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Study on grade evaluation of port shoreline in Jiangsu Province

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Study on Grade Evaluation of Port Shoreline in Jiangsu Province

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DECLARATION

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

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

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ABSTRACT

Port shoreline is not a kind of non-renewable resource, which possesses the attribute of both nature and society. It is also a very important kind of strategic resource to develop shipping industry and accelerate foreign trade and economic development. In China, there are lots of problems in port shoreline; especially that such resource is not made full use. Because of wasting, there is not enough port shoreline for us. In order to make full use of the port shoreline, the author tend to make it into Grade for management.

Port shoreline grade evaluation model is a basic work of its utilizing plan. What is more, it is an essential part of port comprehensive layout plan. This research is due to the involved practice. In chapter 2, the author analyse current situation of port shore line. Establish port shoreline grade evaluation model in chapter 3. Then, apply the model in practice and give some suggestions of port shoreline development.

The appraisal to the grade of port shoreline is a basic research for providing reference information to plan the ports actually. As a complicate system appraising process and an issue of multiple-element appraising, it covers many appraisal indexes and judgment elements. This article has researched it deeply. So the decision makers could take it as a reference when they make decisions. The qualitative and quantitative calculations shall be done further when the information is used practically in future so as to get a more rational conclusion.

Key words: Analytic hierarchy process(AHP), Development suggestion, Port shoreline, Port shoreline grade evaluation model,

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Chapter 1 Introduction

1.1 Research Background

Port shoreline is the non-renewable resource with the natural & artificial double natures, and is also the main strategic resource for developing the shipping business, promoting the foreign trade, and ensuring the economic development.

1.1.1 China Owns the Abundant Port Shorelines

China has abundant port shorelines with over 18000 km continental shoreline and over 14000 km on the islands shoreline along the coast, including big amount of deep-water port shorelines, and China have the natural heritages and long-lasting history of relying on the port shoreline to develop the water transportation.

1.1.2 Achievements in the Development of Port Shoreline in China.

Since the Reform & Opening-up, the coastal and riverside areas in China, with their geographic advantages and relying on their good port shoreline, have made great efforts to enhance the port construction, and promote the development of port-adjacent industries, and develop the foreign trade actively, and the great development of the port shoreline has promoted the big improvement of the regional economy.

1.1.3 Problems in the Development of Port Shoreline in China.

As the development and utilization of port shoreline, a great number of port shoreline, especially the deep-water shorelines, have suffered the damages and wastes in different levels.

The problems including the port shoreline impropriated for other purposes,

deep-water lines used in shallow areas, using dispersedly, disorderly appropriation and use, more appropriation but less uses and even no use, etc. are all existing, which causes the port shorelines do not or are difficult to have functions they should have had, and makes the coastal areas in China lack the port shorelines with the good development conditions and the distribution of them is very unbalanced. The prospect is not so optimistic.

1.2 Research Purposes

The research on the current situation and the development measures for the port shorelines is an important basic work for planning the the port shoreline, and the planning for port is also an important composition part of the overall layout planning of port. Only with the scientific research, can it provide the scientific references for the planning of port shoreline, thus to reduce the phenomena like the port shoreline impropriated for other purposes, deep-water lines used in shallow areas, using dispersedly, disorderly appropriation and use, more appropriation but less uses and even no use, etc. , which will cause the increasing decreases of the good port shorelines for further development, and ensure the sustainability of the development of port shorelines and the port construction. This research is right the basic research work completed for providing the references for the practical works of port planning and port shoreline planning.

1.3 Research Methods:

Before the Reform & Opening-up, most of shorelines in China were used for free. But as the economic development, the important status of port has been more and more prominent, and the advantages for the enterprise production and transporting activities by shorelines are also more and more obvious. It has been very urgent to

solve the problems existing in the shoreline utilization due to the historical reasons. The prior problem is to find a comprehensive method for comprehensively assessing the utilization efficiency of the shorelines.

The root causing the contradiction in the shoreline utilization is still lacking a complete set of the evaluation system for the utilization of shorelines, and shorelines evaluation have not been used in a periodic manner, to promptly master the utilization information of the shorelines, causing some shorelines are unused and wasted. Within the scope of the whole country, there still has been no any port that has evaluated the utilization situation of the shorelines that have been used.

At present, the evaluation for the utilization efficiency and achievements of the shorelines is still restricted in the qualitative analysis, and the analysis is also not comprehensive enough.

After the research and argumentation by the author, the conclusions are: Theoretically, after the proper modification, the coordinating degree function method and the efficiency function method both can be used to evaluate the utilization efficiency & achievement of the shorelines. But, due to there are very few researches on the evaluation for the utilization efficiency & achievement of shorelines at home and abroad at present, plus, restricted by the survey & research conditions and the completing deadline of the paper, many materials, like the data, are all very difficult to be obtained. Based on the ambiguity of the research, this paper plans to select the AHP method, to initially explore the evaluation method for the port shoreline.

1.4 Literatures Review

There are very few researches specialized in the evaluation of shorelines at home and abroad, and most of the researches can be found in the related research reports like the port planning, port evaluation and the function area classification of the ocean, etc. In general, the researches on the shoreline evaluation are mainly in the following research fields:

1.4.1 Current Situation of the Evaluation Research on the Coast Belt

The research on the coast belt is mainly generated due to two reasons: ① Mr. Ren Meie in the article *Discuss the homeland treatment problem in the coastal belt in China*(1985). Armstrong,J.M mentioned in *US Marine Administration* (1986.) , and Mr. Chen Zhongkang in the article *Initial exploration for the development strategy of coastal belt in Hebei Province"* (1987) ,The concentration of the industrial layout towards the scope of the coast belt causes the intense land use in the coast belt, and the deterioration of coastal ecology and environment, which have urged the governmental entities and scientists to attach importance to the research on the coast belt management [1] ② The global climate changes, the increased frequencies and degrees of natural disasters have urged people to carry out the research on the frequency and hazard level of the disasters with the coast belt, a area with the high population density and the concentrated productivity layout. The main research contents in the former include the legislation for coast belt, resource survey in the coast belt and the ocean function area classification, and the research contents of the latter mainly include the ocean level rise, the vulnerability assessment for the coast, as well as

[1] Mr. Ren Meie (1985). Discuss the homeland treatment problem in the coastal belt in our country. Encyclopedic Knowledgee, N7

Armstrong,J.M (1986.5.16). US Marine Administration [M].China ocean press, pp22～23

Mr. Chen Zhongkang (1987). Initial exploration for the development strategy of coastal belt in Hebei Province. Geography and Territorial Research, N3

the invasion of salty water, etc. The researches relating to the shoreline mainly have two parts of contents: The one is the ocean function area classification, Mr. Ji Zixiu in the article *Possible impacts for the erosion of seacoast in Changjiang Delta and Seaside Plain Coast in North Jiangsu Province by the raised sea level*(1993). Guangdong Provincial Working Team for Ocean Function Area Classification in the article *Ocean Function Area Classification in Guangdong Province*(1991) mainly makes the comprehensive evaluation for the coast, the resource combination situation in the close sea areas, the types and the quality of the advantageous resources, or the evaluation for the individual item of the resources, and based on the survey & evaluation for various types of resources, to classify the coast and the close sea areas into several function areas according to their resource combination situations, to serve the sea development. Since 1990s, all the coastal provinces and even the whole country have successively completed the ocean function area classification in their corresponding areas[2]. But in the ocean function area classification, it did not separate the specific shorelines to be evaluated, but merged them into other resources, and some of them were evaluated as space resources, and some were evaluated as land resources, and the evaluations also mainly were the ordinary qualitative evaluations, not forming the independent and systematic evaluation for the individual item of resources. The other research is the coast classification evaluation research relating to the vulnerability assessment, and the typical work is the *Degree measurement model for the types and their vulnerability and risks of the coasts in Southern Marche (Italy)* (1994) by R. D. Cin and U. Simeoni3, and the authors of this paper classifies the coasts for 70km long in the research area into 24 coast segments, and have researched the hydro dynamics and energy

[2] Mr. Ji Zixiu (1993). Possible impacts for the erosion of seacoast in Changjiang Delta and Seaside Plain Coast in North Jiangsu Province by the raised sea level Acta Geographica Sinica,N6

Guangdong Provincial Working Team for Ocean Function Area Classification. Ocean Function Area Classification in Guangdong Province. Science press，1991．46～53.

characteristics, the silting length level on the beaches, the forms and sediment situations of the tides and the beaches as well as the affecting level by human beings in various coast segments, and they have set up 15 variables reflecting the characteristics of the foresaid coasts, and by analyzing the main components and the clustering of the 24×15 matrix comprised of 24 coast segments and 15 variables, they have researched the interrelations between the variables, and carried out the classification of coasts, and established the model to measure the vulnerability and risks of various types of coasts. The value of this paper is: It provides a method worthy for reference for the stability assessment of the shoreline.[3]

1.4.2 Research on Planning for Shoreline in the Port Cities

Forward C.N in the article *Waterfront land use in the six Australian state capitals* (1970) emphasize that, In the port planning, with the factors affecting the port development as the main parameters, use the shorelines as the environmental condition for port development to be evaluated, and besides considering the necessary natural properties of the shoreline (Such as the water depth condition), the evaluation and the utilization planning for the shoreline mainly consider from the perspective of the urban development.[4] Shoreline evaluation mainly considers from the engineering & technology conditions of the shoreline, and the evaluation factors mainly are the water depth condition and the stability of the shoreline, and the evaluation method is mainly qualitative, supplemented with the certain quantitative analyses. At the same time, the cognition for the shorelines has been further deepened, to have the utilization planning research for the shoreline as the relatively

[3] Cin R.D. and Simeoni U(1994). A model for determining the classification, vulnerability and risk in the southern coastal zone of the Marche (Italy) [J]. Journal of Coastal Research, N7.
[4]Forward C N(1970). Waterfront land use in the six Australian state capitals. Annals of the Association of American Geographers

independent resource, which is specifically reflected as: Mr. Zhang Qianyi in the article *Exploration for the several problems in the planning for the use of coastlines in seaside cities*(1998) uses the shoreline utilization planning as a specific planning in the overall planning of the port, emphasizing the resource concept of the shoreline, believing the shorelines are very limited, and when the shoreline is planed, it should be reasonably used, comprehensively deploy the various kinds of constructions for the shorelines that can be used, to implement the sustainable development of the economy and the society.[5] This field is the field with the relatively more researches on the shoreline carried out besides the geographic community at present, where there are many research considerations and ideas worthy for learning from, but due to their research scope is only limited in port cities, and most of them are seaport cities, the research scope seems small for forming the shoreline research with the geographic significance.

