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Approach to model on the fourth generation port competitiveness: an application for PDA

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Approach to model of fourth generation port Competitiveness: an Application for PDA

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DECLARATION

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

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

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ABSTRACT

Title of Dissertation: **Approach to model of fourth generation port Competitiveness: an Application for PDA**

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Today the ports are not the traditional pattern. 4th generation port is a new kind of port in modern life. In these paper I will analysis on the 4th generation port character which is more flexibility and agile. The 4th generation port is a key point of the supply chain service. The aim of the paper is to research on using the fourth generation port model to make more competitiveness of PDA. The survey include both of ideal modern port model and realistic application on PDA.

PDA is a very important port in northeast China and East Asia. It has the good geography environment, powerful economy hinterland. Both the software and hard environment of PDA is excellent in northeast China. This paper focuses on research of the fourth generation port evaluation indicator model which can provide much suggestion for PDA development. After the model of 4th generation port analysis we using AHP-FCE model to evaluation the index of PDA. To analysis the evaluation result of PDA can easy find out the advantage and weakness of it. So that we can make a suitable strategy of PDA development to the 4th generation port with its special characters. Finally, there are some suggestions for PDA to development. By these countermeasures PDA can develop more quickly and smoothly.

Key world: PDA, the fourth generation port model, flexibility, AHP-FCE model,

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LIST OF ABBREVIATIONS

PDA Port of Dalian

AHP Analytical Hierarchy Process

FCE Fuzzy Comprehensive Evaluation

TEU Twenty Equivalent Units

EDI Electronic Data Interchange

4^{th} generation port Fourth Generation Port

FPZ Free Trade Zone

UNCTAD United Nations Conference on Trade and Development

IPDFS Integrated Port Development Factor System

GDP gross domestic product

CHAPTER 1 INTRODUCTION

1.1Background of research

As the globalization process being speed up, transportation and logistic market face more challenges than before. It is well-known that china plays a significant role in maritime transportation. Since 1946 Malcolm Mclean invent container, more and more cargos transport by it. So we can say the container changed the traditional transportation way to the new pattern. Meanwhile because of the large scale using of container, the traditional port changed to be more special. Nowadays sea port is not the center of itself but one of the points in supply chain. The new function of port called the fourth generation port. Early 1999 the UNCTAD give the concept of it. In this concept demand the modern port not only need basic functions of traditional one but also need more agile and lean. This model can help port to get more competitiveness in the market.

Dalian Port is one of the main foreign trade ports in our country; it had long development history until today. PDA located at the entrance of the Bohai Rim, the south end of Liaodong Peninsula, it owns convenient geographical position easily transport the cargo from northeast Asian enter the Pacific Ocean to Far East, South Asia, North America and Europe Japan and South Korea. The hinterland of PDA is called center of the Northeast Asian economic circle. Now PDA play more and more important role in the world port. In 2007, the PDA handled the cargo includes: steel, iron ore, container, corn and other plants, crude oil etc, the total volume of PDA reached 165,440,000 tons, increased 20,252,000 tons than last year. Especially the

Container cargo completes 3,810,000 TEU, increased 18.7%than 2006.[1]

The fourth generation port was referring by UNCTAD [2]1999, but the details of this concept is still developed not format. In general it demands the terminal more flexible, agile and lean. Not the traditional function port but one point during the logistics process. Base on this background this paper focus on the fourth generation port model try to improve PDA competitiveness.

1.2 Research purpose

Base on the concept of the fourth generation port and the status of PDA, using some research methods and actual data to analysis the advantage and disadvantage of PDA. Then give the conclusion about competitiveness of PDA. After the mathematical model of forth generation port analysis, will give a suitable development way for PDA to expand itself and make more market share in future.

1.3 Research content

This paper has seven chapters to analysis the topic of a model on the fourth generation port competitiveness an application for PDA. Chapter 1 introduces some background of the topic, research aim, research content and logic link, and the limitation of this article. Chapter 2 this chapter main introduce the literature review of the whole research. It offered the basic theories which research by other scholar. Chapter 3 states the situation of PDA including the inner factor and outer factor, introducing all about the PDA status with truly data. Chapter 4 tries to set up a

[1] all these data are from the PDA development 2007
[2] UNCTAD refers to United Nations Conference on Trade and Development

mathematical model including all feature with fourth generation port. Base on the AHP and environment evaluation way. Try to find a new and comprehensive method to evaluate the port development. Chapter 5 uses the chapter 4 model to evaluate PDA. Try to analysis PDA with the fourth generation port model in details. Chapter 6 based on above analysis conclusion the countermeasure for PDA and gives some suggestions for development PDA.

1.4 Logic link

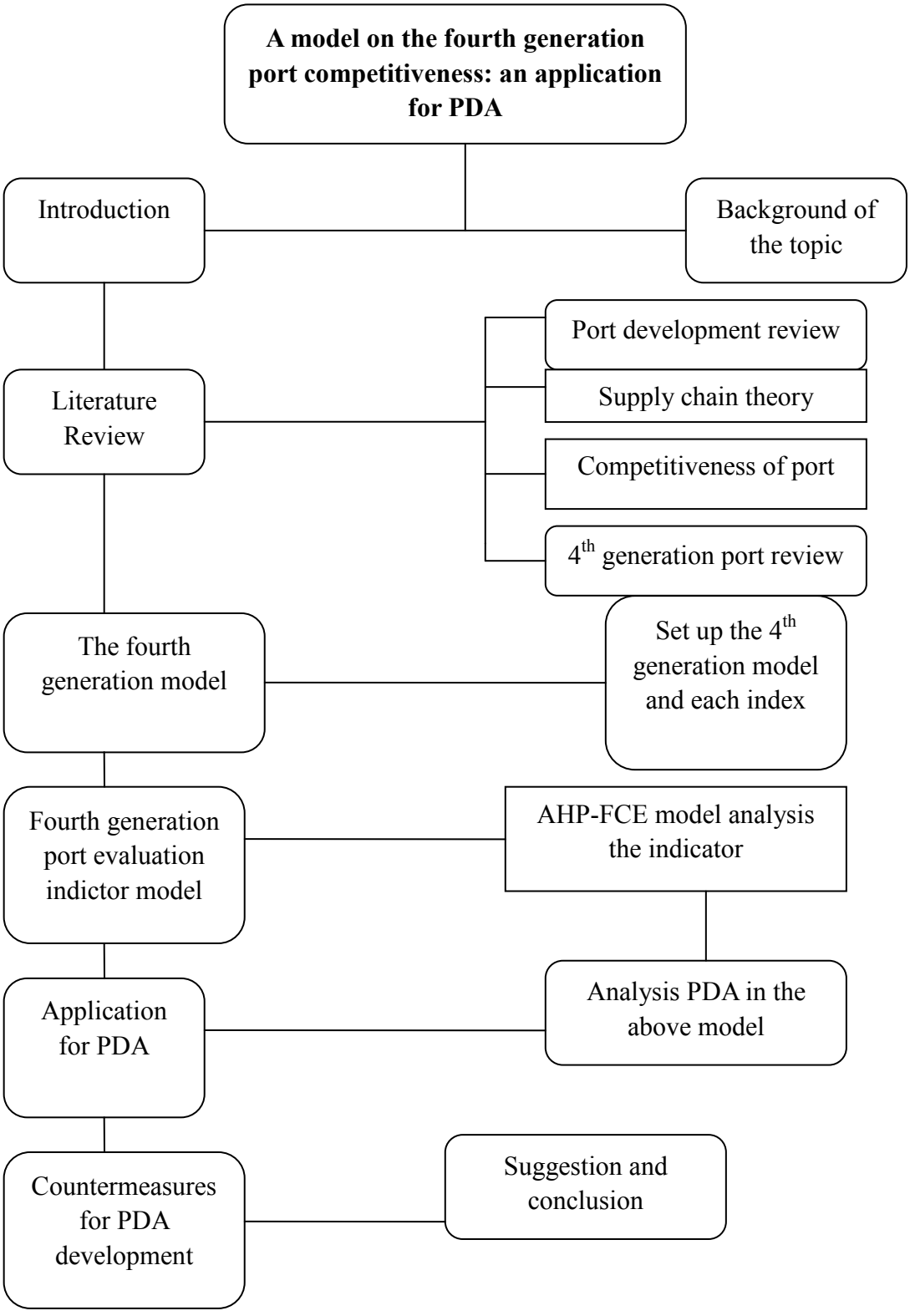


Figure 1.1 content logic links

CHAPTER 2 LITERATURE REVIEW

2.1 Port development

Since 1946 Malcolm Mclean invent container, more and more cargos transport by it. So we can say the container changed the traditional transportation way to the new pattern. Notteboom (2004) said the market environment in which container port and shipping lines are operating is substantially changing. The rise of world containerisation is the result of the interplay of macroeconomic, microeconomic and policy-oriented factors. The large mount of different size or pattern of container to be used for transportation, new built container vessels become bigger than before. All the facts about rapid growth and development affect trade route and container terminal, Ircha (2007). The door to door service demand modern container terminal improves tradition functions to follow the new need of modern logistics.

The first research model of port development was founded by an English geographer Bird (1963). He created the 'Any port model' which described how port infrastructures evolve in time and space. Bird proposed a five stage model to demonstrate how facilities in a typical port develop. Starting from the initial port site with small lateral quays adjacent to the town center, the elaboration of wharfs is the product of evolving maritime technologies and improvements in cargo handling. This is also marked by changing spatial relationships between the port and the urban core, as docks are built further away from the central business district. In the final stages, increased specialization of cargo handling, growing sizes of ships, and ever increasing demands for space, for cargo-handling and storage results in port activity being concentrated at sites far removed from the oldest facilities. During these five stages which forecasted by 1963, more or less fit the port develop progress.

Ministry of Communications of China (1997) clearly defined port as “distributing center of goods to be delivered”. European Port committee (2002) defined port as “the hub that goods to be transported are handled in” In that time this kind concepts of port just can description some basic function of port, during the maritime transportation development port as gate ways , as terminals which can ancillary industry and add value [3]of cargo which refer by Icha (2007).

Since World War II the whole world’s economy has turned into fast development, the port also development fast. According to the version of United Nations Conference on Trade and Development (UNCTAD) 1992, the function of port has been divided into three generations. From early 1950s to late 1980s which demanded the base functions, in 1999 the UNCTAD refer to the fourth generation port concept. But the UNCTAD not give the accurately definition of it. The follow table is Economics Functions of Port.

Table 2.1 the four generations port table

	First Generation	**Second Generation**	**Third Generation**	**Fourth Generation**
Started Period	Before 1960	After 1960	After 1980	After 2000
Principle Cargo	Conventional Cargo	Conventional and Bulk Cargo	Bulk and Unit Cargo Containerization	Specialization in special type of cargo like container

3 value adds means through the logistic service and packaging service etc to add the value of cargoes.

				handling ports
The port development position and Development strategy	Conservative junction of sea and inland transportation	Expansion transportation and production center	Industrial principle international trade base chain connecting transportation system	Itself converting into the industry
Activity Scope	(1) Cargo handling, storage, navigation assistance	(1) + (2) Cargo Type change ship related industry enlargement of port region	(1) + (2) (3) Cargo information, Cargo distribution, logistics activity Formation of terminal and distribution center	(1) + (2) + (3) (4) Developed as regional distribution and logistic center (5) Consultancy service on port project
Structure Formation and specifies	Every Body act individually in the	Relation between port and its user become more	Formation of port cooperation on system,	Port cooperation from port authority,

	port, Port and its user maintain informal relation	close, Emergence of slight correction among port activities, Negative cooperation relation between Port and Self governing community	Trade and transportation chain concentration in the port Relation between port and self governing community become more close Extension of the port structure	Changes from Monopoly market to Oligopoly market structure internally and externally
Character of the productivity	Invention of cargo distribution Individual supply of the simple services	Processing Cargo complex services Increase of the vale added	The flow of cargo and information Distribution of cargo and information Combination	Trade off between economies of scale and economies of scope

			of diversified services and distribution Value added	

Source: Prakash Gaur (2005). Port planning as a strategic tool: a typology. Retrieved May 3, 2007 From the Worldwide Web: http://www.worldbank.org

Follow these table analysis show the first to the fourth generation port characters. The first and second generation port periods passed long ago from us. Before the fourth generation port concept appearance, Paixao and Marlow (2003) showed that the third generation of port would be sufficient if the market is of certainty, but the environment is changeable, therefore, they suggest that ports adopt a new logistics approach, agility, to cope with the market uncertainty. Further on Marlow observed five phases in implementing agile ports, including identification of the port current processes, JIT preparation phase, the running of JIT operations phase, the lean phase and from lean to agile phase. Marlow (2003) has proposed the concept of lean port. A lean port is one that as a business unit makes the best use of its available tangible and intangible resources and, eliminates all sorts of waste in the physical and documentary/information processes related to the cargo and services. He also point that "A lean port network" composed of a number of lean ports will be more efficient and can deliver better customer service and share information. According to Malow's view about the third generation port I think these ideas are so benefit for us to analysis the fourth generation port. McGaughey (1999) regarded agility as the ability of enterprise to respond to change quickly and successfully. Zhen Hong (2005)

present that the port flexibility is a strategic mode satisfying the fourth generation port development，which can help port to suit new economical environment brought by modern supply chain management. He also suggest that port operators must meet the customer demands of diverse service, create an agile port，so that port is put into modern supply chain management，and can enter the range of the fourth generation port.

