580
        3130  2500  3250 5075 5350 5600
        1700  4600  1150 7700 2150 2500
        1250  7100  2450 1300 550  1200
        1100  7500  2950 675  350  110
        1080  7000  2550 575  460  1100;
```

```
Fee_T = 800  5700  3500 800  490   630
        3500 3000  4200 3550 3200  3230
        1600 4500  2700 1250 1500  1230
        1250 6200  3600 600  420   350
        1090 6000  4000 570  500   350
        1200 6000  3700 470  320   520;

QS_Jmax = 1050000 330000 260000 50000 1896000 37000;
QM_Jmax = 1050000 330000 260000 50000 1896000 37000;

Q_Jmin = 100 100 100 100 100 100;

A_Cost = 400 400 400 400 400 400;!##################TBD Value A_Cost :The cost of each
transfer station is different, here is temporarily unified for 400 yuan / unit;
@text()=@status();

enddata

!================;
! The following is the target function:
!================;
min = @sum (CommA(i,j):(Q_GL0(i,j)*Fee_GL0(i,j) + Q_TL0(i,j)*Fee_TL0(i,j) +
Q_SL0(i,j)*Fee_SL0(i,j))*x(j)) +
    @sum (CommB(j,k):(Q_GL1(j,k)*Fee_GL1(j,k) + Q_TL1(j,k)*Fee_TL1(j,k) +
Q_SL1(j,k)*Fee_SL1(j,k))*x(j)) +
    @sum (CommC(i,k):(Q_GL2(i,k)*Fee_GL2(i,k) + Q_TL2(i,k)*Fee_TL2(i,k) +
Q_SL2(i,k)*Fee_SL2(i,k))) +
     @sum( Middle(j):F_Sita(j)*A_Cost(j)*Sita(j)*x(j));

!================;
! The following are all kinds of constraints;
!================;
! Freight station selected collection and distribution network conditions;

@for(Middle(j):Sita(j) = @if(F_Sita(j) #ge# Q_Jmin(j),1,M));

@for(Middle(j):F_Sita(j) = @sum(CommA(i,j):Q_sm(i,j)) +
@sum(CommB(j,k):Q_md(j,k))*x(j));

! Maximum operating capacity of freight station;

@for(Middle(j):QM(j)*x(j) <= QM_Jmax(j) );
@for(Source(i):QS(i) <= QS_Jmax(i));

! Balance of quantity and quantity of goods received in port;
```

```
@sum(CommA(i,j):Q_sm(i,j)) =
@sum(CommA(i,j)|i#ne#j:(Q_GL0(i,j)+Q_SL0(i,j)+Q_TL0(i,j))*x(j));
@sum(CommB(j,k):Q_md(j,k)) =
@sum(CommB(j,k):(Q_GL1(j,k)+Q_SL1(j,k)+Q_TL1(j,k))*x(j));
@sum(CommC(i,k):Q_sd(i,k)) = @sum(CommC(i,k):(Q_GL2(i,k)+Q_SL2(i,k)+Q_TL2(i,k)));

@for (CommC(i,j):Q_sd(i,1) + Q_sm(i,1) + Q_sm(i,2)+Q_sm(i,3) + Q_sm(i,4) +Q_sm(i,5)
+ Q_sm(i,6)= QS(i));
@for (CommB(j,k):Q_md(j,1) + Q_sd(2,1) + Q_sd(3,1) + Q_sd(4,1) + Q_sd(5,1) + Q_sd(6,1)
+ Q_sd(1,1) = QD(1));

!Definition M is infinite;
M = 9999999999999;

To define the minimum demand (or maximum currency) of the port of destination;
R = 15000000;
R = @sum(CommB(j,k):Q_md(j,k)) + @sum(CommC(i,k):Q_sd(i,k));

Define 0-1 X variable:
@for(Middle(j): @bin(x(j)));
```