1.4.3 Research on the Evaluation of the Shoreline on Freshwater

This field treats the freshwater shoreline as a kind of special resource to be specifically evaluated. This research is mainly carried out in China, starting from 1989. In 1989, Nanjing Geographic & Lake Research Institute in China Science Academy and Jiangsu Provincial Planning Committee cooperated completing the *Comprehensive report for the homeland planning in the areas along Changjiang River in Jiangsu Province* and this "Report" has specifically listed out the shorelines on Changjiang, and comprehensively evaluated them. According to the silting situation of the shorelines, they are classified as three types of natural shorelines of eroded shoreline, silted shoreline and stable shoreline, and at the same time, they have drawn the brief chart for the shorelines and utilization situation on Changjiang

[5] Mr. Zhang Qianyi (1998), Exploration for the several problems in the planning for the use of coastlines in seaside cities [J]. City Planning Review， N 2

River in Jiangsu Province. [6]This is the evaluation work specifically aiming at the freshwater shorelines for the first time in China. In 1991, based on the foresaid works, Mr. Yin Guoxing applied the quantitative analysis means, completing the Master's degree graduation paper of *Research on the adaptability evaluation of the shorelines on Changjiang River in Jiangsu Province*(1991). In focus, the paper carried out the adaptability evaluation for the ports, and according to the analysis for the affecting factors for the port construction, he selected seven evaluation factors as the main factors of the adaptability evaluation of port construction with the shorelines on Changjiang River in Jiangsu Province, and through the qualitative and quantitative analyses, he classified the shoreline segments that are appropriate, close to be appropriate and not appropriate for port construction. In addition, Mr. Yin Guoxing has also carried out the initial evaluation analyses for the bridge layout and the adaptability of the industrial layout on the shorelines in Jiangsu. This is the research works specifically for the evaluation of the freshwater shorelines that are relatively detailed and comprehensive in China at present.[7] During 1992 till 1994, the R & D personnel in Map Department in Nanjing Geographic & Lake Research Institute completed the shoreline drawings for the locations in Jiangsu, Anhui, Jiujiang and Shanghai, etc, and according to the shoreline stability, these drawings classifies the shorelines into three natural types for being stable, erosion and silting., and also according to the frontline water depth on the shoreline, they classifies into three natural types of deep water, medium deep water and shallow water. This is the specific freshwater shoreline drawing officially in a map form for the first time in China. In 1997, Nanjing Institute cooperated with Jiangsu Provincial Planning Economic Committee, proposing the research report of *Current situation and*

[6]Nanjing Geographic & Lake Research Institute in China Science Academy, Jiangsu Provincial Planning Committee (1989) *Comprehensive report for the homeland planning in the areas along Changjiang River in Jiangsu Province*

[7] Mr. Yin Guoxing(1991). Evaluation for adaptability of port construction on the coastline of Changjiang River in Jiangsu Province. Master's degree paper in China Science Academy

evaluation for utilization of shorelines on Changjiang River in Jiangsu Province. In this report, they selected the three evaluation indexes of water depth in front of the shoreline, the shoreline stability and the width of shipping route water area in front of the coast, carrying out the evaluation for development conditions of shorelines on Changjiang River in Jiangsu Province, and classifying the quality of the shorelines. At the same time, for the first time, this report applies the GIS means calculating the total length and the classification length of the shorelines on Changjiang River in Jiangsu Province, initially setting up the administration system for the shorelines in Jiangsu Province.[8]

Besides Jiangsu Province, in 1996, Anhui Provincial Planning Committee and Anhui Provincial Geological & Mineral Bureau applied the remote sensing means carrying out the analysis for the shoreline stability and properties for the shorelines on Changjiang River in Anhui Province, and for the results, please refer to the book of *Research on remote sensing application for homeland resources in Anhui Province* [9] In addition, since 1980s, the in-depth researches on the river route forms and evolution characteristics on the medium-lower stream on Changjiang River by related scholars have provided the theoretical background and method references for the evaluation of the shoreline stability.

Next, author conclude the main characteristics of the research on the evaluation of the freshwater shorelines in China:

(1) Ordinary evaluation for the shorelines

[8] Nanjing Geographic & Lake Research Institute in China Science Academy and Jiangsu Provincial Planning Committee, Jiangsu Provincial Planning Economic Committee (1997), "Current situation and evaluation for the utilization of coastline resources on Changjiang River in Jiangsu Province"

[9] Anhui Provincial Planning Committee, Anhui Provincial Geological & Mineral Bureau (1996), The research on the application of remote sensing for homeland resources in Anhui Province.

Represented by the researches by the scholars including Mr. Yu Xiaogan, etc. As one of the initiators of the research on the freshwater shorelines in China, Mr. Yu Xiaogan has launched the freshwater shoreline research, in the article *Situation and countermeasures for the sustainable development in the Changjiang River Delta area(2005)* carry out the ordinary evaluation research for the shorelines on Changjiang River in Jiangsu Province. Later on, he has expanded his research scope to the whole lower-stream area on Changjiang River (Including the trunk-stream areas on Changjiang in Jiangxi, Anhui, Jiangsu and Shanghai), and evaluated and analyzed the gross of the shorelines, the lengths of the shorelines in different segments and the possibilities and potentials of shoreline development in segments in this area.[10]

(2) Classification evaluation for shorelines

Represented by the *Current situation and evaluation for utilization of shorelines on Changjiang River in Jiangsu Province* proposed in cooperation between Nanjing Geographic & Lake Research Institute and Jiangsu Provincial Planning Economic Committee in 1997. This research selects three factors that reflect the most basic natural properties of the shorelines, including the water depth in front of the shoreline, shoreline stability and the shipping route depth in front of the coast as the evaluation parameters, to classify each parameter into three levels, and carried out the evaluation for the development conditions of the shoreline according to the restriction principle, and according to the comprehensive quality of the shoreline segment evaluated, classified the shorelines on Changjiang River in Jiangsu Province into 5 levels. Based on the level classification, also according to the quality requirements for the shoreline by the main utilization means of the shorelines, it

[10] Mr. Yu Xiaogan (2005). Situation and countermeasures for the sustainable development in the Changjiang River Delta area. Acatac Geographica Sinica, N3

determined the adaptability categories of the shorelines in various levels, and the shoreline with the high quality is appropriate for port construction and industrial layout, and that with the bad quality can be used for the agricultural shoreline development or the preserved shoreline. Meanwhile, this research applied the GIS means for the first time calculating the total length and the lengths in classification of the shorelines on Changjiang in Jiangsu Province, and with the research area as an example, it tried the establishment steps and methods for the management information system for the shoreline.

(3) Adaptability evaluation for the shoreline

Represented by the Master's degree graduation paper by Mr. Yin Guoxing *Research on the adaptability evaluation of the shorelines on Changjiang River in Jiangsu Province*(1991). Firstly, this paper specifically makes the innovative description for the shorelines. Then, with the shorelines on Changjiang River in Nantong as examples, it explores the specific methods for evaluation of shorelines. Thirdly, through the adaptability evaluation for port construction on the shorelines on Changjiang River in Jiangsu Province, it has initially established the basic procedures for the adaptability evaluation of the port for the shorelines, including the index selection, weighted proportion setup, classification of evaluation units, shoreline evaluation in parameters and the adaptability classification of shorelines. Finally, according to the evaluation results, it proposes the countermeasure suggestions for development and utilization of shorelines in Jiangsu Province. This paper not only has explored the specific procedures for the port adaptability evaluation of the shoreline, but also has had the initial evaluation research for other two types of utilization means for the shoreline, the industry and the bridge, and aiming at the characteristics of the shorelines on Changjiang River in Jiangsu Province, it classifies the appropriate segments for these two types of utilization

means.

1.4.4 Current Situation of Research on the Value of the Port Shoreline

（Ⅰ）In 1999, in the *Initial exploration for implementing the asset management of the coastline resources at Shanghai Port.* Ms. Ou Haiyan proposes that the resource assets usually all are the natural properties formed by the nature, and before the development and utilization, human beings have not invested labor on it, so it had no value, but it is the necessary foundation of the economic activities, and has the very high use values, and its value is not the labor value in the traditional sense, but is the representation of the economic benefits of the resource proprietary. In the international community, the universal practice for the management of resource assets is to implement the franchise system, for the resource development, and the resource assets can be treated as the capital investment to have the joint-venture operation with other investors, to implement the use with charge.

Shorelines have the value, and should be managed as assets, and the entity utilizing the shoreline can be charged with the shoreline use fee accordingly, and when remising and transferring the shoreline, through the assessment for shoreline, charge the corresponding price for remising and transfer, and based on the original shoreline property account, establish the price reconciliation system and the value account for the shoreline, and in the port construction, bring the value of the shoreline into the cost reconciliation of the project, so as to promote the comprehensive utilization of shoreline, increase the economic benefits and achieve the asset management for the shorelines. Meanwhile, the author also proposes the methods for evaluating the price of the port shoreline: ① For the pure shoreline without the human labor invested in, its price is the economic expression of the shoreline proprietary, and is the asset price of the land rent,

which can be estimated with the calculating method for the land price by Marx, i.e. Land price=Land rent/interest rate. ② For the shoreline formed with the human maintenance or after the construction, its price is comprised of two components, and assuming the value of the part naturally produced without the human labor participating in is P1, and the value produced with the human labor as P2, then the shoreline price P=P1+P2.[11]

(II) The *Comprehensive report for the situation and value research of shorelines at Shanghai Port(2001)* was published on the "Government legal system research", and based on the survey, research and analysis for the situation of the shorelines at Shanghai Port, the report has proposed the plans and ideas for how to represent the resource value of shoreline, and promote the charge use system for the shoreline.

This report points out that the value of the shoreline is comprised of two components, where one is the capital value of the shoreline, which is the labor investment in the shoreline by human being, including the value formed from materialized labor and the live labor investment as the fixed capital of the shoreline. The other is the material value of the shoreline, which comes from the rarity and limitation of the shoreline. The report classifies the factors affecting the value of the shoreline into four categories: ① Natural conditions of the port, ② Concentrated and dispersed transportation conditions on the port, ③ Adjacent level of related enterprises, and ④ Service facility conditions on the port.[12]

[11] Ms. Ou Haiyan (1999). Initial exploration for implementing the asset management of the coastline resources at Shanghai Port. China Ports，N2

[12] (2001) The Comprehensive report for the situation and value research of shorelines at Shanghai. Government legal system research

(III) In the *Exploration for the use with charge of shorelines on Changjiang River*(2005), Mr. Wan Hanfeng and Mr. Cao Dongping pointed out the shorelines on Changjiang River are the limited & valuable resources, and as the development of the economic belts along the river, the deep-water and medium-deep shorelines have been fewer and fewer. At the same time, there are also the problems of unreasonable layout of development projects on some shorelines and the inefficient utilization of land and shorelines as well as the improper use of shorelines, which are not good for the secured, stable and continuous use of shorelines. In terms of implementing the scientific development concept and maintaining the sustainable utilization of shorelines on Changjiang River, it is very necessary to implement the use with charge, and collect the use charge for the shorelines on Changjiang River.

It is the necessary means for promoting the reasonable utilization of shorelines on Changjiang River to implement the charge use for shorelines on Changjiang, and establish the policies with the combined treatment & development and utilization & compensation. For the treatment of river route on Changjiang River, besides the fiscal authorities in various levels still need to enhance the investment efforts, it should also be based on the principle that whoever benefits, whoever bears the burden, and the utilizing entity for the shoreline also must bear the treatment task for the river route. To collect the use fee for the shoreline from the using entity of the shoreline, it is good to overcome the phenomena that emphasizes the development & utilization, ignores the treatment & protection and impropriate more resources and water projects on Changjiang River for free existing at present. The price of the use fee of the shoreline should be determined according to the conditions of the shoreline, to fulfill the good price for quality shoreline, so as to ensure the key project in the country and the project having the important

effects for the domestic economy can get the quality shoreline, and at the same time, limit the entities and individuals from impropriating more shorelines, and impropriating in disorder or impropriating but not using. [13]

[13]Mr. Wan Hanfeng and Mr. Cao Dongping (2005). Exploration on the use with charge for the coastline resources on Changjiang River. JIANGSU WATER RESOURCES，N 6

Chapter 2 Analysis Current Situation of Port Shoreline

2.1 Connotations and Classifications of Shorelines:

2.1.1 Traditional Definition of Shoreline

The shoreline is traditionally defined as the waterlogging line or the submerging line at a certain water level, referring to the revetment and the planning lines in freshwater and the borderline between the average high tide surface and the land along the coast. This is the most fundamental definition of the shoreline from the natural perspective and in the narrow sense, i.e., the natural shoreline.