2.2 The fourth generation port review

2.2.1 Agility port

Zhen Hong (2003) pointed Agility Transport means when customer reduces the cost which use in moving the cargo. The carrier try to do the more selectivity and high quality service, meanwhile, this service must reduce cost, to make the customer satisfaction. Based on the system the carrier tries to careful design, arrange and implement the transportation process. This agility transportation concept is suitable for the harbor. The implementation agility port need to reengineering the flow of port operation.

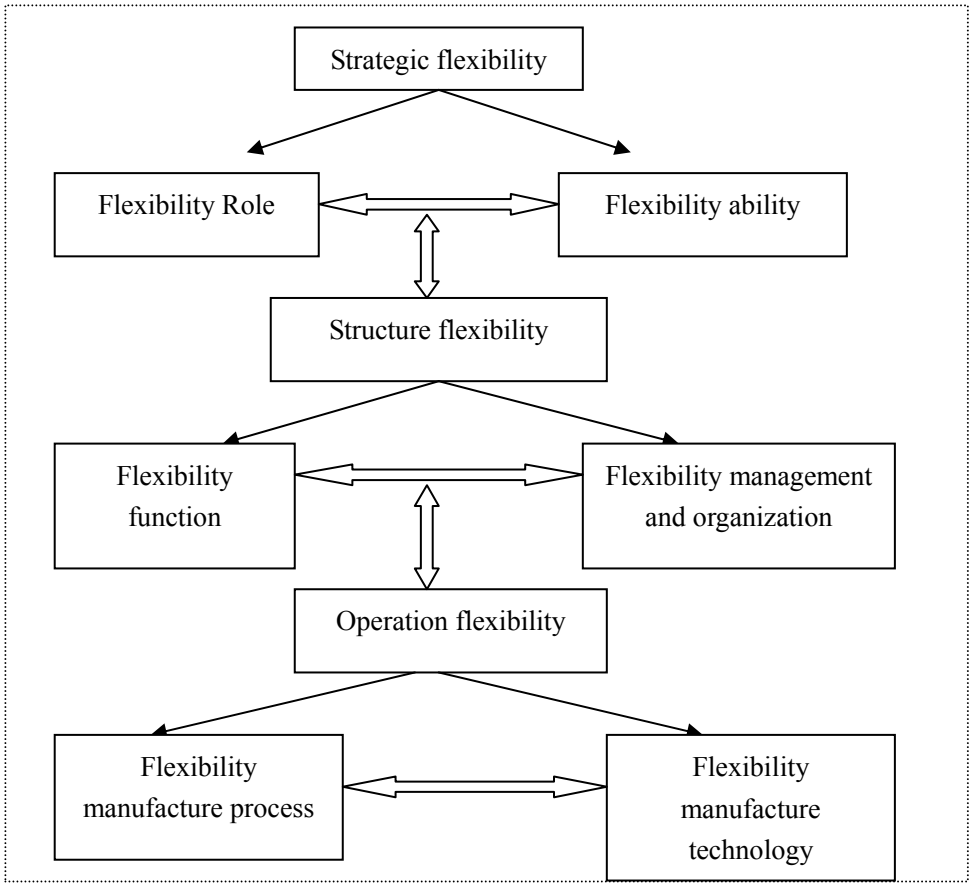
Zhen Hong (2005) said the agility of port reflects the ability of port to response the market. It demands that the port must quickly make response of market change to satisfy all kinds of demand which maybe individuation demand for the customers.

2.2.2 Flexibility port

In Merriam-Webster Collegiate Dictionary the flexibility is defined that characterized by a ready capability to adapt to new, different, or changing requirements. PAIXIAO

(2003) stated that flexibility and agility is for understanding the logistics function of port. They think if the change of the world has the rule to follow that will conclusion that ports develop to the third generation is stopped. But the world changes will not follow the same way. The external of the port Changes unceasingly. In order to adapt the uncertain situation modern port should take new kinds of way to carry the logistic-----flexible management[4].

LIUYI (2005) said that: The consideration scope of flexibility mainly includes resource, ability, organization, manufacture and culture etc.



[4] flexible management means the management method which response the market demand quickly and exactly

Figure 2.1 the flexibility port chart

Source: liu guiyun, Zhen Hong (2007) concept of flexible port and its connotation, *navigation of china*

2.2.3 Green port theory[5]

Wu penghua (2007) give us the concept of green logistic. Green logistic is also called environmental protection Logistics. It means in order to get customer satisfaction Overcoming space and time link the green supplier and the green requirement party to set up green service and management system.

The fourth generation port is green port. Because of lowering costs, saving resources the forth generation port is the trend for port development.

To establish green logistics idea, make green logistics policies and regulations, implement green logistics management, choose the green supplier, is the trend for society development.

The fourth generation port plays the role of supply chain point need to use more green technology. Also nowadays using more environmental protection technology during construction of the port.

2.3 competitiveness of port

The chief problem for container terminal development is competitiveness. During international maritime industry development more and more container terminals participate in the competition. Michael E Porter from Harvard University defines from the direct representation of competitiveness that advantage or disadvantage of

[5] green port theory refers to the environment protection during the port construction

an enterprise refers to the position of the enterprise in the industry. Xu Qin (2006) said the port competitiveness definition as the most basic ability to make port enterprise keep long-term competitive advantage achieve more profit and sustainable development Clarkson Research Studies (1992) pointed that the competition of ports means that the competition between ports operators for achieving profit. Wang Changda (2006) pointed that port competitiveness index reflect the scale and opportunity for sustainable development for a port's development, that is the integration of quality and quantity. Above these views of port competitiveness researchers evaluated it with long-term market share, customer satisfaction, profit etc. Hao Junli& Lei Mi (2005) pointed that port competitiveness as the ability and opportunity for a certain port to provide more attractive price and service quality than other ports. It shows as the ability of a port to get survival and sustainable development in market competition. Also some port chooses to cooperation with other port or shipping company to enlarge their market share for getting more customer satisfaction and profit. Gu Quanlin (2000) proposed four modes of strategic alliance of ports: technical, marketing alliance, regional economic development alliance, and merger and acquisition alliance. All these ways have the same aim that get the competitiveness. In 1990, Shanghai Maritime University summarized 6 main factors in relation to the port competitiveness: Geographic factor, Inland transport factor, Port service and efficiency factor, Price factor, Social economy factor, Information system factor. The ministry of communications of china had published a research on port development. Integrated Port Development Factor System (IPDFS) there are several factors: port layout and design, port management, Container throughput, port infrastructures, port logistics, port economy index, maintenance system, port security, information system, and customer service.

2.4 Supply chain theory

DONGDAI (2008) mentioned that since port is one point of supply chain is quoted. The fourth generation port change from independence role to one point of the supply chain. This change show the port pay attention to itself role in supply chain. This concept can describe the role of port is a service supplier. Also it changed traditional port service a lot such as cost-effective, flexibility and agility service. Regard port as the centre or node, will often lead the logistics to gather here, and consider that time lag logistics as a kind of rational phenomenon. Regarding port as a point in supply chain, emphasize information and material object flow through here with high efficiency.

Wu penghua (2007) said that Port logistics change from modern logistic management to supply chain management. Because the competitions are not between the ports but the competition of supply chain which port in it. Put emphasis on optimization supply chain.

2.5 Conclusion

Conclusion the literature review, first we can find a good container market. Nowadays container terminal industry takes a press during the competition. To build a powerful container terminal get more competitiveness an important issues. Many factors affect the competitiveness of container terminal. During the port develop from the first generation to the fourth generation. Today's container terminal need more lean and agile than before. Research aim of this paper is that according to the new characters of the fourth generation terminal model to build a more powerful PDA

CHAPTER 3 THE FOURTH GENERATION MODEL

3.1 Difference between the third and the fourth generation port

This paper research about the fourth generation port. Before set up the fourth generation model, we should emphasize the difference between the fourth and third generation port. By the aim of making sure the model under fourth generation port.

Since 1999 UNCTAD gave the fourth generation port concept. The fourth generation port handling Containerized cargo, the development strategy is by Port border alliance and Port navigation alliance. The production characteristic is the conformability physical distribution; the key to success is the decision-making, the management, the promotion, the training and so on soft factor[6]. They give the harbor illustration for the American Los Angeles and Long Beach's combination port as well as the Danish Copenhagen and Sweden Maimo's [7]combination port, and thought that the management joint the different local harbor cause the harbor development to enter a new stage.

The author thought that basic difference between the 4th and 3rd generation port does not in the hardware aspect. Because when the harbor developed to the third generation, it had already reached the hardware aspect which modern economy request. Also the author opposed that does not consider and the contemporary economy to blind expands the scale in the hardware aspect. Now with the economic development society request more about the harbor soft environment aspect. Only then, when the harbor had new special characteristic which never show before, the

[6] soft factor is on the opposite of hardware factor refers to the factor which can not see by eyes, many of the soft factor are about policies and management

[7] Du Kai (2006) how to develop domestic port p 27 for example .

shape of 4th generation of harbor appeared. The special characteristic of 4th generation port displays in the following several aspects.

Except meets hardware requirement of third generation port: Large scale, deep hydration, specialization, high tech, fourth generation port emphasize construction of harbor software service aspect, request to provide the individuality variation service. The 4th generation port must adapt all the demand of the market supplies chain. These characters inevitably to test the harbor soft environment aspect. Port provides the flexibility service, and provides agiler and seamless service of supply chain. Competition relationship among ports changes to cooperation, through the way of administration, the property right link, pooling of interests etc. In order to make strategic alliance[8] among various harbors in the same region.

The flexibility and agility is the Characteristic of logistics service function of 4th generation harbor. Some people believed that ", if world economics' change has the determination rule to follow or has determinism, then the harbor developed the 3rd generation to be enough." But the fact is, the world economic development is filling with uncertainty. The external environment of harbor changes unceasingly, is containing many uncertain market factors. Therefore, in order to deal with this indefinite factors, the modern harbor must adopt new physical logistics operation way - - flexibility management

3.2 The characters of the 4th generation port

3.2.1 Environment protection character analysis

[8] Strategy alliance refers to the port cluster strategy or other cooperation alliance management ways.

The 4th generation port is green harbor. Green logistics is the inevitable trend of port development. Setting up the green logistics idea, using the formulation green logistics policies and regulations, implementation green logistics management and choice green suppliers to realize the green logistics activity and take the reversion logistics is ultimately. The 4th generation harbor play as one node of supply chain logistics must take more green technology. The advanced environmental protection technology and the ecology technology will also be application in the port city's flood and field development.

3.2.2 high-tech character analysis

The 4th generation harbor is the technical port. The feature of harbor equipment shows: large scale, science and technology, informationization and network. The trend of port construction moves toward deep hydrated, large scale and the specialized. At present the top 30 container port, above 20 have more than 15m deepwater berth. It is common that they have above 100,000 t standard container berth and above 20,000 t dry bulk cargo wharf as well as above 300,000 t crude oil wharf. Meanwhile Ultra-large type deep water wharf has already constructed and at the same time the both sides loading and unloading inserting or floats dock has designed. Because of higher technology application the port becomes the public information platform of the city. And give more intelligent and high-tech service.