2.1.2 Connotations of Port Shoreline

According to the fore-mentioned definition of the port shoreline, from the perspective of the natural shoreline, the port shoreline is a kind of valuable strategic resources that are irreproducible. It is of great significance for driving the development of the national and regional water transport, perfecting the integrated transportation system and promoting the economic and social progress.

From the angle of the manual shoreline, port shorelines include all shorelines formed by passenger transport and freight docks of various kinds except for fishery and military purposes, transfer facilities of offshore cargoes, fastening and docking facilities as well as locks and relevant facilities for port support, guarantee, maintenance and engineering system etc.

As is stipulated in the *Port Law*, the port refers to an area comprising of waters and land in a certain range, and equipped with corresponding dock facilities, for ship passage, berthing, calling, passenger transport, cargo loading and unloading, transport by lighter, storage and other functions. New ports shall be built in

accordance with the port layout plans set forth by the state and the province, the autonomous region or the municipality directly under the Central Government. The general plan of any port shall be worked out by taking into consideration the opinions of relevant departments and military institutions, asked for by the port administration.

The port shoreline refers to the shoreline located within the port area, including the deepwater shoreline and the non-deepwater shoreline. When port facilities are to be built in the water and land areas of the port, if the deepwater shoreline at the port is to be used, the competent traffic department under the State Council shall obtain the approval from the Macro Economic Regulation and Control Department of the Economy under the State Council; and if the non-deepwater shoreline is to be used, the approval shall be obtained from the port administration. However, if the State Council or the Macro Economic Regulation and Control Department of the Economy under the State Council has approved the construction of a project using the port shoreline, no other approval formalities shall be separately processed for the use of the port shoreline. The standard of the deepwater shoreline of the port is formulated by the competent traffic department under the State Council.

2.1.3 Classification of Port Shorelines

(1) According to conditions of natural water depth, port shorelines include port deepwater shorelines, port shorelines with medium water depth and port shorelines in shallow waters.

The existence of port deepwater shorelines refers to, when water is naturally that deep, the -8m-deep fathom lines are less than 200m to 500m away from the embankment, or there are shorelines where water is at least 10 meters below the

surface within an area of 200 meters in front of the shorelines. They are mainly in the service of ocean routes. Effective utilization and reasonable protection of them will exert major influences on the foreign trade transportation and the economy of the entire nation.

The existence of port shorelines with medium water depth refers to, when water is naturally that deep, fathom lines 5m to 8m deep below the water surface are less than 200m to 500m away from the embankment, or there are shorelines where water is 5 to 10 meters deep below the surface within an area of 200 meters in front of the shorelines. They are mainly in the service of offshore and coastal routes. Effective utilization and reasonable protection of them will exert major influences on the domestic trade transportation across regions and the national economy.

The existence of port shorelines in shallow waters refers to, when water is naturally that deep, fathom lines 2m to 5m below the water surface are more than 500m away from the embankment, or there are only shorelines where water is less than 5 meters deep within an area of 200 meters in front of the shorelines. They are mainly in the service of the intraregional integrated transportation network. Effective utilization and reasonable protection of them will exert certain influences on the intraregional integrated transportation and the national economy.

(2) According to the requirement of the shoreline utilization and the scope of service, port shorelines can be divided into public port shorelines and industrial port shorelines.

Public port shorelines: generally port shorelines featuring stability, no alleviation and sedimentation or just little, deep water or medium deep water, a wide expanse of

pathway at the backside, conformity to modern transportation-oriented ports as well as development and construction of batches of public docks, in addition to scale operation and management.

Industrial port shorelines: less demanding than public port shorelines on the river regime, mud and sand, water depth and the land, good for meeting the demand of intensive production, specialized transportation and standardized environmental protection of enterprises characterized by high water and energy consumption and large transport volume, sailing in close proximity to the shore (along the coast and rivers). They are generally distributed in the downstream and leeward direction of towns, and keep some distance away from the towns, reserves of water resources and ecological reserves.

(3) In the order of development, port shorelines can be divided into utilized port shorelines (established port shorelines), planned port shorelines (port shorelines to be developed) and preserved port shorelines (prospective port shorelines).

Utilized port shorelines (established port shorelines): refer to the port shorelines formed by established docks and other water transport infrastructure.

Planned port shorelines (port shorelines to be developed): refer to the port shorelines in the prospective area in the development of the port approved by the competent traffic (port/port affairs) department of the government.

Preserved port shorelines (prospective port shorelines): refer to the port shorelines which cannot be developed for the moment yet are preserved for future port construction. They are port shorelines enjoying a good prospect of development, thus

protection shall be granted.

2.2 Analysis of Port Shorelines:

2.2.1 Survey of Port Shorelines Abroad

Foreign countries with advanced water transport systems all attach high importance to the reasonable utilization of shorelines. They make full use of shorelines to promote the regional economic development. For example, an economic belt is formed along both banks of the Rhine in Europe. This is inseparable from the reasonable plan and control executed by countries along the river as well as their continuous perfection and development of legal systems. These measures adopted mainly concern two aspects: firstly, various national governments have published a series of relevant policies to direct the development of the inland waterway transport, such as the industrial outward movement policy under which it is unnecessary to take up deepwater shorelines, the principle of deep use of deep water, reduction of some inland waterway shipping tax so as to direct the branching of cargoes to the water transport; and secondly, various countries along the river have successively formulated relevant codes and treaties, such as the law on use of shorelines, law on use of land for the port and urban development, law on investment promotion etc. The reasonable plan and control as well as continuous improvement and development of legal systems have effectively guaranteed the integrated development and utilization of the Rhine.

In spite of different national conditions and widely different organizational forms of construction adopted, all countries attach high importance to the use of shorelines and the port planning. In sparsely-populated Brazil with long coastlines, though there are sufficient shorelines for the construction of ports, the construction plan of the

port shall be approved by the Brazilian Government. For specific dock or construction projects, firstly, the project shall conform to the general plan of the port and secondly, the plan for environmental protection shall pass the censorship by the bureau of environmental protection. In Brazil, apart form these two requirements, namely, conformity to the port plan and the purpose of environmental protection for specific construction projects, the power in other respects is transferred to lower levels. Work from the project feasibility study to examination and approval of the tentative plan is all presided by the owner and approved by the local port administration, while the government no longer performs to go through any examination and approval procedures. In this way, the time needed for approval is greatly shortened, conducive to faster port construction. In the Netherlands where shorelines are deficient, the management on the use of shorelines is ever more rigorous. The construction of ports is under the centralized organization of the port administration: the port company applies for building a new berth with the port administration, which will act to conduct the feasibility study of the project. If it is proved to be feasible, the administration will submit a report to the city government for approval. If it is approved, the administration will also organize the design and construction. After the berth is completed, it will be rented to the operator for a lease of 25 years once.

Abroad, the use of shorelines and the use of land are simultaneously authorized. In China, the situation is quite different.

2.1.2 Survey of Port Shorelines in China

In China, the *Port Law* came into force as of 1 January 2006, which provides a vigorous legal guarantee for the reasonable utilization of shorelines.

Currently, the Ministry of Communications is drafting a law on the management of port shorelines, planning to exercise classified management and paid use of port shorelines along the coast and the inland river. On 10 March 2006, the Ministry of Communications published the standard on deepwater shoreline of port, in which it is stipulated that the area under the Nanjing Bridge across the Yangtze River is included into the area of port shorelines, where berths above the level of ten thousand tons can be built according to the standard on deepwater shorelines. It is also stipulated that the two-level approval system will be implemented for the use of port shorelines. Apart from projects approved by the State Council and the National Development and Reform Commission, which require no separate approval any more for the use of shorelines, the use of other deepwater port shorelines shall be all approved by the Ministry of Communications together with the National Development and Reform Commission, while the non-deepwater shorelines shall obtain provincial approvals.

In light of the value of shorelines and their significance for the economic development, various port cities are actively exploring ways of scientific and standard management of shorelines. In Liaoning, Zhejiang, Jiangsu, Hubei, Fujian, Anhui, Shanghai, Dalian, Fuzhou, Wuhan, Suzhou, Nantong, Chizhou as well as many other cities and regions, management methods of development and utilization of shores have been successively published; and in Liaoning, Fuzhou, Shanghai and other cities, procedures for the legislation by the Provincial CPC Standing Committee have been completed. However, currently, various local methods focus more on the main body of management, limits of authority and procedures, and seldom involve optimization and efficient allocation of shorelines as well as the mechanism of access to and exit from the use of shorelines etc. In spite of this, they share some common grounds: firstly, adhere to the principle of unified management and classified approval, and coordinate and plan as a whole the management of

shorelines through the joint discussion and consultation system; secondly, implement the system of shoreline use permission, as the *Administrative License Law* has been published, various places are actively striving to win the legislation support from the province and the CPC for their shoreline management methods and statutes etc.; thirdly, industrialize shorelines and establish the system of compensable use of shorelines. From 1993, the system of compensated use of shorelines was established in Shanghai. This year, some amendments are made to the charging standard and methods of calculation, which have been supported by Shanghai CPC through legislation. In Liaoning Province and the city of Fuzhou alike, there are provisions on compensable use of shorelines; fourthly, development is required to be carried out within a prescribed time limit, and the construction period is stipulated. Generally, it is stipulated that if the owner has failed to develop and build the shoreline for the approved purpose within 2 years, its access to the shoreline will be reclaimed. Liaoning Province and the city of Suzhou have set forth even stricter requirements that the developer will be deemed as being incapable of development if construction is not started within one year or the investment in the first year is lower than 10% of the project total; and fifthly, encourage the rectification and development of shorelines. The city of Fuzhou stipulates that investment in shorelines for rectification and development can enjoy 50% to 70% access to the newly-added land area.

China has made outstanding achievements in the acceleration of the development and utilization of shorelines, but some problems have also cropped up, like generally inefficient use of shorelines, mainly manifested in the following aspects:

(1) Unreasonable structure, inefficient development and utilization

In many places, though the utilization rate of shorelines is not low, more than half for

quite some, due to bad layout, it is difficult to arrange new projects along the remaining shorelines. Meanwhile, of the port shorelines that have been taken up, only a small proportion have been actually used as dock berths, even only around 1/3 for some.

For example, in the Beicang deepwater port area of Ningbo, some owners have forestalled to take up shorelines for docks, making it difficult for centralized arrangement of container docks, resulting in lack of functional coordination and waste of resources, thus it is difficult to realize scale and intensive management, consequently, the integrated benefit and the utilization rate of the shorelines are greatly reduced.

(2) Serious waste of shorelines, problems of using less than possession, using no shoreline possessed and shallowly using deepwater etc.

In the Yangtze River Delta region, the waste of shorelines is astonishingly huge. Along the shoreline more than 800km long in the reaches of the Yangtze River below Nanjing, many deepwater shorelines have been taken up by small port docks and factories. In the city of Nantong, in an area of about 2.5km along the Tongzhou Sand Shoal, with approvals from different departments, 4 homogenous enterprises have separately established docks of their own. In Zhenjiang, Jiangdu, Taixing, Changshu, Taicang as well as other counties and cities, LPG docks have been built in recent years. Deepwater shorelines are strategic quality resources, yet unluckily, current in China, there remain outstanding problems concerning the shallow use of deepwater. Take the golden waterway of the Yangtze River for example, such rare and irreproducible strategic resources are reputed as “platinum shorelines in the golden waterway”. However, while cities along the river are vigorously promoting the implementation of the strategy of “rejuvenating the city through the port”, duplicated

construction, indiscriminate investment, shallow use of deepwater, “take more, use less” and other problems have cropped up in some places. In Wuhan with a shoreline as long as over 140km within its territory, only one place, i.e., Yangluo is the most ideal for the construction of the deepwater port. Though the shoreline is about 2,000m long there, it has not been effectively protected. In the case of one cement company, although a shallow-water shoreline is more than enough to meet its production need, the company unexpectedly intended to go beyond the plan and take up a deepwater shoreline more than 700m long. Duplicated construction at low levels has not only led to structural surplus of the port capacity and vicious competition, but also to waste of valuable shorelines, hence restricting the development potential of the deepwater port.

(3) Serious problems of construction without approval or use of shoreline in disguised form

Next, the problem of construction without approval or the use of shorelines in disguised form is rather serious. It is known that the shorelines, in the entire city of Ningbo, which were constructed without approval, are as long as 36km in all. In most cases, enterprises close to the port control the land first, then seize the land area at the backside of the port, and thus use the shoreline in a disguised form. This phenomenon can be found in many cities of China.

Chapter 3 Port Shoreline Grade Evaluation Model

3.1 Basis for Port shoreline Grade Evaluation Model

3.1.1 Preliminary Classification of Port Shoreline Grade

According to exploitation grade of port shoreline, it is planned to classify port shoreline into three grades: the first grade (reasonably exploited and utilized port shoreline); the second grade (exploited port shoreline which exists problems in development and utilization); and the third grade (port shoreline which is not yet developed and utilized).

The adjudgment index of port shoreline can be categorized into 3 grade: S={grade I, grade II, grade III}，S={S1, S2,S3}, According to the research results of before, and consider the authority suggestions. The quantification of index should be: S={S1, S2, S3}={0.85, 0.70,0.60}

3.1.2 Determination of Model judgment Factors and Components of Evaluation Index System

Selecting an evaluation index system which can reflect not only the overall perspective of comprehensive conditions of any coastline complying with objective of port shoreline grade evaluation, but also with feasible characters from numerous complicated contributing factors is the basis and key of port shoreline grade evaluation.

Essentially, constructing port shoreline grade evaluation model is to determine the judging factors of grade evaluation and their interrelationship, establish evaluation indexes and their correlations. However, judging factor and evaluation index all involve many respects of contents such as natural condition, economic technology

and regulation environment and so on.

Based on the fact that this research is one of the preliminary work of port development and construction, as well as basic work of regional port layout planning and important components of overall planning for a single port, its purpose is to discuss the development foreground of port shoreline from the interrelationship of natural and manmade coastline, therefore, selected judging factors and evaluation indexes not only differ from general criteria system of natural resource, but also differs from the comprehensive evaluation index system for basic construction project.

Considering the need of port shoreline exploitation and construction development, this text subject to reflect the inner relation between natural and manmade coastline and their transformation condition in a comprehensive way, measuring by combining previous research findings and correlating with the latest statistical data as well as opinions of related specialists, through field investigation and justification, finally selected five groups of judging factors such as natural condition, transportation location, economic location, matching condition and regulation environment, in which each group of judging factor contains several evaluation indexes, and the five judging factor can be subdivided into 24 detailed evaluation indexes.

According to influencing and inclusion relation between these judging factors and evaluation indexes, it is possible to establish a hierarchical and integrated evaluation index system for port shoreline grade evaluation, the influencing and inclusion relation between judging factors and evaluation indexes are discussed as follows:

（1） Natural condition

Natural condition is the basic condition to determine port grade. As a port shoreline which is to be constructed as a modern berth, its natural conditions sometimes are the prerequisites for technical feasibility of port construction and economical rationality of port operation.

Port shoreline located in different geographic location, different status of water and land area, meteorological and hydrological conditions, landform, topographic feature and sediment movement determines the difficulty of port construction, which influences directly on effective working days or actual operational capacity (efficiency) of port production.

The natural conditions of port shoreline waters mainly contain water depth, frost, siltation and wave defend etc., they have great relationship with size of ship entering a port, sail in port area and anchor condition, difficulty degree of daily maintenance in water area etc, so they are the important factors concerning whether the port shoreline can be developed and port can have good development. In the end, they can affect the development scale and characteristic of port. Especially in recent 20 years, because the ship-building technology is progressive, the using big ship can produce advantage of scale economy and the merchant ship on the sea, especially major bulks ship, quickly features large size, the influence on port which is caused by natural condition of water area become more and more obvious. Thereinto, the perfect water area defense and water depth in front of shore are the basic conditions under which the ships can sail in and out smoothly and anchor; the vast water area is convenient for scale operation and scientific management of port.

The natural conditions of land area beside port shoreline refer to natural condition of terrain and geologic condition. They not only directly affect basic processing amount

and project scale during construction of land area, but also are related to plane layout in port area and the economic efficiency of daily operation. Besides, the vast and even back land is convenient for scale operation and scientific management of port. The natural conditions of land area beside port shoreline also affect the contact between port and hinterland, the disadvantage terrain will hobble the construction of traffic lines and even affect the hinterland scope and development scale; on the contrary, the perfect navigable fairway is convenient for the contact between port and hinterland, and then produce excellent effect for development of port.

Furthermore, the good weather and hydrological condition are prerequisite which can ensure safe production of berth, increase operation days of docks and improve the operation efficiency; the stable river regime and shoal can avoid a large amount of regulatory works in a long term; the good hydrological condition can greatly reduce cost of base treatment in hydro structure construction of docks; the sediment movement situation without silt or tiny slit can greatly reduce the dredging engineering amount of fairway and bay and can also reduce the operation cost of port effectively.

（2） Traffic region location

The development and use of port shoreline depends on the ascendant traffic location. The port shoreline and its development is not a single geographical phenomenon but a regional phenomenon. The traffic region conditions have a large influence on the degree of port shoreline, and it is one of the key factors to determine whether the natural shoreline with the probability to become a port can turn into a real important port finally.

Among them, nodes located in the main shipping track like high sea and short-range

ocean and sub main hipping track like sea coast and river coast are external motivity to develop the port shoreline. A complete hinterland transportation network can accelerate the port from a transportation hinge to a logistic base. Take the Singapore, well-known port for example. Because it is in the center of South-East Asia and the intersection of the transportation on the South-East Asian sea, and at a key location of the south of Strait of Malacca, which is the main shipping line between the Pacific Ocean and the Indian Ocean. All ships from Europe, Mid Asia to East Asia and Australia should go through it. Therefore, this important transport location makes Singapore one of the most famous and busiest international transport centers.

（3） Economic region location

Port cities in the hinterland and its economic factors play an important part in the Port coastline comprehensive evaluation.

Port hinterland is the region attracted by the port. The Port has a certain convergency and radiancy over this region. Hinterland includes common hinterland and foreland. Compared to the foreland, the hinterland is most closely associated with the port development and port construction and development. It is the origin and consuming place of the exporting goods of the port, as well as the base for the development of port shoreline. Relying on the cities as the most direct port hinterland, its urban planning, the economic structure and level of development is the most important regional factors of the Port coastline. The development and utilization of port coastline depend on the economic development of hinterland, particularly the industrial base and development of the port city.

Different ports lie in different economic region. Different economic conditions of the hinterland, and different requirements for the transportation and its scale, all will

affect the economic region location of the port shoreline. Good port shoreline regions sometimes also are the best region for the development of the city and industry at the same time.

The degree and characteristics of the port shoreline is determined by the scale and the level of economic development of the hinterland, and realized through the transportation connection between the port and the hinterland, namely, the gathering and dispatching system. Because the dominating factor to affect the size of the port hinterland is the gathering and dispatching costs of the passengers and goods, the density ,degree and scale of freshwater and railway transportations have the most important connection with the development and construction of the port because of its low costs. Therefore, the development of the port coastline and the construction and development of the port are usually accompanied by the form and perfection of the high degree freshwater route and railway transportation network extending into the vast hinterland. For example, Rotterdam in Netherland becomes one of the most important ports in the world based on its golden water course and, Shanghai becomes the first port in China because of its dense railway network.

The developing level of the hinterland economics is also key factor to determine the degree of the port coastline and the construction scale of the port. The hinterland with advanced economy is necessarily a city with a developed industry and trade. This brings a stable and abundant goods source to the development of the port coastline. Port city embodies the formation of the recent and modern regional market and international market, the development of regional and international division of market and the advancement of the tools and technology of transportation at sea. It promotes the gradual amalgamation of the functions of port and city, and finally forms a new burgeoning type of cities. It is an economic region with an excellent port as a window, with certain hinterland as backstopping, with developed port economy

as dominance, and with the linkage of the land and the ocean. In this region, the transportation, industry, and trade form an organic whole. Port is the core. Its development and construction led to the rise of associated industries. Industry is the foundation. The rise of port-related industries, especially the pillar industries has promoted the port's prosperity, and led to the urban formation and development. Trade is ties. Every kind of industry combines organically with each other through markets and makes the production continue in the market exchange.

The broad and developed hinterland economic regions and zones offer strong support for the constant development and intensive utilization of the port coastline. The open port cities with abundant economic force will benefit the function extension and structure adjustment of the port. The coast industrial layout with high energy and water consumption and large shipment volume will provide sufficient and stable water source to the port; meanwhile it will promote the construction of specialized wharf berth and the formation of the specialized port area. The scale extension port layout of many development parks (High-tech development zone, special industrial park, storage bonded processing zone, port Logistics Park) will accelerate the integration progress of port and city and improve the comprehensive utilization benefit of the port coastline.

（4） Complementary Conditions

The development and utilization of the port shoreline depends on the convenient complementary development conditions.

The city is the carrier of the port, which can provide a material and tolerable space for all kinds of industries while the homonymous development of various traffic vehicles is the fundamental guarantee for the sustainable development and

construction of the port; the normal operation of the economic systems, including finance, banking, municipal government, communication, are the premises for the port shoreline's shipping to function well and are also the important factors deciding the level of the port shoreline.

The financial, insurance and business environment of where the port shoreline is located and material service level will sure to influence the development and construction mode of the port shoreline, the development of the port and its own social characteristic positioning. The comprehensive environment is composed of the influences produced by all these different aspects and further influence the development and compositeness of the port after being completed.

Among them, a perfect comprehensive transportation network, a good municipal complementary facility, especially the convenient business complementary conditions, will reduce the development cost of the port so as to improve the compositeness of the transportation operation and to promote the transformation of the port from the transportation hub to material flow base and business center.

（5） Legal Environment

The development, utilization, planning and protection of the port shoreline are closely related to a series of laws, policies, rules and relevant development planning for the industries concerning the national economy. The grade evaluation of the port shoreline should also be integrated with a series of relevant laws and rules environment.