3.2.3 Port in supply chain analysis

The 4th generation harbor is supply chain logistics service harbor. The 4th generation harbor not only need to be standardization and formalization but also need to be more agile and flexibility which to satisfy the market demand. Also 4th generation

harbor provide higher quality and lower cost service to get customer satisfaction. According to different customers give individual service. Meanwhile Harbor and other logistics activity parties make a seamless supply chain logistics system. The 4th generation harbor makes itself as the service provider, considers for the customer, in order to get the market satisfaction as far as possible.

3.2.4 Cooperation of port analysis

The relationship among 4th generation port is not competition but cooperation. The economic globalization causes the competition from individual competition to coordination competition. The 4th generation harbor does not mean some individual harbors or docks but the group of harbor. In order to reduce cost and provide supply chain service, development of harbor group is inevitable. Because of the separated space and provided flexibility service the 4th generation port need to enlarge wide range of information system. All of these can not finished by EDI system which used in small scale range.

3.3 The 4th generation port evaluation model

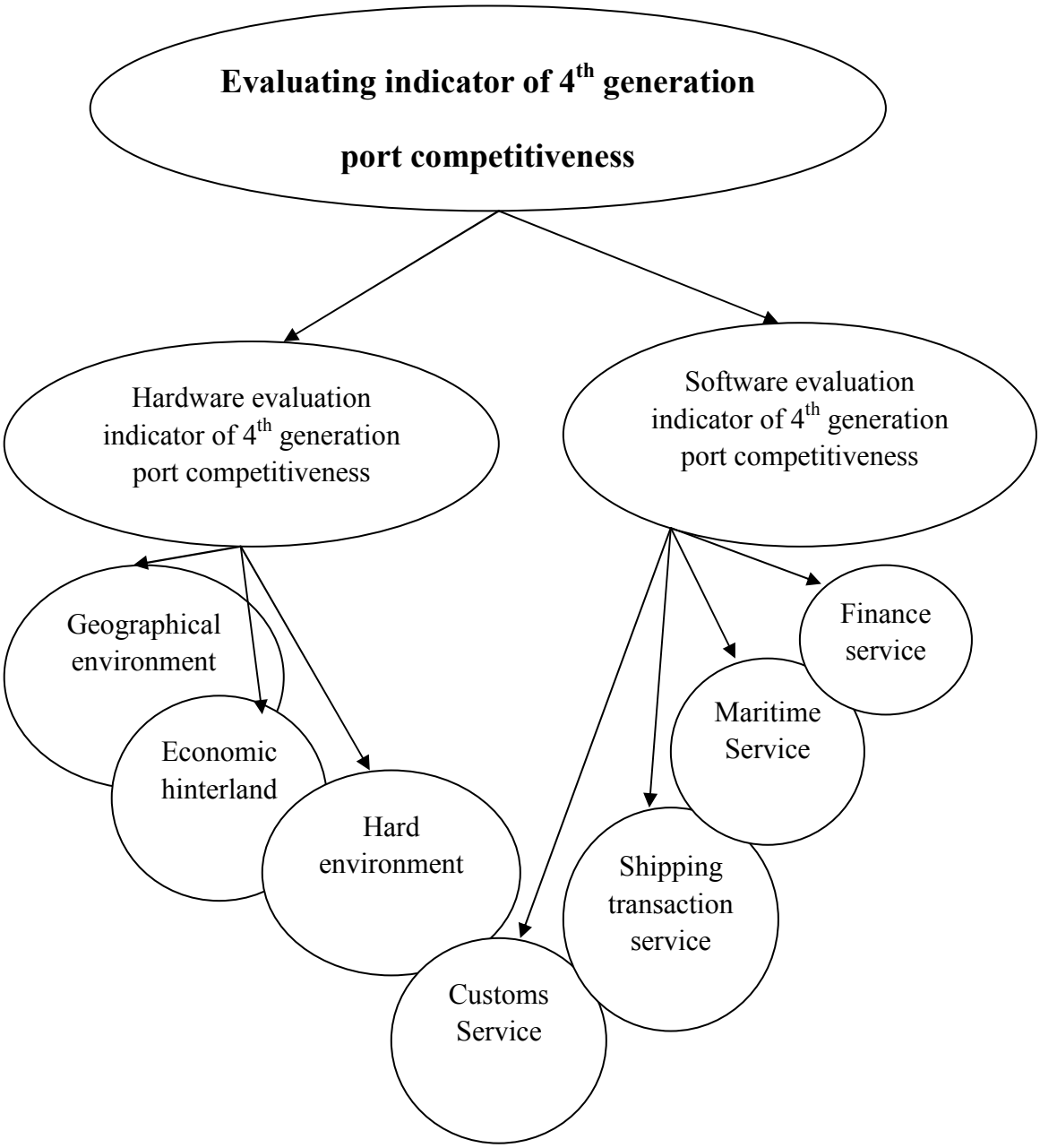


Figure 3.1 Evaluation indicators on Model of Fourth generation port competitiveness

3.4 Analysis on each Factor of Evaluation model

3.4.1 Geographical environment index

Geographical environment of 4th generation port is the first important factor which affects the competitiveness. The geography factor can limit construction and development of the 4th generation port. The space advantage of 4th generation port includes port construction condition, multimodal transportation condition and port position. The ideal location of 4th generation port is that near the economical development zone, good transportation network, close to the international main route, have enough deep water berth, have the good weather and geography condition.

3.4.2 Economy hinterland index

The hinterland of the 4th generation port is where the container cargoes and other cargoes come from is the most important effect of the 4th generation sustained development. The development level and industrial structure of 4th generation port hinterland directly influence the port development. The hinterland economic contain that city port development, total quantity of GDP, even industrial structure of hinterland, freedom level of international trade etc. also the hinterland divide to direct or indirect hinterland. With the port development the indirect hinterland will transform to direct hinterland.

3.4.3 Port hardware environment index

The harbor hardware environment of 4th generation port means the synthesis infrastructure condition of port. It contain that ability of equipment handling, storage facilities ability, efficiency of machinery, turnover capacity of port , berth quantity of port as well as ability of ships allowed . Currently competitions among international harbor are intense. With the Global logistic development make higher request of port such as reduce ships in port time in order to speed up ships' turnover time and make

more profit of shipowner as well as increased marginal benefit. Therefore hardware facility condition of port is much more concerned by the shipowner and cargo owner.

3.4.4 The harbor software environment index

Soft environment of harbor mainly include : internationalization and liberalization level of port, port policy ,the finance and insurance environment of port, the business environment and logistics service etc .The free port policy attracts the customer mainly because the custom does not take intervention of storage, circulation, simple processing of cargo , packing in this area. So it will be easier for customer. At the same time the competitiveness tariff policy of port is direct influence the competitive power of port in the market. For example, Malaysia's got two big customers which are Maersk and Evergreen by cheaper tariff from Singapore port.

3.5 Detail analysis of 4th generation port competitiveness evaluating indicator

3.5.1 Harbor position

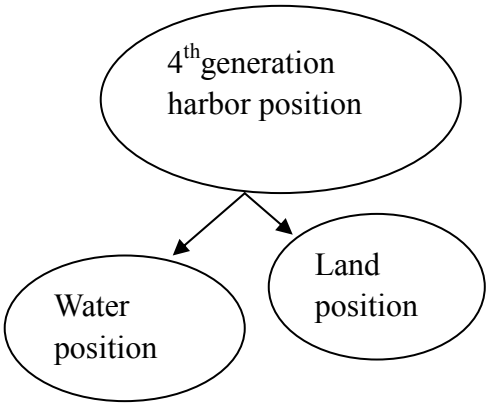


Figure 3.2 harbor position

The harbor location is important factor for competitiveness of port. The harbor positions divide into the waters position and the land position. The water position refers to the international route network of harbor in world. The 4th generation port must locate in cross point of many international routes. The land position refers to the hinterland and convenience of multimodal transportation. The 4th generation port must locate in the center of economic cycle and have powerful hinterland and convenience transportation condition

If the harbor wants to attract more sources of cargoes, to become the international shipping center, it must own the good geographical position. Which means have good water position and land position. Because the main competitions of the port is the cargo. Have both good water positions which the cross point of international main route and good hinterland will be better to the port development. Also lots of cargo owners choice the call port must be basic the principle low down the cost. On the contrary, if a harbor is far away from the international main route, even if have good port facilities, can easy lose competitiveness. The best examples are Singapore and Hong Kong both of them have good water position and land position.

3.5.2 Harbor layout condition

The layout of port directly affects the capability of port. And also influence the competitiveness of port. This factor includes that number of berth, water depth, equipment and other port establishment etc. The most important point is the deepwater berth which can limit port development. Because the deepwater berth have higher efficiency and lower cost. At present, water depth of main channel of the 4th generation port must reach -15meter which can pass fifth generation container ship. All above factors detail about port layout can be the 4th generation port

competitiveness evaluating indicator.

For example: The Rotterdam port keeps first-class port for long time. The successful point is with the development of market demand the Rotterdam port always followed the trend. Making enough deepwater berths and adjusting the layout of port.

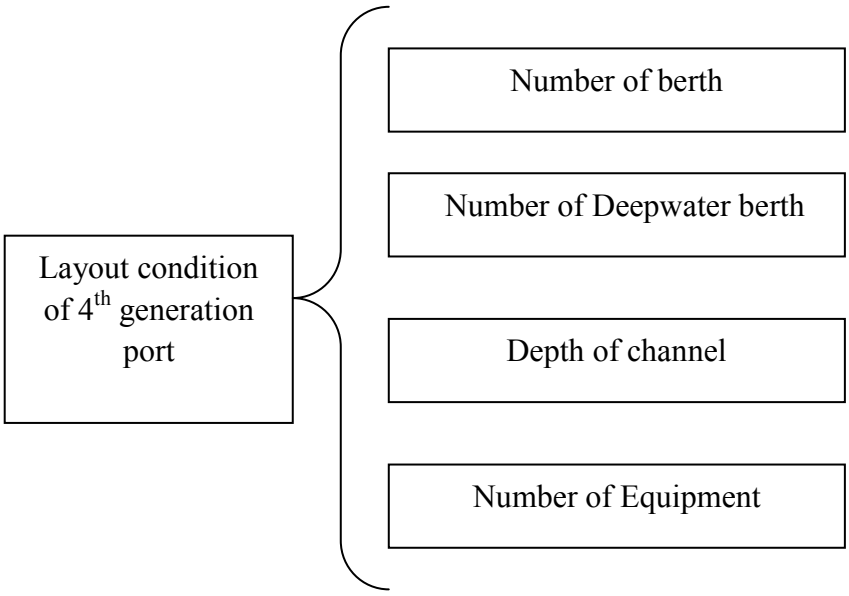


Figure 3.3 layout condition of port

3.5.3 Shipping service

The level of shipping market service can influence 4th generation port development. Also it can show the maturity of the port. The shipping marker service can measure by some numbers such as number of shipping company, number of cargo and ship agent, density of international route etc. Matthew Effect describes container liner shipping. The more flight in port, the bigger coverage scale, the more money and cargoes. Meanwhile prosperity shipping market can attract more flight to call ship.

So the shipping market service level will be important factor for 4th generation port development.

In order to make the port growth more quickly we need to development the transportation market, the generalized shipping market, which refer to all kind of service related with transportation. Because the shipowner and the cargo owner always think about if the port have good and convenient agent. So the shipping market service will direct affect the selection of customer.

There are some other industry which related with Shipping market service such as ship manufacturing industry, harbor machinery manufacturing industry, ship maintenance industry, maritime court, maritime consultation service, classification society, ship insurance and finance service etc. All of these will support 4th generation port development. Above all there are soft environment services for port development. The good soft service will give more convenience for customers. If the port get mostly customer satisfaction it will get more market share and competitiveness.

provide highly effective, the high quality shipping service, moreover may enhance the harbor to a great extent the popularity: If London, because although the route has lost former days' magnificence, but there has the world-famous Lloyd's information service company, the Lloyd's classification society, Drury consults society and so on shipping Service organizations, they enabled London still to enjoy the international shipping center great reputation.