Among them, the transportation industrial policy the local government, especially the position, function and its relevant policy guidance (support, incentive or limitation)

of the water transport are key factors deciding whether the port shoreline can gain an exclusivity; the differentiation of the marine function of the water domains of the ports or the planning of the river flow domains (flood prevention planning) decide whether the port will obtain the water domain condition that is necessary for the development of the port; the general planning of the city where the port is located and the general planning of the national land usage will directly result in whether the port is able to obtain land condition eligible for the development; the local environmental protection and planning and relevant plans related to the cultural relics protection, to some extent, influence the definition and grade evaluation of the port shoreline.

Above all, the distinctive factors and index system of grade evaluation model of the port are shown in the following Table3-1:

Table 3-1 Factors and Index System of Grade Evaluation Model of the Port

Distinctive factor(F)	Evaluation index (I)
F1 Natural condition	I1 Water domain protection condition
	I2 Designed off-shore distance of the dock front
	I3 Land depth
	I4 Stability degree of the shoal(river regime)
	I5 Perennial operation days, thick fog, strong wind
	I6 Wave height
	I7 Water flow speed
	I8 Geologic setting
	I9 Water domain sediment condition
F2 Traffic location	I10 Adjacent navigation route types
	I11 The position and function in the national and

	regional comprehensive transport system
	I12 Direct hinterland road/railway/inland river navigation routes/ channel network density
	I13Road/railway/ hinterland water routes/ channel distribution among the port area
F3 Economic location	I14 Inland dependable type
	I15 City dependable type
	I16 Scale oriented garden area facing the port(economic development/ professional industrial garden/ Storage tax free processing area/ Material flow garden area) quantity
	I17 Inland transport demand(heavy consumption/ heavy water consumption/ heavy deliver industrial layout and enterprise quantity)
F4 Complementary condition	I18 Municipal infrastructure
	I19 Financial infrastructure
	I20 Custom's check
	I21 Agent services
F5 Legal environment	I22 Transport indusial policy of the local government (the emphasis on the port transport)
	I23 Port shoreline development and marine function division
	I24 Port construction and urban integrated plan

3.2 Construction of Evaluation Model Based on AHP

3.2.1Construction Steps of AHP Model

The steps are below:

(1)Construction of Hierarchical Model

After deeply analyzing the encountering problems, divide the factors in the problems into several groups according to the different attributes, forming different levels, such as objective level, normal level, index level, scheme level and measure level etc. When one level of them contains more factors (if exceed nine), which will be further divided into several sub-levels.

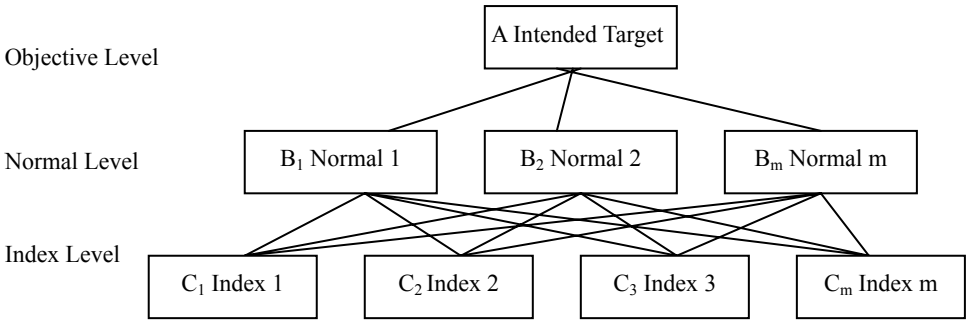


Fig. 3-1 Hierarchical Structure of Levels and Subordinate Relationship of Factors

As principles, the factors of the same level will dominate some factors in the next level and they are dominated by the last level. Figure 3-1 illustrates the hierarchical structure of levels and the subordinate relationship among factors.

(2) Judgment Matrix of Structure

The information of analysis of hierarchy process is based on the judgment about the relative importance of each factor at each level and the judgment is shown by numerical value, which forms the judgment matrix. The general form of judgment matrix is as shown in Table 3-2. The code at the top left corner in the table of judgment matrix stands for a certain principle item relative to the evaluation at last level.

Table 3-2 General Form of Judgment Matrix

A	B_1	B_2	…	B_n
B_1	b_{11}	b_{12}	…	b_{1n}
B_2	b_{21}	b_{22}	…	b_{2n}
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
B_n	b_{n1}	b_{n2}	…	b_{nn}

The judgment matrix refers to the relative importance among the relevant factors at this level in accordance with a certain factor of last level. The value of judgment matrix reflects the cognition of people on the relative importance of each factor (or merit, preference and intensity, etc.). Generally, adopt the method in 1-9 and the method of scaling of its reciprocal of A.L. Saaty. Table 3-3 for the scale of judgment matrix and its meaning. When the importance of comparing factors one another can be illustrated by the ratio with practical meaning, the ratio can be as the value of the corresponding element of judgment matrix.

Table 3-3 1-9 Scaling Method of AL Saaty (judge scale and meaning of matrix)

Scale	Meaning
1	Means that the factor i is of the same importance comparing with the factor j
3	Means that the factor i is a little more important comparing with the factor j
5	Means that the factor i is obviously more important comparing with the factor j
7	Means that the factor i is much more important comparing with the factor j
9	Means that the factor i is extremely more important comparing with the factor j

2, 4,6,8,	Means the quantitative scales when the above neighboring scales need to be comprised.

The judgment of matrix should be confirmed according to many kinds of comprehensive considerations, such as analyzing the relative data or employing specialist consultation and theoretical calculation and so on.

The elements of judging matrix has the following property:

$b_{ij}>0$ (i, j=1,2,3,…,n)

$b_{ij}=b_{ji}=1$ (i=j i, j=1,2,3,…,n)

$b_{ij}=1/b_{ji}$ (i≠j i, j=1,2,3,…,n)

(3) Single hierarchy ordering and checking it

The calculation of the ordering priority of these elements concerning the elements of above tier according to the judging matrix is named single hierarchy ordering.

The characteristic root of $A=[b_{ij}]_{n\times m}$ can be judged by the regular method of matrix feature vector, such as square root method, summation method, average reciprocal method and so on.

$$AW = \lambda_{\max} W \qquad (3\text{-}1)$$

Its result $W = [W_1, W_2, ...W_n]^T$ is the ordering priority of the same tier factors concerning some factors of above tire after being dicompositonal treatment。

In order to check the coherence of the single hierarchy ordering, the following indexes need to be computed:

Coherence index $CI = \dfrac{\lambda_{\max} - n}{n-1}$ (3-2)

Casual coherence index $CR = \frac{CI}{RI}$ (3-3)

The value of average casual coherence index R1 can be found in the Table 3-4

In the case of CR ＜0.10,the result of single hierarchy ordering is considered to be of satisfied coherence, which also means the weight coefficient is rational, or the value of judging matrix element needs to be regulated so as to redistribute the value of weight coefficient.

Table 3-4 Average Random Consistency Index Determination

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

(4)Level total sequence and its consistency test

The process of previous level single sequence is adopted. After the calculation of the sequence values of every level's judgment matrix, in order to obtain the combined weight of certain level element to general objective and the mutual influence with the upper level element, the weight values of all elements' importance in this level are calculated by using this level sequence results and the combined weight of the upper level element, that is, the sequence weight value of all factors' related importance to the highest level (general objective) is calculated, which is called level total sequence.

It is required to carry out this process from the highest level to the lowest level gradually. For the second level from the highest level, its level single sequence weight is the level total sequence weight.

If the upper level A contains m factors $A_1, A_2, \ldots A_m$, its level sequence weights are $a_1, a_2, \ldots a_m$ respectively. The lower level B contains n factors, $B_1, B_2, \ldots B_n$, and their

level single sequence weights to factor A_j are b_{1j}, b_{2j}, …b_{nj}, respectively.(when B_k is not linked with A_j,b_{nj}=0) . At this time, the B level total sequence weight value is given in Table3-5.

Table 3-5 B level Total Sequence Weight Value

LevelA / Level B	A_1	A_2	…	A_m	B level total sequence weight
	a_1	a_2	…	a_m	
B_1	b_{11}	b_{12}	…	b_{1m}	$\sum_{j=1}^{m} a_j b_{1j}$
B_2	b_{21}	b_{22}	…	b_{2m}	$\sum_{j=1}^{m} a_j b_{2j}$
…	…	…	…	…	…
B_n	b_{n1}	b_{n2}	…	b_{nm}	$\sum_{j=1}^{m} a_j b_{nj}$

To assess the consistency of level total sequence, it is required to test the consistency like the level single sequence. This step is also carried out from the highest level to the lowest level gradually.

If the index of some level B factors to A1 single sequence consistency is CI_j, and the corresponding average random consistency index is RI_j, B level total sequence random consistency ratio is

$$CR = \frac{\sum_{j=1}^{m} a_j CI_j}{\sum_{j=1}^{m} a_j RI_j} \qquad (3\text{-}4)$$

Similarly, when CR＜0.10, the level total sequence result is thought to have satisfactory consistency. Otherwise, it is required to adjust element determination

of the judgment matrix.

3.2.2 Simplified AHP Method

When determining the weight of index with AHP method, the most critical step should be the constitution of adjustment matrix on every hierarchy. The formation of increased hierarchy structure model serves as the basis of constituting adjustment matrix.

The simplification of AHP method stated in this paper is in fact the simplification of increased hierarchy structure model. It is performed for the purpose of simplifying adjustment matrix and reducing matrix calculations.

The simplified increased hierarchy structure model is as shown in Fig.3-2

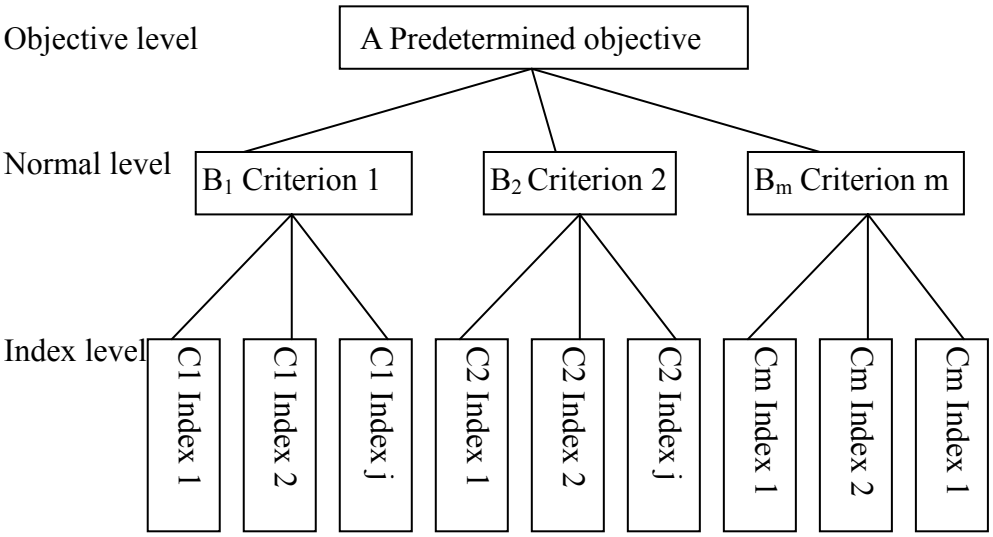


Fig.3-2 The Simplified Increased Hierarchy structure Model

Compared to the traditional AHP method (Increased Hierarchy structure model is as shown in Fig. 3-1), the simplified AHP method can avoid redundant crossed communication between different rule layers and index layers. That is helpful for centrality of judgment, and the aim of multi-factors and multi-object decision can be

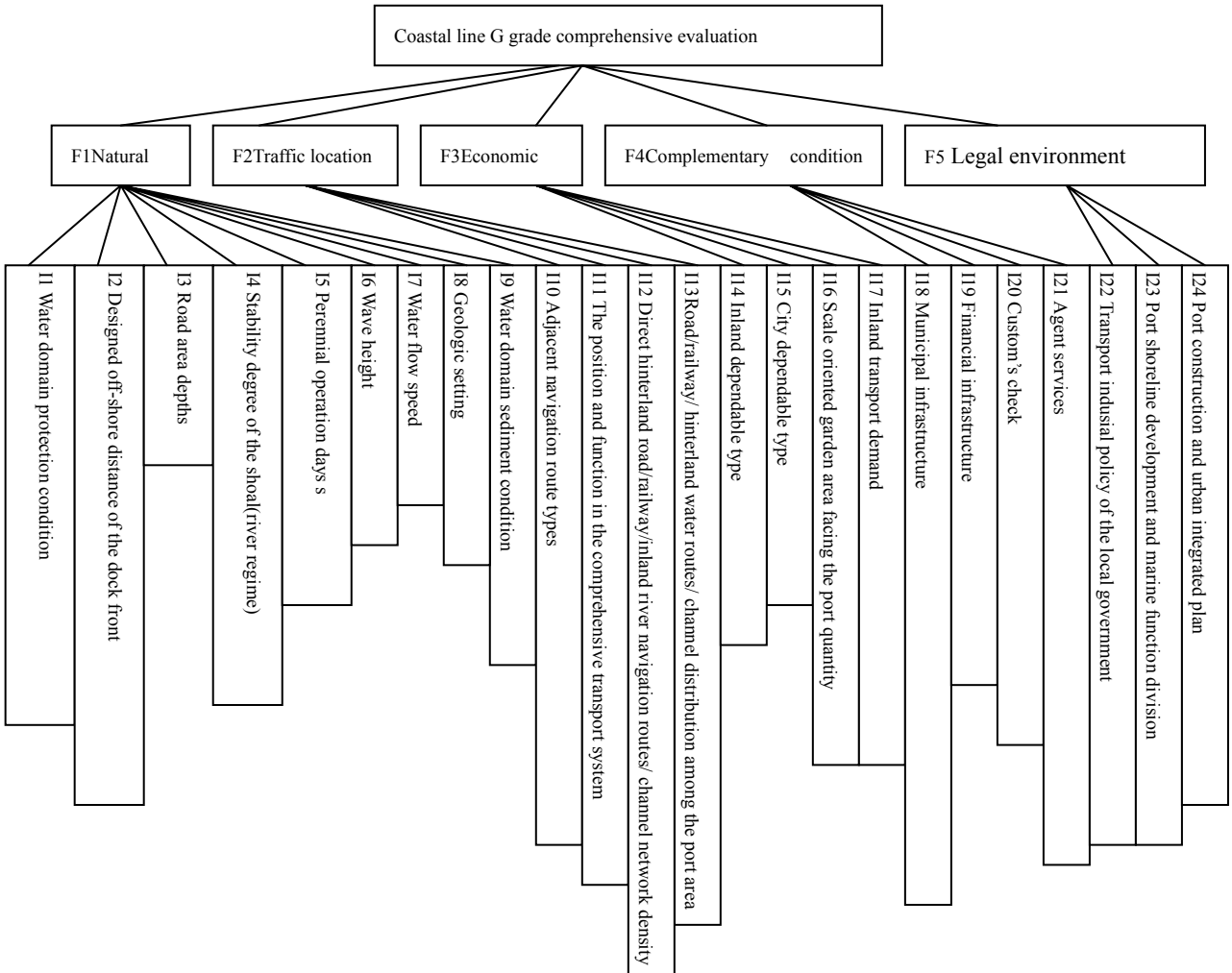
achieved also.

3.2.3 Adjustment Factor for Coastal Line Grade Evaluation Model and Establishment of Adjustment Weight of Index

(1) Establishment of increased hierarchy structure model of adjustment factor and evaluation index

The increased hierarchy structure model with ascertained adjustment factor and evaluation index has been established in accordance with the adjustment factor and evaluation index of coastal line grade evaluation as determined by 3.1, and on the basis of the aforesaid AHP method-based increased hierarchy structure model. The objective level G, factor level F, index level I and their relation are shown as in Fig. 3-3.

Fig. 3-3 Increased hierarchy structure model with ascertained adjustment factor and evaluation index



(2) Jugged the maximum feature vale and the corresponding characteristic vector of the matrix by constructing the factor layer

Carry out pair comparison to various elements in the factor layer, pursuant to the stipulated graduation, formulate the matrix form upon the quantization of significance of the pair comparison. Please refer to table 3-6.

The graduation method adopted here: combining the previous research fruits, relevant latest statistics materials and opinions of related experts for comprehensive measuring, use figure 1,3, 5，7，9 to indicate the former is equally important, slightly more important, obviously more important, quite more important and extremely more important than the latter in a pair comparison; use 2，4，6，8 to describe the transition status between them, the more important graduation value of the latter than the former will be denoted by the reciprocal of the significance graduation value between the comparison of the former and the latter.

Find the maximum characteristic value of the matrix and the weighting vectors of the corresponding factors, carry out conformity check in accordance with the maximum latent root calculation uniform indexes CR. If CR〈0.1, the check is qualified; otherwise, the result is not satisfactory. The matrix should be reconfirmed and judged unit to the satisfaction.

The matrix calculation uses MATLIB software and please refers to Table 3-6 for the calculation results.

Table 3-6 Matrix to Judge Various Determinant factors

G	F1	F2	F3	F4	F5	W	C
F1	1	3	2	4	5	0．8155	0．43
F2	1/3	1	1/2	1	2	0．2538	0．13
F3	1/2	2	1	2	3	0．4488	0．24
F4	1/4	1	1/2	1	1	0．2085	0．11
F5	1/5	1/2	1/3	1	1	0．1604	0．99
λ max =5.0406，CR=0.0091〈0.10 W=weight vector， C=weight							

(3) Construct the index layer judging matrix to find the maximum characteristics value the corresponding characteristics vector

Construct judging matrix with various elements in the index layer under a certain factor category in accordance with the aforesaid approaches. Please refer to Table 3-6 to Table 3-11. It is also needed to adopt the same approaches to calculate the relative weighting of various indexes of this category. The matrix calculation uses MATLIB software, and the calculation results can be seen in table 3-6and table 3-11.

Table 3-7 Judging Matrix of Various Assessment Indexes under F1.

F1	I1	I2	I3	I4	I5	I6	I7	I8	I9	W	C	Z
I1	1	2	3	7	5	4	6	3	2	0．7231	0．29	0．12
I2	1/2	1	2	3	2	2	3	2	1	0．3728	0．15	0．06
I3	1/3	1/2	1	3	2	1	2	1	1/2	0．2330	0．09	0．04
I4	1/7	1/3	1/3	1	1	1/2	1	1/2	1/3	0．1112	0．04	0．02
I5	1/5	1/2	1/2	1	1	1	1	1/2	1/3	0．1378	0．06	0．03
I6	1/4	1/2	1	2	1	1	2	1	1/2	0．1990	0．08	0．03
I7	1/6	1/3	1/2	1	1	1/2	1	1/2	1/3	0．1173	0．05	0．02
I8	1/3	1/2	1	2	2	1	2	1	1/2	0．2208	0．09	0．04
I9	1/2	1	2	3	3	2	3	2	1	0．3879	0．15	0．06
λ max =9.0904， CR=0.0078〈0.10 W-weight vector， C-relative weight， Z-total weight												

Table 3-8 Judging Matrix of Various Assessment Indexes under F2.

F2	I0	I11	I12	I13	W	C	Z
I10	1	3	7	5	0．9142	0．59	0．08
I11	1/3	1	3	2	0．3392	0．22	0．03
I12	1/7	1/3	1	1/2	0．1124	0．07	0．01
I13	/5	1/2	2	1	0．1912	0．2	0．02
λ max =4.0192， CR=0.0071〈0.10 W-weight vector， C-relative weight， Z-total weight							

Table 3-9 Judging Matrix of Various Assessment Indexes under F3.

F3	I14	I15	I16	I17	W	C	Z
I14	1	1/2	4	2	0．8222	0．52	0．12
I15	2	1	8	4	0．5482	0．35	0．08
I16	1/4	1/8	1	1/2	0．0685	0．04	0．01
I17	1/2	1/4	2	1	0．1370	0．09	0．02
λ max =4，CR=0〈0.10 W-weight vector， C-relative weight， Z-total weight							

(4) Calculate the overall weighting of the various indexes in the overall assessment model

Multiply the corresponding weighting of the index in the index layer with the related certain factor's weighting to get the overall weighting of the index in the entire assessment system. Please refer to table 3-6 and table 3-11 for the calculation results.

Table 3-10 Judging Matrix of Various Assessment Indexes under F4

F4	I18	I19	I20	I21	W	C	Z
I18	1	5	3	7	0．9209	0．59	0．06
I19	1/5	1	1/2	2	0．1953	0．13	0．01
I20	1/3	2	1	2	0．4126	0．20	0．02
I21	1/7	1/2	1/2	1	0．1267	0．08	0．01
λ max =4.0419， CR=0.0155〈0.10 W-weight vector， C-relative weight， Z-total weight							

Table 3-11 Judging Matrix of Various Assessment Indexes under F5

F5	I22	I23	I24	W	C	Z
I22	1	2	3	0．8468	0．54	0．05
I23	1/2	1	2	0．4660	0．30	0．03
I24	1/3	1/2	1	0．2565	0．16	0．01
λ max =3.0092， CR=0.0079〈0.10 W-weight vector， C-relative weight， Z-total weight						

3.3 The Quantization of the Classified Assessment Indexes in the Port Coastline Grade Assessment Model

It is quite complex to carry out port coastline classification assessment index quantization

Part indexes can be directly quantized, such as day numbers due to annual foggy days or other severe weather leading to operation halt in the port. As for the distance of the front port to the deep water area, siltation amount in front of the coastal line, investment amount required to reconstruct the water and land area conditions, the direct benefit of using coastline, etc., it is only required to identify a satisfaction value (the upper limit) and dissatisfaction value (the lower limit) in accordance with the hydraulic engineering design technical criteria or the commons sense and interpolate values in accordance with the actual value and the upper limit (1) and lower limit (0).

$$M_{kj}=\frac{P_{kj}-P_{j,\,worst}}{P_{j,\,best}-P_{j,\,worst}} \qquad (3\text{-}5)$$

Mkj: the quantization grade of the jth assessment index in the K sect port coastline, 0〈m〈1

Pkj- the direct quantization value of the jth assessment index in the K sect port

coastline

Pj,best- the satisfaction value of the jth assessment index in the port coastline (upper limit)

Pj,worst- the satisfaction value of the jth assessment index in the port coastline (lower limit)

Other indexes belong to the qualitative indexes, and they can not be described by quantization. The “grading” method can be adopted to make them quantization. i.e. set the satisfaction value (upper limit)1, dissatisfaction value (lower limit)0.

Then the assessment index values after quantization will be between 0 and 1. Please refer Table 4-1 to the initial results of the port coastline classification assessment index quantization.