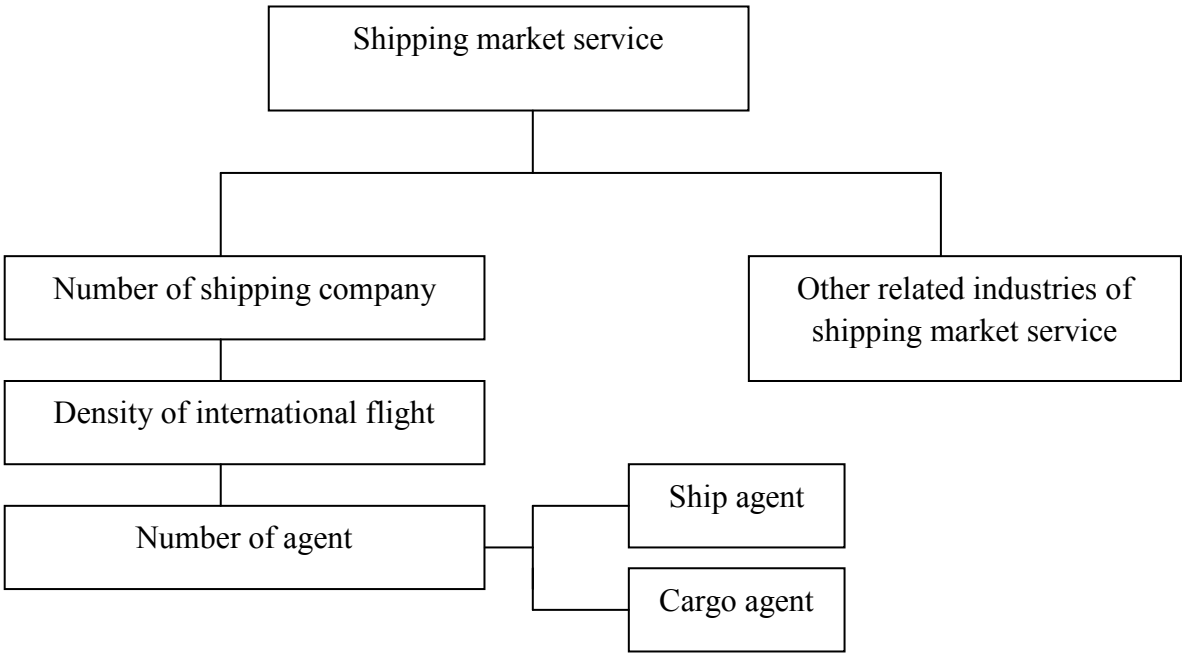


Figure 3.4 shipping service

3.5.4 Harbor performance

Harbor performance refers to the scale of port and production capacity. The 4th generation port competitiveness manifests in port throughput and work efficiency and quality. In order to improve the performance port should improve efficiency of handling cargoes and reduce the ship in port time as well as make sure the quality.

With the ship become bigger and bigger the 4th generation port should use some modern equipments to handle cargo more agility. Above all the big throughput of port and satisfactory service quality and efficiency service will be the demand of 4th generation port.

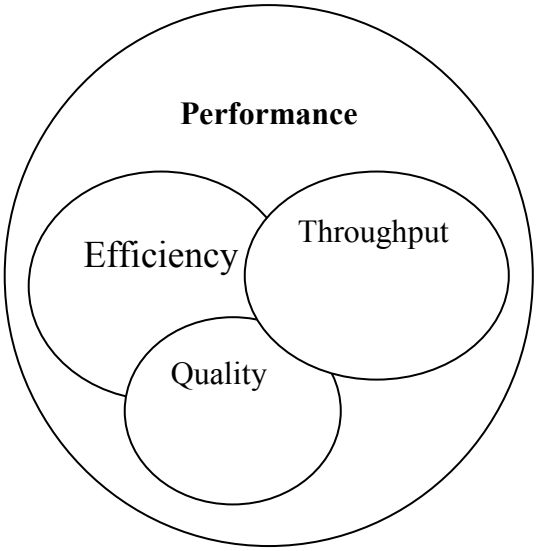


Figure 3.5 Harbor performance

3.5.5 Government factor

The government factor refers to the policy and management which the port city government made. Currently the port is not the traditional one but the windows of countries. So Government will support port with finance and policy. And today the 4th generation port competitiveness direct affect by these finance and policy support. In this sense the harbor enterprise's competition will be replaced by the market competition and the policy competition. The Local government gives policy guidance for the harbor development will promotes the harbor competitiveness. The government management of port will help the 4th generation port to provide higher service and get market share. On the contrary, the bad government factor will give more blocks for port development.

3.5.6 Harbor environment

The harbor environment means

The harbor freedom policy is different from government policy. The degree-of-freedom of the port can help port to attract more customers. Because the freedom port can develop more flexibility in the market. And the most important character of 4th generation port is flexibility, so with the freedom policy the port can develop flexibility.

The efficiency of Cargo through the custom is important for modern port. Currently some high-tech way used by modern port. The information service takes the important role of modern port development. This information service of port refers to share common information among the cargo owner, the carrier and other partner of the business. The harbor information service raised work efficiency of the port. And it is better for port resource to gather up as well as to reduce the time in port. So it can raise the supervision power of custom. To development of information-based port can attract more customers. The 4th generation port plays the role of information collection and distribution center. Information technology will make the 4th generation port to be more powerful in the market. Now modern port built information center, in order to adept the demand of electron business and digitization of information transmission. The agility information system can be the most important factor of the 4th generation port.

3.5.7 Harbor management

The 4th generation port management factor contains four parts which are handling efficiency, port traffic, intelligent level of port and cost of each ship arrive in port. Modern management of port is the inevitable trend which development international big port. Under the market economy environment, harbor management system and

the operation system is the most important factors for 4th generation development. The flexibility, agility and efficiency management model can be the obvious factor of 4th generation port. It can improve the handling efficiency and service level of the 4th generation port. The ability of port management should affect the operation and management level of port managers. Port manager through the effective management to realize that valid use of the harbor resources and both of cargo owner and shipowner satisfaction. Value-added service can win more customer satisfaction.

Port handling efficiency will affect the ships in the port operation time. Along with the development of large ships, shipowner takes much attention of the unit transportation cost of large-scale container ships. High efficiency of port handling may reduce the ships in the port work time and save cost for shipowner. This can explain why large-scale ships always choose alongside in the high handling efficiency harbor. Therefore improving port handling efficiency to be considered as the 4th generation competitiveness factor.

Both Port tariff and the port handling efficiency influence the shipowner. The port tariff is an important attribute affect the harbor competition status. Especially in the containerized transportation, the shipowner may compare port tariff of each call port. China port administration organizations give each port the elasticity port tariff limitation. Therefore the port tariff also becomes competition method between the harbors. The port tariff is refers to fee of port service, maritime affair, navigation, customs supervision, inspection. Cutting down the port tariff will be possible to enhance the competitiveness of harbor.

Harbor intelligent level and automated level is the symbolization of 4th generation. The intelligent level of port can improve cargo handling efficiency greatly. Also it

guarantees the quality of cargo handling and storage. Meanwhile the intelligent port management can reduce the labor intensity.

3.5.8 Harbor transportation network system

The powerful transportation network of port can optimize the transportation route and reduce cost. The transportation network can to be possible to provide the highly effective cargo logistic for cargo owner. The harbor transportation network system will gain stable source of goods enhance harbor competitiveness. Therefore highly effective transportation network is the important external factor which affects the harbor development, immediate influence to harbor turnover. In order to develop port we necessary to develop the transportation network system which can make sure the port turnover.

3.5.9 Port city economy and finance condition

Port and city development are closely linked. The economic and finance condition of hinterland will provide a good space for port development. The international trade environment and GDP of city will attract customer. The port city economical finance condition include that the internal and external business trade [9]of the city, the number of finance organization, the freedom level of port city and the foreign investment scale. All of these factors can be direct affect the 4th generation port development.

[9] The most important part of the trade for port development is the foreign trade

CHAPTER 4 AHP-FCE [10]MODEL ANALYSIS THE FOURTH GENERATION PORT COMPETITIVENESS AND PDA

4.1 Introduction the general content of chapter 4

In the first three chapters we introduced the 4th generation port development process. And trying to set up the 4th generation port evaluation indicator which can give us some general ideal to understand the 4th generation port and how to measure the competitiveness of 4th generation port.

After the basic introduction the next step is to choose methods to measure these indicators of the 4th generation port. So that we can find out the weight of these evaluation indicators to affect 4th generation port competitiveness.

The American scholar LAZadeh said that "the more complicated of the research system the more effect factors therefore the ability of precision will be lower." So this research chooses to combine the Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation (FCE) methods. First make the qualitative analysis to set up the evaluation indicator system, then expert analysis each indicator. These indicators of the 4th generation port competitiveness will be showed by AHP model. This AHP model can fix quantify of weight about each indicator. At last the FCE methods to give the final result of the port.

4.2 Introduction the mathematics method of AHP

Wang zongjun (1998) said that: the analytic hierarchy process (AHP) was brought by

[10] AHP-FCE model refer to Analytical Hierarchy Process and Fuzzy Comprehensive Evaluation

the renowned scientist Professor T.L.Satty who taught in University of Pittsburgh in the mid-70s. It will be one kind will determine the nature of the system analysis method. The layout of AHP method basic on first divided the complex question to several component elements in order. Then compare them to make sure the weight of each element. Using analytic hierarchy process to determine weight of target as main step following:

4.2.1Establishment hierarchical structure model of AHP

In order to analysis first step is to establish the evaluation target and method. So that we need to put each indicator in their position and clear about the relationship of them. We put all them together to make a multi-level structural model system.

4.2.2Building the comparison judgment matrix of AHP

After hierarchical structure establishment, second step is to compare each two essential factor, and quantification them use the judgment criterion in order to build comparison judgment matrix.

Table 4.1 comparison judgment matrix

H_K	A_1	A_2	. . .	A_j	. . .	A_n
A_1	a_{11}	a_{12}	. . .	a_{1j}	. . .	a_{1n}
A_2	a_{21}	a_{22}	. . .	a_{2j}	. . .	a_{2n}
A_i	a_{i1}	a_{i2}	. . .	a_{ij}	. . .	a_{in}
A_n	a_{n1}	a_{n2}	. . .	a_{nj}	. . .	a_{nn}

Table 4.2 Judgment criterion table

Judgment	Important level
9	For HK, Ai is Absolutely important than Aj
7	For HK, Ai is More important than Aj
5	For HK, Ai is Obvious important than Aj
3	For HK, Ai is Slightly important than Aj
1	For HK, Ai and Aj at same Important level
2,4,6,8	intermediate quantity between criterion

4.2.3 Calculates the indicator weight of AHP model

In order to refine the useful information from the judgment matrix, so that can help us to make a decision. The next step is to calculate each matrix weigh and the whole judgment matrix weight.

4.2.4 The consistency check of judgment matrix of AHP

After calculation the weight of judgment matrix. The consistency check is the way to measure if judgment matrix weight is extract and reasonable. When the judgment matrix has uniformity character, the maximum value is slightly bigger than matrix

number n. Meanwhile other characteristic values close to 0. Only by this way the conclusion AHP model is reasonable, the examination formula is as follows:

$$CR = \frac{CI}{RI}$$

In the formula CR is the comparatively measurement of the consistency check, if $CR \leq 0.1$ the judgment matrix is reasonable. On the contrary need to adjust the data of judgment matrix.

In the formula CI is measurement of the consistency check, when

$$CI = \frac{(\lambda \max - n)}{(n-1)}$$

λmax is the maximal characteristic value of judgment matrix, n is the judgment matrix number; RI is the average random sample of consistency check, the value of RI may find out in value table.

Maximum value of the judgment matrix is λmax. The formula as following

$$\lambda \max = \sum \frac{Swi}{ni}$$

In this formula, S is the judgment matrix, ω_i is the weight factors for judgment matrix S, w is the Sω factor.