It should be pointed out that no matter the direct quantitative indexes, or the qualitative indexes, the identification of the index value should combine the previous survey results, related latest statistics materials as well as related expert’s opinions for comprehensive consideration. In addition, the spot survey and demonstration are also recommended.

3.4 Port Coastline Grade Assessment Model

To sump up, the port coastline grade assessment model built up will be multi-factor and multi-layer comprehensive assessment model, and the numerical formula is as follows:

$$S=\sum_{j=1}^{m} Z_j M_{kj} \qquad (3\text{-}6)$$

Sk- the direct quantization value in the k section port coastline, 0〈Sk〈1

Zj- the total weighting of the jth assessment index in the port coastline, 0〈Zj〈1

Mkj-the quantization grade of the jth assessment index in the K sect port coastline, 0〈Mkj〈1

In accordance with the established model, the simple and clear formula can be adopted to carry out multi-factor, multi-layer grade comprehensive assessment to the port coastline.

Chapter 4 Application of Port Shoreline Evaluation Model

4.1 The Application of Port Shoreline Evaluation Model

As the Phase one, two and three work of Yangtze Estuary Deepwater Waterway Regulating Projects has been or being completed, together with Shanghai municipality and Jiangsu Province, the Ministry of Transportation and Communications will implement the lower Yangtze waterway regulating project extended upwards from the Yangtze estuary deepwater waterway, that is, -12.5m waterway extended to Nanjing, which will enable 50,000-ton ship directly sailing to the lower navigational channel of Yangtze through the Nanjing No. 2 Yangtze River Bridge.

In order to adapt to the new development prospect down the Yangtze River from Nanjing, the Ministry of Transportation and Communications has adjusted the management mode towards ports down the Yangtze River from Nanjing, that is, integrating the ports down the Yangtze River from Nanjing into national coastal port transportation system from the national inland port transportation system, and has specified coastal port shoreline as the feature and nature of the river port shoreline in Jiangsu Province in newly publicized announcements such as Deep Water Standard of Port Shoreline (2004) and Brochure of Main Coastal Ports in China, as well as the newly constituted plans such as Costal Port Layout Planning in China (2005), Layout Planning of Ports along Yangtze Delta Region (2005) and Construction Planning of Ports along Yangtze Delta Region (2004).

Therefore, the Port Shoreline Evaluation Model is applied in the evaluation of port shoreline of Jiangsu region, and the result is shown in Table 4-2.

Table 4-1 Measurability of Evaluation Indexes of Port Shoreline Classification

Factors (F)	Indexes	Preliminary Results			
F1 Natural conditions	I1 Water domain protection condition	Port type(0.9)	Estuary type(0.8)	Grit/bank type(0.7)	Silt/open type (0.6)
		Good (breakwater not necessary) (0.9)	Common (small breakwater)(0.7)	Bad (large breakwater) (0.5)	Worst (0.3)
	I2 Designed off-shore distance of the dock front	Within 100 (0.9)	Within 200 (0.8)	Within 500 (0.6)	Beyond 500 (0.4)
	I3 Land depth	＞1000 (0.9)	＞400 & ＜=1000 (0.7)	＞100 & ＜=400 (0.5)	＜=100 (0.3)
	I4 Stability degree of the shoal(river regime)	Stable (no need for renovation, or dredging up a bit) (0.8)	Basically stable (proper renovation or necessary dredging up) (0.6)	Basically unstable (large swing extent, hard for renovation) (0.4)	Unstable (huge swing extent, not possible for renovation)(0.2)
	I5 Days of freeze, downfall (daily precipitation ＞ -25mm), thick fog (visibility ＜ 1km), gale (force＞level 6)	＜=30 (0.8)	＞30&＜=40 (0.6)	＞40&＜=50 (0.4)	>50 (0.2)
	I6 Height of wave (following and quartering seas)	<=2.0 (0.8)	>2.0 & <=4.0 (0.6)	>4.0 &<=6.0(0.4)	>6.0 (0.2)
	I7 Speed of river flow (fluctuating river flow and barotropic tide)	<=2.0 (0.9)	>2.0 & <=4.0 (0.7)	>4.0 &<=6.0(0.5)	>6.0 (0.3)
	I8 Geologic conditions (percentage of groundwork disposal expense in port and yard civil construction expenses)	<=0.1 (0.9)	>0.1 & <=0.2 (0.7)	>0.2 &<=0.3(0.5)	>0.3 (0.3)
	I9 Mud and Sand Silting	<=0.1 (0.9)	>0.1 & <=0.5 (0.7)	>0.5&<=1.0(0.5)	>1.0 (0.3)

F2 Transportation Zone	I10 Major types of route of the region	Ocean route (0.9)	Near ocean route and coastal route (0.7)	The Pearl River trunk stream and Beijing-Hangzhou Grand Canal (Hangzhou to Jining) route (0.5)	Not major channel route of national water carriage (0.3)
	I11 Position and function in national and regional comprehensive transportation system	National hinge (0.9)	Regional hinge (0.7)	Local hinge (0.5)	Edge/end of the comprehensive transportation system(0.3)
	I12 Density of direct hinterland road/railway/inland river route/ pipeline network	High (0.9)	Ok (0.7)	Low (0.5)	Lower (0.3)
	I13 Level of access to port area of road/railway/inland river route/ pipeline network	Leading to the wharf apron of the port (0.9)	Leading to storage yard (0.8)	Route connected with the port area (0.6)	No route connected with the port area (0.3)
F3 Economic location	I14 Based on hinterland	Yangtze Delta/the Pearl River Delta/Bohai Bay area (0.9)	Other coastal economic belt (0.7)	River/canal economic belt (0.5)	Undeveloped area (0.3)
	I15 Based on city	Special economic zones (0.9)	Coastal cities (0.8)	Cities along the Yangtze River(0.7)	Cities not opened up (0.5)
	I16 Quantities of scale zones along the port (economic development zone/professional industrial park/warehouse and bonded processing zone/logistics park)	Many (0.9)	Ok (0.7)	Not so many (0.5)	Few or none (0.3)
	I17 Transportation demands of hinterland (the layout and quantity of energy-consuming/water-consuming industries with large transportation volume)	Many (0.9)	Ok (0.7)	Not so many (0.5)	Few or none (0.3)

F4 Auxiliary conditions	I 18 Availability and level of Civil infrastructure (electricity/water/sewage/ Communication/fire-fighting)	Completed (0.9)	Fairly completed (0.7)	Not so much (0.4)	Very incomplete (0.2)
	I19 Convenience of financial services (banking/insurance/securities/futures)	Good (0.9)	Ok (0.7)	Not so convenient (0.4)	Inconvenient (0.2)
	I20 Promptness of entry-exit inspection (custom/National business inspection/frontier inspection)	Good (0.9)	Ok (0.7)	Not so prompt (0.4)	Bad (0.2)
	I21 Maturity of agency services (shipping agency and cargo agency)	Good (0.9)	Ok (0.7)	Not so mature (0.4)	Bad (0.2)
F5 Law environment	I22 Transportation industry policies established by local government (attention to port transportation)	Special support (0.9)	Encourage and support (0.8)	Unrestricted (0.6)	Restricted (0.4)
	I23 Compliance of port shoreline development and division of ocean functions (drainage area/flood-proofing planning)	Compliant (1)	Ok (0.8)	Partly deviated (0.5)	Totally deviated (0)
	I24 Compliance of port construction and overall urban planning (and land use planning)	Compliant (1)	Ok (0.8)	Partly deviated (0.5)	Totally deviated (0)

Table 4-2 Evaluation on the Segments of Port Shoreline, Jiangsu Section of Yangtze River

Position of bank segment				Result			
Bank	City		Segment	Score	Gradeing		
					Level 1	Level 2	Level 3
South Bank	Nanjing		Banqiao	0.87	●		
South Bank	Nanjing		Old ports of Xiaguan, Shang Yuan Men	0.94	●		
South Bank	Nanjing		Xin Sheng Wei	0.95	●		
South Bank	Nanjing		Longtan	0.84		●	
South Bank	Zhenjiang		Gaozi	0.90	●		
South Bank	Zhenjiang		Longmen	0.83		●	
South Bank	Zhenjiang		Dagang	0.94	●		
South Bank	Zhenjiang		The side of Yangzhong Island by the main river route	0.63			●
South Bank	Changzhou		Lu An Zhou-Weitang	0.72		●	
South Bank	Wuxi	Jiangyin	Old Tao Hua Port-Fanshui Station, Xia Port	0.78		●	
South Bank	Wuxi	Jiangyin	Fanshui Station, Xia Port-Shi Yu Port	0.95	●		
South Bank	Suzhou	Zhang Jia Gang	Wushan Port-Laotao Port	0.91	●		
South Bank	Suzhou	Changshu	Changhu river mouth-Xu Liu Jing Kou	0.85	●		
South Bank	Suzhou	Taicang	Langgang Kou-Qiya Kou	0.78		●	
North Bank	Nanjing		Pukou	0.86	●		
North Bank	Nanjing		Xiba	0.67			●
North Bank	Yangzhou		Liuyu	0.92	●		
North Bank	Yangzhou	Jiangdu	San Jiang Ying-Sima	0.65			●
North Bank	Taizhou		Kou'an	0.90	●		
North Bank	Taizhou		Yong An Zhou	0.87	●		

North Bank	Taizhou	Jingjiang	Dongxing	0.63			●
North Bank	Taizhou	Jingjiang	Bawei	0.76		●	
North Bank	Taizhou	Jingjiang	Jingcheng	0.78		●	
North Bank	Taizhou	Jingjiang	Shang Tian Sheng Port-Jiaogang Port	0.62			●
North Bank	Nantong	Rugao	Chang Qing Sha-Hong Bei Sha	0.68			●
North Bank	Nantong	Rugao	Heng Gang Sha	0.61			●
North Bank	Nantong		Old port of Nantong	0.95	●		
North Bank	Nantong		Langshan	0.92	●		
North Bank	Nantong	Haimen	Shuishan dock-Haitai Ferry	0.63			●

In order to validate whether the results coming from the valuation model of port shoreline is consistent with the actual development situation of the shorelines, the actual status of utilization and planning of the river port shoreline in Jiangsu section will be listed for comparison and reference. See Table 4-3 for the actual status of utilization and planning of the port shoreline segments in Jiangsu, Yangtze River.

It's easy to find through comparison that the two are consistent for most of the segments, that is, the development sequence of shorelines basically conforms to the results coming from the valuation model, which has indirectly proved the rationality of the model.

The value of model which I established is that: the model use Scientific and objective mothods, this research is the Latest and Comprehensive.

Table 4-3 The Actual Status of Utilization and Planning of Port Shoreline Segments in Jiangsu Section, Yangtze River

Position of bank segment				Actual Status of Utilization and Planning		
Bank	City		Segment	Shoreline with high development and utilization level currently	Key shoreline to be developed in the near future	Preserved shoreline for long-term development
South Bank	Nanjing		Banqiao	●		
South Bank	Nanjing		Old ports of Xiaguan, Shang Yuan Men	●		
South Bank	Nanjing		Xin Sheng Wei	●		
South Bank	Nanjing		Longtan		●	●
South Bank	Zhenjiang		Gaozi	●		
South Bank	Zhenjiang		Longmen		●	
South Bank	Zhenjiang		Dagang	●		
South Bank	Zhenjiang		The side of Yangzhong Island by the main river route			●
South Bank	Changzhou		Lu An Zhou-Weitang		●	
South Bank	Wuxi	Jiangyin	Old Tao Hua Port-Fanshui Station, Xia Port			●
South Bank	Wuxi	Jiangyin	Fanshui Station, Xia Port-Shi Yu Port	●		
South Bank	Suzhou	Zhang Jia Gang	Wushan Port-Laotao Port	●		
South Bank	Suzhou	Changshu	Changhu river mouth-Xu Liu Jing Kou	●		

South Bank	Suzhou	Taicang	Langgang Kou-Qiya Kou		●	
North Bank	Nanjing		Pukou	●		
North Bank	Nanjing		Xiba			●
North Bank	Yangzhou		Liuyu	●		
North Bank	Yangzhou	Jiangdu	San Jiang Ying-Sima			●
North Bank	Taizhou		Kou'an	●		
North Bank	Taizhou		Yong An Zhou	●		
North Bank	Taizhou	Jingjiang	Dongxing			●
North Bank	Taizhou	Jingjiang	Bawei		●	
North Bank	Taizhou	Jingjiang	Jingcheng			●
North Bank	Taizhou	Jingjiang	Shang Tian Sheng Port-Jiaogang Port			●
North Bank	Nantong	Rugao	Chang Qing Sha-Hong Bei Sha			●
North Bank	Nantong	Rugao	Heng Gang Sha			●
North Bank	Nantong		Old port of Nantong	●		
North Bank	Nantong		Langshan	●		
North Bank	Nantong	Haimen	Shuishan dock-Haitai Ferry			●

4.2 Port Shoreline Development Suggestions

As mentioned above, port shorelines are classified for better use and development of them. This classification serves as the basis for the formulation of measures for the development of port shorelines. On this basis, author hence work out development strategies catering to various classes.

4.2.1 The Development Surgestions of Grade-I Port Shorelines

Ports worldwide have experienced development for roughly three generations: the first generation of ports are mainly unloading, loading and storage centers of ocean shipping cargoes; the second generation of ports become service centers for value-added benefits of goods and also engage in industrial and commercial activities; and the third generation of ports are gradually becoming international logistic centers, to meet the requirements of global economic, trade, shipping and logistic development. At present in China, the second generation of ports remain the development mainstream, but the transition to the third generation has started. grade I port shorelines which are excellent in all aspects shall consider taking a suitable path towards international logistic centers, in light of their own conditions.

Some development strategies are provided as follows, which can be adopted by GradeI ports in light of their own conditions.

(1) Unified governmental planning, construction and management, and independent enterprise operation. The city government owns infrastructure of the port area. The port administration carries out unified development of land, docks, channels and other facilities in the port area, construction of the port and the industrial park as well as efficient, safe and convenient shipping transportation management. The port administration then rents the port to a private enterprise for management, which only needs to make investment in the machinery, equipment, storage ground and other auxiliary facilities on the dock.

(2) Establishment of large highly specialized logistic centers. The government shall encourage and build large logistic centers, construct special transportation channels for the logistic centers, provide necessary equipment for logistic

operation, adopt the most advanced information technology, as well as render value-added services and in-site customs services.

(3) Explicit division of logistic work and intensive management. There shall be explicit division of work in the logistic center of the port area. Try not to repeat businesses, so as to effectively avoid waste of resources and enhance the specialization of all logistic centers.

(4) Highly correlated logistic industry and “one continuous line” and value-added services. All logistics companies shall work as an organic whole to deal with businesses, which are complementary. The companies shall conduct cooperation to integrate such dispersive and single business activities as dock handling, stacking, storing, transporting, packing and other links into “one continuous business line”, so as to bring into full play the competitive advantages of working as a whole. Various value-added services will be provided for the owner: not only 24h self-service ATM machines, vehicle maintenance, storage, office buildings, clubs, convenience stores as well as other facilities and services shall be in place, but other value-added services like card board packaging, paper board packing, auto dismantling/container entry, cargo conveying, notarization and check of goods etc. shall be also provided.

(5) Highly automated logistics and flexible operation. Stacking of international containers can be planned, coordinated and supervised through the automation system. In the computer system, detailed information of every container has been saved. The system can also provide multiple inquiry, reporting and analysis tools, to assist in the storage of containers. The automation system is connected with the “information exchange service” and the automation system

of the paddle program. Ideally, the system can also specially display the three-dimensional map of the stacking ground and show at any moment the accurate positions of 90,000 TEUs at most on the dock. With the adoption of these advanced technologies, the berthing time of ships can be shortened, turnover of container trucks at the dock accelerated and customers' special requirements can be flexibly treated.

(6) Use of modern information technology and adoption of networking management. The port of Hong Kong makes use of modern logistic technologies and electronic information management to create spatial and temporal values for products, so as to further lessen the idle fund as well as reduce costs of dispatch and storage, hence integrating such concepts as supply chain management, e-commerce, timely supply of goods and zero inventory etc.

(7) Cultivation of the port logistic chain and common development between the port and the processing industry. The port park can be constructed in combination with attraction of foreign investment. Some land and berths close to the port are provided as special transfer bases for trans-national companies, which are in turn encouraged to build logistic centers and dispatch centers etc. in the port area. In this way, port logistics can provide professional and efficient logistic services for industries to enhance the processing level, which will further drive the increase of business benefits of the port.

4.2.2 The Development Suggestions of Grade-II Port Shorelines

With the development and utilization of port shorelines, a large number of port shorelines, esp. deepwater shorelines, have been destroyed and wasted to varying degrees. Many problems exist with the port shorelines, such as misappropriation for

other purposes, shallow use of deepwater, dispersive utilization, random use, “take more, use less” and even “take without use”. As a result, port shorelines have not brought or met with difficulty in bringing into play their due functions, and coastal areas of China are lacking in resources of port shorelines which can be well developed. The prospect allows of no optimism. Under the circumstances, to guarantee the development of port shorelines and maintain sustainable development of the port, China government have to put an end to or lessen the waste of port shorelines, but how to achieve this?

First, the problems at present should be cleared. Then, find out solutions to the problems.

The following are some suggestions for your reference:

(1) In the case of shallow use of deepwater port shorelines, the port shall be reasonably re-planned, and berths designed in light of one’s own situation, such as the economic development in the hinterland, the collection, distribution and transportation, for optimized layout of the port.

(2) Port shorelines misappropriated for other purposes shall be forcibly stopped by the government, because it is not only a waste of resources, but has also destroyed the environment. From whatever angle, such a waste of resources shall be compulsorily stopped.

(3) Port shorelines featuring dispersive utilization, random use, “more take, less use” and “take without use” shall be directed to development into the port cluster in combination with the surroundings. The port cluster is the result of the world port development catering to the economic development, and also a necessary choice for the port development to serve the economic

development. For example, the Bremerhaven, Hamburger, Amsterdam, Rotterdam and Antwerp ports in Europe just form a group of ports. In the world, the existence of several large ports in one region is actually not rarely seen. In economically-developed regions with flourishing transportation demands in particular, it has become a common rule for several major ports to coexist and bring into play the advantages of a port cluster. Though these neighboring ports are just scores of kilometers or one to two hundred kilometers away from each other, they develop side by side, both as rivals and supplements, to ensure that the economic development needs of the region are satisfied.

There are also constraints of the development of the port shorelines, contributing to utilization of port shores not good enough. Thus the following are also some suggestions for your reference:

(1) A complete collection, distribution and transportation system of the port. The capability of a port to render services for the hinterland economy and the expansion of its functions are both closely linked with its collection, distribution and transportation channels encompassing highways, railways, inland rivers and pipelines etc. In China, the ports do not have smooth collection, distribution and transportation channels and are not capable enough. This is a common problem, indicating that the construction and development of traffic infrastructure in China remains at a crucial juncture, so this is also a development problem. Currently, this issue has been addressed in the national plan of the expressway network. Believably, with the development of highways, railways, inland waterways and pipelines as well as improvement of the national integrated transportation network, problems concerning the port collection, distribution and transportation can

be effectively solved. On the other hand, the port shall cooperate with the government, to enhance the efficiency and shorten the stopover time of cargoes at the port, and accelerate their circulation.

(2) Explicit division of logistic work in the port and complete customer services. There shall be explicit division of work in the logistic center of the port area. Try not to repeat businesses, so as to effectively avoid waste of resources and enhance the specialization of all logistic centers. All logistics companies shall work as an organic whole to deal with businesses, which are complementary. The companies shall conduct cooperation to integrate such dispersive and single business activities as dock handling, stacking, storing, transporting, packing and other links into "one continuous business line", so as to bring into full play the competitive advantages of working as a whole.

4.2.3 The Development Suggestions of Grade-III Port Shorelines

Grade-III ports mostly refer to those with backward hinterland economy and bad support conditions in spite of excellent natural conditions of their own. Such port shorelines are mostly not developed or highly underdeveloped. For this type of ports, vigorous efforts shall be made to develop their regional economy and increase the traffic construction so as to increasingly improve the traffic network here. The industrial parks shall be also established, to attract investors with preferential policies, in order to make the conditions to develop the port shorelines more mature. Once the conditions are mature, vigorous development can be carried out.

Ports of various grades shall cooperate with each other in light of their own conditions and situations. They shall compose a port cluster to enhance the competitive strength.

Chapter 5 Conclusion

The appraisal to the grade of port waterway is a basic research for providing reference information to plan the ports and the port waterways actually. As a complicate system appraising process and an issue of multiple-element appraising, it covers many appraisal indexes and judgment elements. This article has researched it deeply and the conclusions are as following:

I. Determining the weight of each index is one of the difficulties of the multiple-element and multiple-purpose decision; therefore, the AHP can be applied based on appraising the economy comprehensively, the relative importance of all indexes shall be compared as per the classification standard (grade 1 to grade 9 shall be used) and a judgment matrix shall be built to resolve the character value of the matrix. The weight of this element to this rule shall be gotten by calculating the max character value of this matrix and the orthogonalization character vector corresponding to it. Upon this, the proportion of the elements in each layer to this rule can be found by calculation.

II. Based on the simplified AHP, this article determines the weight of the judgment element and appraisal indexes for the model of port waterway grade appraising and it has built a foundation for the comprehensive appraising model.

III. Regarding to the quantitative appraisal indexes, it can be determined directly—i.e. just determine a satisfaction value (top threshold) and dissatisfaction value (bottom threshold) in according to the technical criteria of the water engineering or the common sense while the top threshold is (1) and the bottom threshold is (0); for the qualitative indexes, the quantitative description cannot be described directly while its quantization shall be determined by “scoring”, i.e. setting the satisfaction value (top threshold) to 1 while the dissatisfaction value (bottom threshold) to 0; thus the values of appraisal indexes are between 0 1 after the

quantization.

IV. As the determine method of the appraising index weight based on the simplified AHP could cover various subjective and objective information scientifically and completely, it is an effective method, and the model for appraising the grade of the port waterway based on it shall be applicable.

V. Based on researching and probing into the method of determining the index weight of the comprehensive appraising model, this article uses a systematic appraising approach for appraising tens port waterways along the Yangtze river in Jiangsu Province and gives the initial result of the quantitative analysis which matches perfectly with the actual development of the port waterways.

So the decision makers could take it as a reference when they make decisions. It also sets forth the development measures for each different grade, which are also referential to the relevant departments. The qualitative and quantitative calculations shall be done further when the information is used practically in future so as to get a more rational conclusion.

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