4.3. Fuzzy Comprehensive Evaluation (FCE)

Qin shoukang (2003) mentioned that recently FCE method develops quickly and be used in so many areas. The advantage of the method is the measurement consider about the complexity internal relationship of objective things as well as the fuzziness of value system.

4.3.1 The main principle of FCE[11]

The Fuzzy Comprehensive Evaluation is the method which utilized of fuzzy mathematics tool to makes to Comprehensive Evaluation. U= {u_1, u2… u_m} is the set of sub factor. When the U contains lots of factor, the important coefficient of each factor is smaller. At this time the final result is hard to distinguish of good or bad. The V= {v_1, v2… v_n} is the set of evaluation. We need to use U and V and the fuzzy matrix R to give the final result.

4.3.2. The three essential factors of fuzzy Comprehensive Evaluation:

Factor set: U= {u_1, u2… u_m}

Evaluation set: V= {v_1, v2… v_n}

Single factor judgment $\tilde{f} : U \rightarrow F(V)$, u_i α $\tilde{f}$ (u_i) = (r_{i1}, ri2…r_{in}) $\in$ F (V)

From $\tilde{f}$ can get the fuzzy relationship

$R_f \in$ F (U*V)

$R_f(u_i, v_j) = r_{ij}$

$$R = \begin{bmatrix} r_{11} r_{12} \ldots r_{1n} \\ r_{21} r_{22} \ldots r_{2n} \\ r_{m1} r_{m2} \ldots r_{mn} \end{bmatrix}$$

Because of the fuzzy weight of the factor set $A = (a_1, a_2, \ldots, a_m)$ R change to the fuzzy set B by using the evaluation set V

$$B = A \circ R$$

[11] Qin shoukang (2003) Fuzzy Comprehensive Evaluation and application

So that (U, V, R) set up the integrated evaluation model

The fuzzy model through this way

$$A \in F(U) \rightarrow R \in F(U \times V) \rightarrow B = A \circ R \in F(V)$$

4.3.3 Multistage fuzzy evaluation model

In the practical application, the evaluation object factor sets are not single but multistage. So as following we will introduce the multistage fuzzy evaluation model. We take the second-level fuzzy evaluation model for an example.

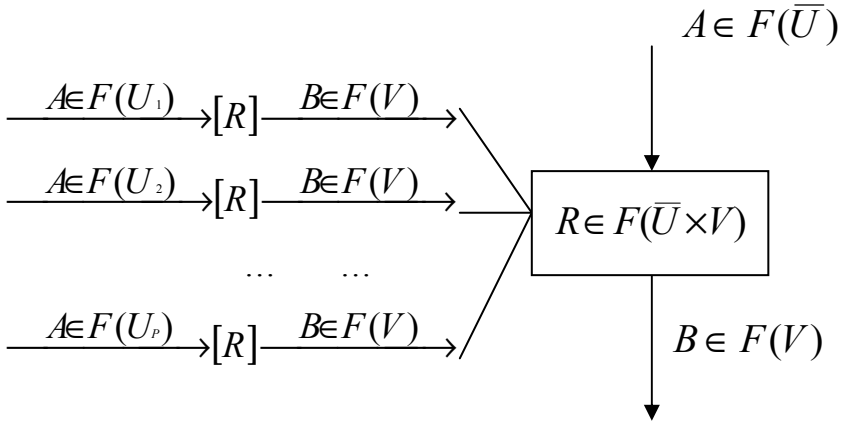


Figure 4.1 second-level fuzzy evaluation model

Source: dong jianhua (2004) vessel estate and evaluation indicator

4.4 Application of the AHP-FCE model on 4th generation analysis

4.4.1 Evaluation indicator of 4th generation port competitiveness

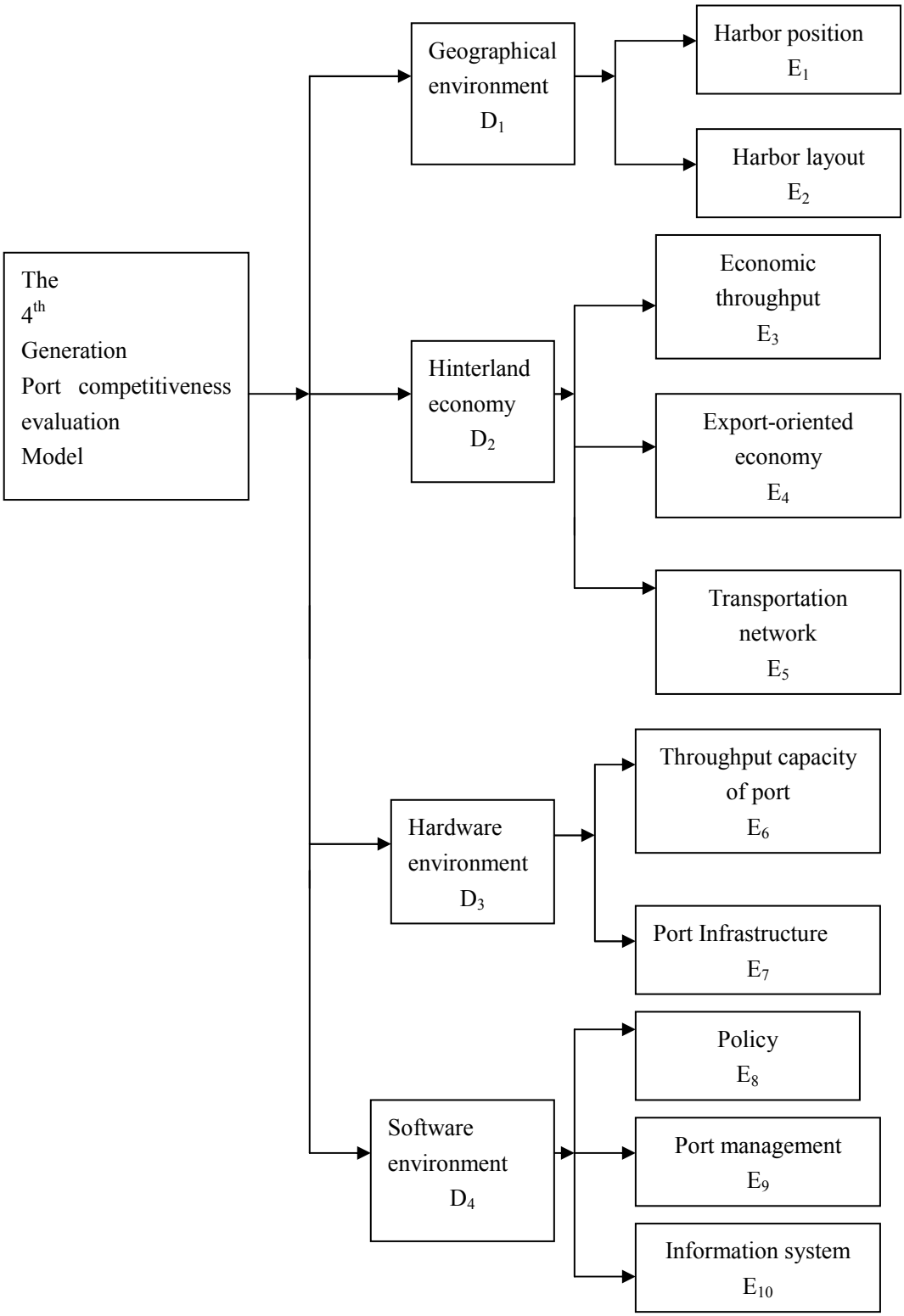


Figure 4.2 Evaluation indicator of 4th generation port competitiveness

4.4.2 Index of the model

The picture show the target of model is (c) the 4th generation port competitiveness. Middle level is the criterion level include by the geographical environment (D1), the hinterland economy (D2), the hard environment (D3), the soft environment (D4). All above index criteria can weigh and manifest the target criterion. The last target level include harbor position (E1), the harbor layout (E2), the center economic output (E3), the Export-oriented economy(E4), the transportation network (E5), port throughput capacity (E6), the harbor infrastructure (E7), the policy (E8), the harbor management (E9), the information system (E10). These ($E_{1\text{-}10}$) are belong to ($D_{1\text{-}4}$) which can affect the final target.

Through the survey report from expert, we can calculate the weight of each evaluation indicator. When CR< 0.1 the judgment matrix have the satisfaction result. But when $CR \geq 0.1$ the judgment matrix must be adjusted.

4.4.3 Allover weight of 4th generation port competitiveness

Table 4.3 weight of 4th generation port competitiveness

The competitiveness evaluation indicator is C , the Uniformity Proportion is 0.0245 , weight for the final aim is 1.000					
4th generation competitiveness evaluation indicator	Hinterland economy (D2)	Geography environment (D1)	Hardware environment (D3)	Software environment (D4)	W_i
Geography environment	0.6703	1.000	2.2255	1.2214	0.2716

(D1)					
Hinterland economy (D2)	1.000	1.4918	3.3201	1.4918	0.3854
Hardware environment (D3)	0.3012	0.4493	1.000	1.000	0.1418
Software environment (D4)	0.6703	0.8187	1.000	1.000	0.2012

Table 4.4 Geography environment factors evaluation indicator

the Uniformity Proportion is 0.0000 , weight for the final aim is 0.2716			
Geography environment (D1)	Port position (E1)	Port layout (E2)	Wi
Port position (E1)	1.000	0.6703	0.4013
Port layout (E2)	1.4918	1.000	0.5987

Table 4.5 Hinterland economy factors evaluation indicator

the Uniformity Proportion is 0.0171 , weight for the final aim is 0.3854				
Hinterland economy D2	Economic throughput E3	Export-oriented economy E4	Transportation network E5	Wi

Economic throughput E3	1.0000	1.4918	2.7183	0.4983
Export-oriented economy E4	0.6703	1.0000	1.2214	0.2923
Transportation network E5	0.3679	0.8187	1.0000	0.2094

Table 4.6 the hardware environment factor evaluation indicator

the Uniformity Proportion is 0.0000 , weight for the final aim is 0.1418			
Hardware environment (D3)	Throughput capacity of port(E6)	Port Infrastructure(E7)	Wi
Throughput capacity of port(E6)	1.0000	1.2214	0.5498
Port Infrastructure(E7)	0.8187	1.0000	0.4502

Table 4.7 The software environment factor evaluation indicator

the Uniformity Proportion is 0.0043 , weight for the final aim is 0.2012				
Software	Policy(E8)	Port	Information	Wi

environment(D4)		management(E9)	system(E10)	
Policy(E8)	1.0000	1.8221	1.4918	0.4517
Port management(E9)	0.5488	1.0000	1.0000	0.2650
Information system(E10)	0.6703	1.0000	1.0000	0.2833

4.4.4 Final evaluation indicator of the 4th generation port competitiveness

Table 4.8 Final evaluation indicator weight of 4th generation port competitiveness

Factors	Weight
Economy throughout (E3)	0.1920
Export-oriented economy (E4)	0.1127
Transportation network (E5)	0..807
Port position (E1)	0.1090
Port layout (E2)	0.1626
Throughput capacity of port (E6)	0.0780
Port Infrastructure (E7)	0.0638
Policy (E8)	0.0909
Port management (E9)	0.0533
Information system (E10)	0.0570

After the analysis of AHP model, we get the each factor weight for the 4th generation port competitiveness. We get some information to development 4th generation port. After established the 4th generation port competitiveness evaluation indicator system

we analysis the port internal and external environment. Finally this AHP model will provide us some general idea for development of the 4th generation port.

These weight data of the factor which affect harbor development will help the port to check itself. And compare with the other port. Meanwhile it will be give the port some suggestion to development for their character in the future. If the port know itself well they will do the right development countermeasure[12].

4.4.5 FCE model analysis the AHP result and get the final result of PDA

After the AHP model, this paper will use the evaluation indicator weight to further analysis by FCE model to check the 4th generation port competitiveness factor in PDA. In order to get the final result of each factors weight in PDA. Then we can basic on this result to give the Target-oriented countermeasure to develop PDA to become the competitiveness 4th generation port.

Analysis the evaluation indicator weight by FCE to give PDA a general evaluation

The factor set of U contain that u_1 is the geography environment, u_2 is hinterland economy, u_3 is the hardware environment of port, u_4 is the software environment of the port.

$U=\{U_1,U_2,U_3,U_4\}$={geography environment, hinterland economy, hardware environment, software environment}

$U_1=\{U_{11},U_{12}\}$={port position, port layout}

$U_2=\{U_{21}, U22, U23\}$ = {throughput of economy, export-oriented economy, transportation network}

$U_3=\{U_{31},U_{32}\}$={throughput capacity, port infrastructure }

$U_4=\{U_{41},U_{42},U_{43}\}$={policy, port management, information system}

[12] the development countermeasure in details are showed in the chapter 6

The evaluation set is V which contains that excellent, good, general, bad.

V= {V1, V2, V3, V4} = {excellent, good, general, bad}

Base on the result of AHP model

A= (0.2716, 0.3854, 0.1418, 0.2012)

A1= (0.4013, 0.5987)

A2= (0.4983, 0.2923, 0.2091)

A3= (0.5498, 0.4502)

A4= (0.4517, 0.2650, 0.2833)

After the data analysis the result of PDA need some experts to give mark of each factor of the 4th generation port competitiveness application on PDA. So we use the survey report of port experts to analysis the AHP-FCE model application on PDA.

The final result is that:

B_{PDA}= (geography environment, hinterland economy, hardware environment, software environment)

B_{PDA}= (B1, B2, B3, B4)

$B_{PDA=}$ (0.28, 0.25, 0.24.0.23)

4.5 conclusions

After the whole AHP-FCE model analysis the 4th generation port competitiveness evaluation indicator of PDA. Finally, we get the result of general evaluation on PDA. From the result we can find that for development 4th generation port PDA need to adjust the weakness part and keep the advantage. Something in detail we can find that the geography environment of PDA is excellent, and the software environment is

not so good. So PDA is necessary to do some countermeasure to adjust the software environment of the port. If we use the result to make a design and do efficiency measurement, the PDA can be the competitiveness 4^{th} generation port.

CHAPTER 5 ANALYSIS THE RESULT OF AHP-FCE MODEL ON PDA

After the AHP-FCE 4th generation port analysis in chapter four we found the weakness and the advantage of PDA. In this chapter will be further analysis the weakness and the advantage in details. About the Geographical environment, hardware environment, software environment and hinterland economy this chapter will do further analysis about these 4th generation port evaluation indicators. In chapter after the AHP-FCE 4th generation model analysis the weakness of PDA development is the software environment. And the advantage of PDA is the geographical environment; in the middle are the hinterland economy and the hardware environment. As following analysis will be further study on each part of these indexes of PAD.

5.1 geographical environment of PDA

The geographical environment contains that port position and port layout condition. In this evaluation PDA have obviously advantage to develop to be the 4th generation port.

5.1.1 The advantage on PDA Position

PDA located in the center of the northwest Pacific Ocean. It is in the center of Northeast Asia economic cycle which is on the rise. Also it is the biggest estuary of Northeast area of China. PDA is the nearest point into Pacific and other foreign countries in Bohai area and Liaodong Peninsula. PDA adjoins to the Yellow Sea and Bohai, separated with Japan, South Korea, and North Korea by the sea. PDA face to the economic vitality area of Pacific Ocean, with close economical relationship of

Russian, the Mongolian by land route connected. PDA is the important junction of the Europe and Asia continental bridge. Meanwhile PDA is the transport hub which connects Northeast China, North and East of China, and it is also the import link point with Northeast Asia, Southeast Asia to the various European countries.

PDA[13] located in the intersection point of Bohai and the Yellow Sea. It has the coastal mainland of 2290 kilometers, occupied 1/8 of the whole country. As well as the suitable port coastal mainland is more than 1000 kilometers and the deep water waterfront is more than 400 kilometers. PAD has the hydraulic mean depth of 12m and the deepest place reached 33m. PAD is one of four big deep water ports in our country. The port has the ability to handling the giant container ships and also PDA has been able to adapt the trend of large scale world ships development. PDA has about 100 year's history and has the good relationship with more than 100 countries' ports. PDA is the world famous trade port close to international main channel of sea transportation. With the deep water resources and the superior port construction condition advantageous. PDA has the strong advantage of geography environment to develop to be the 4th generation port.

[13] All the paragraph data are up to date data which gave by Liaoning government report

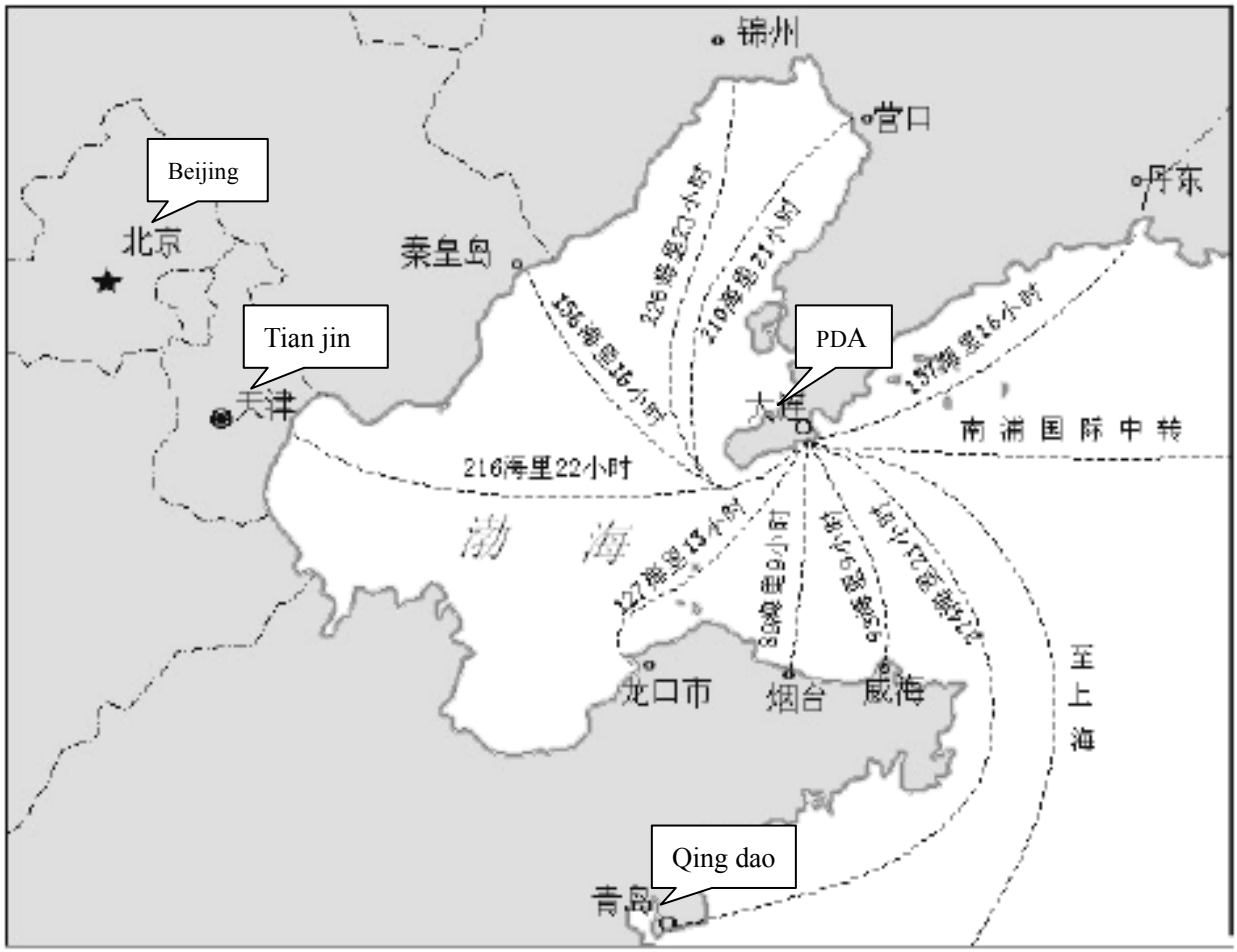


Figure 5.1 Geography position of PDA in yellow sea and bohai area

Source: Liaoning government (2008) Dalian international shipping center in northeast China

There are three points can show the good Geography position of the port: The first point is the mean distance between ports which refers to the mean value distance between one ports to other various harbors. The shorter distance the better position. The second point is the distance from the international main channel which refers to if the port is near to the international main channel it will be in good position to compete the cargo resource in hinterland. The third point is the Route number which refers to the more number of routes the port owned the stronger ability to collection good of port. So the port has the competition advantage.

Table 5.1 PDA position index

Index	PDA
Mean distance between ports	Shorter than 6500 mile
distance from the international main channel	More close
Route number	About 16 main liner shipping routes About 50 Coastal waters routes

Source: liu gengyan (2007) Comparative study on the function transformation of Dalian port

Table 5.2 International main routes of PDA

Source: li hengxing (2008) PDA: enhance to construction the international northeast shipping center

The date	Route	Geography detail
1988	Dalian---Northern Europe	Nonstop liner shipping
1989	Dalian---America and Canada	Nonstop liner shipping
1991	Dalian---Southeast Asia	Nonstop Bulk shipping
1993	Dalian---South Africa	Container liner shipping
1994	Dalian---Japan and Korea	Container liner shipping
1997. 5.13	Dalian---Southeast Asia	Container liner shipping
1997. 8.24	Dalian---American West coast	Main liner shipping
1998.12.24	Dalian---European Mediterranean Sea	The first main Foreign liner shipping

1999.12.10	Dalian---American east coast	Main liner shipping
2002. 4.15	Dalian---West northern Europe	Main liner shipping
2003. 6.8	Dalian---West US	Main liner shipping
2003. 7.5	Dalian---Europe	Main liner shipping
2004. 2.18	Dalian---Europe	The first call port is Dalian by the coast is Tianjin, Qingdao, shanghai Ningbo, yantian, Hong Kong, Rotterdam Hamburg etc
2004. 6.19	Dalian---Europe	Call ports: Dalian, Qingdao, shanghai, Ningbo, Melbourne, Sydney etc.
2005. 1	Dalian---Black Sea	Call ports: Tianjin, Dalian, Qingdao, shanghai, Ningbo, Pusan etc.
2007. 12.18	Dalian---Black sea	Main liner shipping

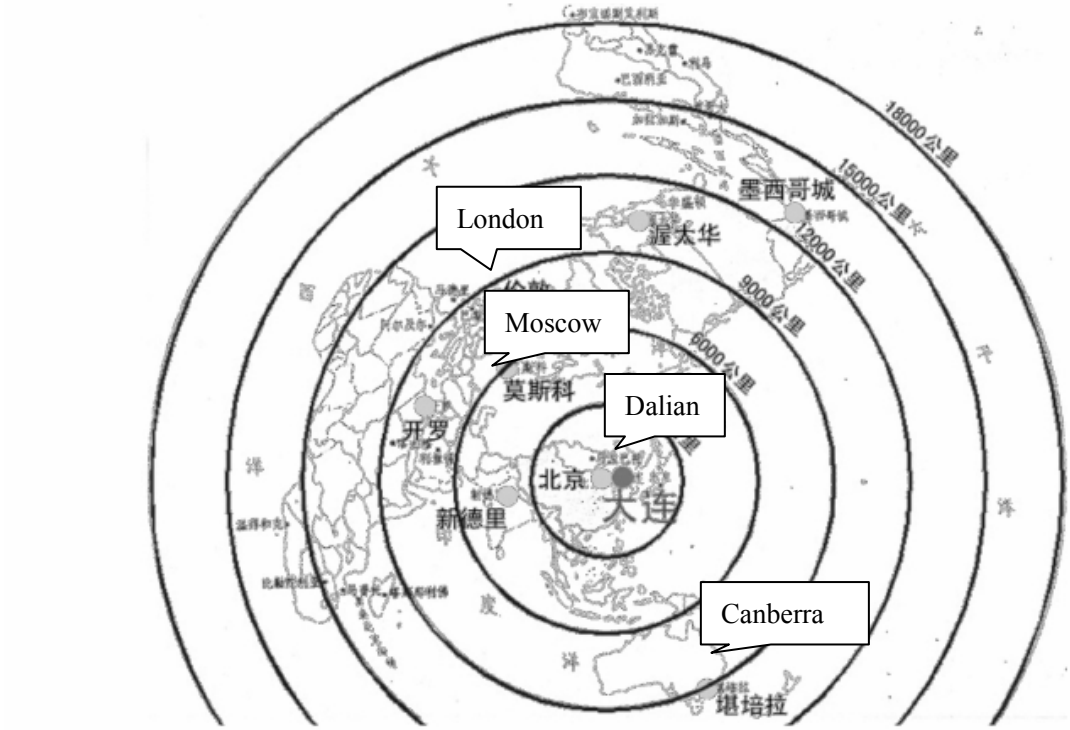


Figure 5.2 global position of PDA

Source: liu gengyan (2007) Comparative study on the function transformation of Dalian port

5.1.2 The layout condition of PDA

PDA not only has the good geography environment but also has the good layout condition of port. The 4th generation port need good condition for port layout which includes depth of water, Silt condition, period of ice, length of wharf, area of warehouse, condition of wave etc. PDA has the 1906km coastline, which is the longest one in China. And the deepest waterfront reached 18m. As following table shows the condition of PDA which compared with port of Singapore and port of Hong Kong.

Table 5.3 port layout condition of Singapore, PDA and Hong Kong

index	Water depth(m)	Condition of silt	Period of ice	Length of wharf	Area of warehouse(Ten thousand m^2)	Condition of wave
port of Singapore	8-11	Good	Not frozen	11112	538	Little wave
Port of Hong Kong	12.2-15.5	Little silt	Not frozen	7831	/	Relative calm
PDA	10-33	Good	Not frozen	11981	231	Natural haven

Source: duan zhiqiang (2006) Dalian international shipping center development mode research

After the analysis of the geography environment of PDA will be find that both the port position and the layout condition of PDA are able to develop to be the 4^{th} generation port. So that in the AHP-FEC model analysis the geography environment evaluation indicator of PDA is suitable to development the 4^{th} generation port.

5.2 The economy hinterland of PDA

In the result of AHP-FCE model the PDA hinterland economy is not as good as its geography environment. The hinterland condition of PDA includes that the economical throughput, the Export-orient economy and the convenient transportation network. The main hinterland of PDA is Liaoning, Jilin, Heilongjiang provinces and east of Inner Mongolia. About 1,250,000 km^2 area of hinterland and 12.9% population of China. The condition of hinterland economy can direct affect the cargo throughput of the port. The more good condition of hinterland economy the more

large cargo throughput of port it has.

5.2.1 The GDP and Export-orient economy of PDA hinterland

Table 5.4 2000-2007 GDP and Foreign trade balance

year	2000	2001	2002	2003	2004	2005	2006	2007
GDP(Hundred million)	9734	10617	11587	12940	14582	17131	19700	23325
Foreign trade(Hundred million dollar)	245.6	264.2	298	380.6	480.2	571.1	692	871

Source: 2007 http://www.stats.gov.cn/

The most important of 4th generation port development is the hinterland economy development. In the AHP-FCE model analysis the hinterland economy of PDA is not strong enough. After the research will easy find that the hinterland of PDA is the Northeast old industry area. In this area the most important part is Heavy industry. Recently our country provides a lot of preferential policy to development this area. Because of the traditional idea and the Backwardness Economic system may hinder the development speed of economy. Meanwhile the total hinterland GDP of PDA and the Export-orient economy level obviously drop behind Yangtze River triangle[14] area and Pearl River triangle area. So PDA hinterland economy development will directly affect the PDA development to the 4th generation port.

5.2.2 The transportation network system of PDA

Status of PDA transportation network contains the railway system, highway system,

[14] there are three triangles in China coastland respective are Yangtze River triangle, Pearl River triangle and bohai triangle which are more openness than inland area.

airport system and the pipeline system:

Railroad: because of the particularity geographical position and dependence with the hinterland cargo PDA has the extremely dependency with the railway transportation system. The Northeast area has the number one railway density of our country. Ha-da railroad is the main axle of Northeast railway network. About 1400km railroad system connects PDA with the national road network.

With the development of container transportation the Northeast container logistics system has almost set up. Yan-da ferry is the longest cross-ocean domestic railroad ferry. This ferry route make PDA become the key port which connected East China cross-ocean.

The highway network covered the majority cities of China. Liaoning province is the first one to finfish all covered with highway system in our country. Shen-da highway is the longest one with 8 traffic lane in domestic highway system. About 4613km highway system has formed that by Shen-Da and da-zhuang highway penetration north and south.

The Dalian international air harbor has more than 100 routes. The routes and volume of cargo by domestic and foreign way reached the leader position of northeast of China.

The pipeline transportation system in PDA connected lots of Petroleum chemical industry enterprises. The Daqing-dalian pipeline is the longest and the most completely pipeline in China.

The weakness of PDA transportation network system. On the skeleton, stresses excessively transport the Northeast mid-west area which greatly the channel is, but the eastern area lacks the penetration north and south the railroad and the first-class highway. The traffic structure is unreasonable; the transportation resources have not been able to obtain conformity. Railroad transfer station of Shenyang, Changchun,

Harbin are narrow and small area, the function not entire and limitation of ability restrict the development of multimode transportation. Meanwhile the lowness efficiency connection with various mode of transportation also restricts the PDA transportation network system development.

5.3 The software environment of PDA

In the AHP-FCE model analysis the PDA software environment is the weakness point for PDA development to the 4th generation port. As we know that in the 4th generation port evaluation index the most important one is the software environment index. Because the hardware of port can development quickly and if the port has good geography environment to build the 4th generation port and it also has the good hinterland economy will be development quickly. But the software of 4th generation port is higher than other evaluation. The 4th generation demand flexibility and agile service for the market. In the next part of the paper will use fuzzy model again to analysis the weakness of software environment of PDA in details. In order to find the real distance for PDA to be the 4th generation port in software environment.

5.3.1 Set up the evaluation indicator model of PDA in software environment

Table 5.5 evaluation indicator model of PDA in software environment

Generalized Customs service (U1)	The customs service (U11)
	Inspection and quarantine service (U12)
	Border controls service (U13)
Shipping and trading services (U2)	Shipping Information (U21)
	Charter (U22)

	Ship maintenance and shipbuilding (U23)
	Crew labor (U24)
Marine service (U3)	Vessel inspection (U31)
	Logistics service (U32)
	Maritime Safety Management (U33)
	Marine information and search & rescue (U34)
	Technology and Arbitration (U35)
Financial services(U4)	Insurance (U41)
	Financing (U42)
	Clearing (U43)

5.3.2 Using FEC model to analysis on software environment of PDA

V= {V1, V2, V3, V4} = {excellent, good, poor, very poor}

According to the reports of expert get the important level of each factor

A1= {0.4, 0.4, 0.2}

A2= {0.25, 0.3, 0.15, 0.3}

A3= {0.12, 0.31, 0.2, 0.1, 0.27}

A4= {0.3, 0.5, 0.2}

Then get the Comprehensive Evaluation Matrix of R1, R2, R3, and R4

$$R1 = \begin{pmatrix} 0.1,0.2,0.4,0.3 \\ 0.15,0.2,0.35,0.3 \\ 0.4,0.3,0.2,0.1 \end{pmatrix}$$

$$R2 = \begin{pmatrix} 0.3,0.25,0.25,0.2 \\ 0.3,0.35,0.2,0.15 \\ 0.25,0.35,0.2,0.2 \\ 0.35,0.25,0.2,0.2 \end{pmatrix}$$

$$R3 = \begin{pmatrix} 0.3,0.35,0.2,0.15 \\ 0.32,0.34,0.22,0.12 \\ 0.2,0.25,0.35,0.2 \\ 0.3,0.3,0.2,0.2 \\ 0.35,0.3,0.2,0.15 \end{pmatrix}$$

$$R4 = \begin{pmatrix} 0.45,0.25,0.2,0.1 \\ 0.1,0.2,0.3,0.4 \\ 0.35,0.3,0.2,0.15 \end{pmatrix}$$

Finally get the B1, B2, B3, and B4

B1= {0.18, 0.18, 0.36, .028}

B2= {0.29, 0.29, 0.24, 0.18}

B3= {0.3, 0.3 0.21, 0.19}

B4= {0.24, 0.2, 0.24, 0.32}

Summarized Comprehensive Evaluation Matrix

B= {0.24, O.2, 0.36, 0.3}

5.3.3 Conclusion of the FCE model on software analysis of PDA

Generalized Customs service of PDA is 0.24, Shipping and trading services is 0.2,

Marine service is 0.36, and financial service is 0.3. So that the marine service is the best of all the software services. The result tells us the Vessel inspection, Logistics service Maritime Safety Management, Marine information and search & rescue, Technology and Arbitration are doing better than other services. And the financial service in PDA is not bad but still need to make perfect. But for the Shipping & trading services and Customs service of PDA is not good enough. There are lots of weakness needs to be adjusted. According to these problem of software weakness analysis will find that the customs in PDA and inspection department of PDA have the lower Work efficiency and lack for cooperation. Meanwhile the service of shipping agent can not provide high quality of service and exact shipping information. So the shipping Intermediary service industry in PDA need to development. The specialists of shipping industry in PDA are much shorter than the real need. So that leads to the ship maintenance and shipbuilding industry development not good enough. As well as the information service of PDA did not reach the 4^{th} generation port index. The weakness of information service will direct affect the level of flexibility and agile of port service. So the PDA need to development these parts of software environment.

5.4 The hardware environment of PDA

The hardware environment contains the Port handling capacity and the Infrastructure of the port. The Port handling capacity of PDA show at the following table

Table 5.6 year 1959-2007 Throughput of PDA

year	Throughput of PDA (Ten thousand tons)
1959	1030

1972	2000
1984	4000
1989	5000
1994	6000
1997	7000
1999	8500
2006	14500
2007	16544

Source: Li hengxing (2008) PDA: enhance to construction the international northeast shipping center

Table 5.7 The status of PDA container berth

berth	Depth of water (m)		Berth length (m)	Number of berth	Berthing capacity (10,000 tons)	through capacity per year	
	design	real				10,000 tons	10,000 TEU
PDA 22,23 berth	9.1	8.9	270	1	4000	/	5.0
PDA 24,25 berth	11.0	10.6	270	1	25000	/	15.0
Daytona Berth 3	12.1	11.6	289	1	30000	/	25.0

Daytona Berth 4	12.1	11.6	289	1	30000	/	25.0
Daytona Berth 5	12.1	11.7	248	1	25000	/	20.0
Daytona berth 6	14.0	13.8	342	1	50000	/	15.0
Daytona berth 7	14.0	13.6	332	1	50000	/	15.0
Daytona berth 9	9.4	9.4	185	1	10000	30	17.5
Daytona berth 10	9.4	9.4	177	1	10000	30	17.5

Source: Liaoning government (2008) Dalian international shipping center in northeast China

The hardware environment of PDA is still need to development. Recently the Infrastructure of PDA need to Modernization and high-tech supporting. The deep water berth is not enough still need to build more of them. PDA has the good geography environment for 4th generation port development. Meanwhile it PDA should development the hardware environment to match the 4th generation port development. At the same time PDA should also pay much attention that don't develop blindly but suitable for the market demand.

CHAPTER 6 THE COUNTERMEASURE OF PDA TO DEVELOPMENT TO 4TH GENERATION PORT

6.1 The general strategy [15]of fourth generation port

The 4th generation is the modern port which has the good geography environment, the stronger hinterland economy, modern and powerful port hardware environment and the most important feature is the software service of port. 4th generation port has the agile information system which can response the market quickly and accurately. So the 4th generation port can always provides flexibility service to the customers. Meanwhile the 4th generation port does not compete like the traditional port. They choose a kind of new way to cooperation and get more profit than before. So if we want to develop our traditional port to the 4th generation port except the hardware environment and geography environment also need to think about all above characters of 4th generation port.

6.2 The exact development strategy [16]of PDA

By the aim of this paper is to research the suitable way for PDA development 4th generation port with its feature. In chapter 3, 4, 5, we use three chapters to analysis the 4th generation port model with AHP-FCE model and make a careful analysis of PDA. After that we get the result of PDA in each 4th generation port evaluation indicator. PDA need to development 4th generation port in the suitable way of itself. Based on the character of PDA is has good geography environment to develop 4th generation port's deepwater berth etc. as well as PDA located in northeast of china

[15] general strategy refers to the general stander of the 4th generation port not in details
[16] exact development strategy refers to the strategy suitable for PDA, and only application for PDA

which owned great potential economy hinterland. There are lots of preferential policies which gave by government to development 4th generation port. So the exact strategy of PDA to development 4th generation port needs consideration about their characters.

6.3 The countermeasure of PDA to develop 4th generation port

As the result of above analysis we get the 4th generation port evaluation index of PDA. The geography environment of PDA is excellent. Both the position and the port layout condition of PDA are suitable for development 4th generation. But in port hardware environment mainly about the Infrastructure of PDA need Construction. The hinterland economy of PDA is not as good as its geography environment because of the economy hysteresis quality of northeast of China. So we need to development the hinterland as the same time with port development. If the hinterland economy is not good enough we must development the transportation network system to get more cargo from other place. About the software service the 4th generation port demand that the port provide flexibility and agile service to customer and response the market change quickly. All of these need PDA development the software service.

6.3.1 The countermeasure of PDA to construct the Regional Port Cluster

The 4th generation port advocates that the new generation port need do more cooperation than competition. PDA develops of 4th generation port need to adjust nearby port resource make a port cluster. Facing by the competition of bohai area and the internal port of Liaoning province, it is necessary for PDA to integrate the internal region port resources. PDA to be build as an international hub port, it is

necessary to integrate the port resources Liaodong Peninsula. in the port cluster PDA is the core and peripheral port is the two wings. This port cluster connects with the main and sub-route

Simultaneously allows domestic and foreign strength harbor enterprise to do the management of PDA by way of rent, stock, merger etc. using these way PDA can introduce much more customer and get more good experience for port development. Also PAD can get lots of money to enlarge the scale of port. These new kind of cooperation will make more profit and get market share.

Figure 6.1 Regional Port Cluster of PDA

Source: PDA (2006) Dalian port development report

6.3.2 The countermeasure of PDA to develop the transportation network system

As we know that the hinterland economy of PDA is not as good as shanghai so we need some countermeasure to adjustment this situation. The transportation network system is a good way to get more cargo from other hinterland to PDA. PDA has already own the convenient transportation system with railroad and highway. But we need to development further by the aim of lower cost and higher quality of service.

First, enhance the hinterland transportation way. there are three channel need to repair which are the middle part northeast channel from Tonguing, Jiamusi , hairpin to Dalian, and the east of northeast channel from flyaway, rumen, Dandong to Dalian. The last one is the south northeast way from neimeng, Fuxin, to Jinzhou. The three railroads can provide more transportation service of northeast hinterland.

Second, enhance the near sea highway transportation. To make five highways which connect Dalian, dayaowan, changing, yingkou port these five highway will connection the port cluster much closer.

Meanwhile PDA must maintenance the traditional transportation network makes sure this system can work well. The 4th generation port with the convenient transportation system which can support logistics service more flexibility. PDA need also development the system of transportation not only maintenance the ready-made but also build the new one connection them together to be a powerful transportation system.

6.3.3 The countermeasure of PDA to develop the Free port zone

PDA should enhance the degree of openness and construct Dalian free port zone. With the development of port industry the function of harbor far more than the transportation center. In China the city openness is not balance between north and south, so setting up the international free port of PDA can balance the situation. PDA should do more than the traditional port which of modernized loading and unloading, the warehousing allocation, logistics function etc. the 4th generation port need free port strategy. PDA develops the international free port need using the resource of free trading zone of Dayaowan. And connection the free trading zone with PDA together. We must make sure the free trading zone extend to Dayaowan and Dagushan peninsula which can promote the development of PDA. The plan and the design of the free-trade zone must according with the international rules

With the free trading zone PDA will become to the has the international transition center , international logistics center, the warehousing processing center, the commodity demonstration center and near port service center which can provide value add service. PDA develops to the international free trading zone needs hardware environment and policies to support.

6.3.4 The countermeasure of PDA to adjust the port development policy

PDA should consummate the policy and rules of port development. PDA should give the suitable policy and related law criterion for the waterfront management, the harbor management, the ships service, the intermediary agency service, the examination quarantine service etc. these policies and legal rules can provide more definitude and powerful criterions for PDA development to the 4th generation port. The government should provide the legal and government platform with Public fair and transparent policies. These policies contain that the port construction policies,

the port management policies, shipping policies etc. all above policies can provide more standardized criterions for PDA development to the 4th generation port.

6.3.5 The countermeasure of PDA to construct the finance center

PDA should speed up construction of finance center. The modern financial industry development and the shipping center financial service function development can provide good finance environment for PDA development. The modern financial service system combined by the future industry, international finance and international insurance. We should construct international trade center which with Dalian commodity exchange as the core develop the stock industry, increase the stock variety, perfect market function. PDA based on the geography environment advantage introduce more finance institutions to development the headquarters economy, promote international balance and the foreign currency trading etc. with the development of PDA the city finance should follow the trend to provide finance and insurance service.

6.3.6 The countermeasure of PDA to develop the Port logistics industry

Establishment the modern logistics system, PDA should based on the geography environment, port position and city integration service system to set up the logistics system. PDA needs to have the logistics policies system, logistic establishment and logistic information platform. These elements can provide the good logistics software environment to development port logistics and also will attract more logistics enterprise investment. These logistics enterprise connect together for a logistics system. The PDA logistics system should enhance the special logistics service, the third party logistics, enterprise logistics and logistics information system. PDA may build up a northeast international logistics center which by international purchase,

international delivery and international transition transportation together. PDA should Speed up the construction of Dalian Dagushan peninsula, Dalian Changxing Island, Dandong Yalu River area, the Jinzhou Bohai area, Huludao near port area and the Yingkou port 6 key logistics industry center. By the industry advantage of near port area, to speed up the establishment of petroleum product, grain, automobile, the mechanical and electrical products, the aquatic product, the fruit vegetables and so on specialized logistics center. Meanwhile PDA should speed up the construction of north gain logistics center, Establishment fast transport the channel between the Northeast grain main production area and southeast grain consumer area.

6.3.7 The countermeasure of PDA to develop the information system

today the competition of port are intensity, PDA construct the information system in advance can raise harbor informationization level which may help PDA get more competitive advantage in the market. The construction of information system provided the information support for port to enhance the service level. Presently, PDA is turning toward the 4^{th} generation port which with characteristic of high technical, powerful information system and agile logistics service. The 4^{th} generation port information system construction is necessary to based on electron data exchange (EDI) system and other modern high-tech. PDA should use the internet technology to build the PDA internet station and electron business system which can connect the internal and external information. This kind of information system construction provides the common information to share, which can promote the construction of PDA. We also need to Promotes the EDI technology application on railway and highway transportation system which can expand. In order to provide the higher quality electron data exchange platform for the domestic and foreign users.

Also we should pay attention to the connection of information technology and the production development which adapt the development of EDI and CCS. Meanwhile PDA needs to enhance enterprise interior information network and set up the marine transportation market database which can realize information resource sharing. PDA should enhance the modern integrated management level to provide more powerful competitiveness in the port market.

6.3.8 The countermeasure of PDA on Talented person strategy

There is an opportunity of the promotion Northeast Industrial area. Because the development of 4th generation port need the specialist person, so we must strengthens the personnel training. In order to support PDA to develop the fourth generation harbor. When we develop the 4th generation port there are lots of science and the technical question need to solve. And also there are some question about harbor construction, business, finance, information and logistics. Therefore, making specialist personal training is necessary for PDA development. First, to introduce some specialist person in shipping and port industry who are worked in high level navigation countries and domestic area. Second, to establish the perfect personnel training system, using the maritime universities and research department resources to training shipping and port industry specialist. Third, to strengthen the cooperation between the enterprises and scientific research institutions, in order to make some R&D center, laboratory etc. for shipping industry and port industry research. The market should support the platform for the shipping and port industry specialist to exchange their idea and research. So the specialist person training is very important for PDA development to 4th generation port. This can provide enough experts to support the port development.

6.3.9 The countermeasure of PDA on Environmental protection

The Environmental protection of PDA to development 4th generation is important. The 4th generation development is the green development. It demands that with the development process we must protect the environment. Our country has the special law to rule it which contain about saving resource and reducing pollution. So the 4th generation port development is the green ways which need the government supervised. With the development of PDA we must pay much attention to such part: the reclamation project which cut hill and put into sea. Controlling the water pollution and protecting Biology of sea.

6.3.10 The countermeasure of PDA to develop the near port industry

The near port industry depends on the harbor resources which is the port enterprise group construction nearby the harbor .the near port industry can promote the port development. With the global resources optimum composition process of Multinational Corporation, the near port region is the ideal region for modernized industry located. We can Use the superiority position of Dalian's port to develop the near port industry.

First, we use the resources of manpower, technology, nature to develop petroleum chemical industry, the shipbuilding industry and the automobile and the spare part processing industry.

Second, we use the Northeast hinterland to be the core foundation of the near port industry and introduce agriculture, forestry, mineral resource of Northeast hinterland to Dalian in order to realize value added.

Third, we can learn from case of Shanghai which conformity waterfront of port to make more near port processing regions based on Dalian economic development zone, the free port area, in order to promote industry structural and technical level.

The near port industry development can lead to the sustainable industry development of PDA. The development of near port industry not only may provide the rich source of goods for Dalian harbor, but also can break up the bottleneck of growth slowly of economic in .Northeast. The advantage of near port industry is can reduce transportation times of raw material and the product which can maximum limit the cost of transportation.

Near port industry area can attract investment of the Multinational Corporation with "near the port economy". Also it can attract the heavy industry and labor-intensive industry of developed countries to movement here. So the near port industry can promote the development of PDA to be the 4^{th} generation port.

6.4 Summary of this chapter

After all the information analysis on the 4^{th} generation port, we can find the basic criterion of the 4^{th} generation port development. But each port has it special character of geography environment or software environment etc. So we need to consider about the special feature of PDA to make some development countermeasure in this chapter we summarize ten general countermeasures for PDA to develop the 4^{th} generation port. These countermeasure respectively analysis in hardware environment construction, software environment construction, cooperation regional port cluster, construction of free port zone etc all of these measurements can promote PDA development process.

CONCLUSION OF THE DISSERTATION

The 4th generation is the trend of port development. This paper tries to analysis the up to date information of the 4th generation port and conclusions the development stander of it. In this paper chapter three is the model of newly fourth generation features and the difference between the three generation ports which is the traditional port. After the model shows to the reader and gave the general idea of the 4th generation picture in our mind, on the following chapter go further analysis the 4th generation port in details. AHP- FCE model is a new kind of method which combined the analytic hierarchy process and Fuzzy Comprehensive Evaluation together. It is a good and practical mathematics method to analysis port. Because this model integrate two kinds of model may escape many subjective mistake which made by analysts.

Chapter four uses the AHP-FCE model analysis each evaluation indicator and give the final result of the each index weight of the factor which may affect the 4th generation competitiveness. Meanwhile put PDA into the AHP-FCE model analysis and get the final weight of each evaluation indicator on PDA. So if use the final each indicator weight of PDA we are easy to find the advantage and the weakness of PDA. The final result told us the software environment and the economy hinterland of PDA is not in a powerful condition. As well as the geography environment and the hardware environment are better, but still need to enlarge construction by suitable way.

The weakness of PDA will be direct affect the development of it. To solve these problems must to know them well, so in research paper there gave a carefully analysis on the weakness of PDA. After all the analysis we must summarize all the

details and give the final measurement to solve these problems.

So in the last chapter there are ten countermeasures which in each part of PDA. According to the weakness, the special characters and the 4^{th} generation port competitiveness stander we can get the suitable measurements for PDA development. I hope based on the research of the fourth generation competitiveness model: an application on PDA will provide some useful ideas for PDA development. Because of the time limitation and my knowledge limitation there are some flaws in this dissertation. I will go on enhance my special knowledge on this subject and further research on the topic in future.

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