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Comparative analysis of Lianyungang port's competitiveness based on calculation of principal component analysis

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COMPARATIVE ANALYSIS OF LIANYUNGANG PORT'S COMPETITIVENESS BASED ON CALCULATION OF PRINCIPAL COMPONENT ANALYSIS

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DECLARATION

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

Title of research paper: **COMPARATIVE ANALYSIS OF LIANYUNGANG PORT'S COMPETITIVENESS BASED ON CALCULATION OF PRINCIPAL COMPONENT ANALYSIS**

Degree: **MSc**

Lianyungang Port (LYGP) is located in the middle of coastlines of china and is the east start point of the New Euroasia Continental Land Bridge (NECB) and the most convenient and economic seaport for the middle and western region of China.

To understand the strength and weakness of itself grab the opportunity and prepare itself better to face challenges, LYGP needs to have a relatively objective evaluation of its competitiveness. Since the measurement of competitiveness is always related to the comparison between different entities and because of the actual threat that Rizhao Port (RZP) imposes, it is selected as the counterpart in the competitiveness assessing system.

First of all, a Port Competitiveness Assessing System (PCAS) needs to be built up. Later on, based on the assessing system, the comparative analysis between LYGP and RZP is carried out to get the detailed information needed for further evaluation. Then, all the detailed data are collected and are inputted to the model of Principal Component Analysis (PCA), under the assistance of MATLAB, the final score of evaluation can be calculated. In the end, a judgment on the result of comparison between two ports' competitiveness and some suggestion for LYGP to improve its

competitiveness will be given in this part.

KEYWORDS: competitiveness, Port Competitiveness Assessing System (PCAS), Principal Component Analysis (PCA)

LIST OF ABBREVIATIONS

LYGP:	Lianyungang Port
RZP :	Rizhao Port
NECB:	New Euroasia Continental Land Bridge
PCAS:	Port Competitiveness Assessing System
PCA:	Principal Component Analysis
TEU:	Twenty Feet Equivalent Unit

TABLE OF CONTENTS

Chapter 1 Introduction

1.1 Background And Significance of The Research

With the development of the economy of China and international trade, people put more and more attention on the status of transport in national economy system. Port, as the pivot in solid transport system and distributing center of cargoes and passengers, plays a very important role all through the ages. Reasonable port layout, proper port construction and efficient port operation are the guarantees for a country to develop transport system and strengthen international communication. So, to understand port, research port and raise port competitiveness to make port serve the national eonomy better become more and more significant.

Lianyungang port (LYGP) is located in the middle of coastlines of china and is the east start point of the New Euroasia Continental Land Bridge (NECB) and the most convenient and economic seaport for the middle and western region of China.

Lianyungang was one of the first 14 coastal cities opened to the outside world by the central government. Lianyungang Port is a natural deep-water

harbor, and it is a major regional transport hub linking the west coast of the Pacific to the east coast of the Atlantic by the NECB.

After years of construction and development, a land, sea and air transport network has been developed around the port. Lianyungang Port has become an international trade cargo transport hub with complete port facilities. Today, the number of 10,000-ton berth, 50,000-ton berth, 100,000-ton berth and 5th generation container berth all together has reached to 34. It has 60-odd container-liners every month to and from Hong Kong, Japan, Korea, Europe and the west coast of the North America. In the past 2005, the throughput of LYGP surpassed 60 million tons, the throughput of containers increased over 100% than that of 2004, and was beyond 1 million Teu.

Although the development of LYGP is very fast, it also come across many problems. Especially in recent years, the near Rizhao Port (RZP) with even greater pace of development caught up LYGP very quickly and now the total cargo throughput of RZP has exceed that of LYGP far away.

This dissertation, based on the essence of competitiveness, analyses the internal and external competition environment which LYGP faces, compares the competitiveness of LYGP and its main rival RZP through Port Competitiveness Assessing System (PCAS). Author hopes that the research and comparison involved in this paper can help LYGP find out what problems they have and how to solve them to ensure a healthier and faster development of the port in the future.

1.2 Methodology

1. Principal component analysis

Involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. The uncorrelated variables are linear combinations of the original variables, and the last of these variables can be removed with minimum loss of real data.

2. Questionnaire

This paper uses questionnaire to get the evaluation score. A total number of 20 copies of questionnaire sheets are sent to Commercial Division of CSCL, Agreement Department of PIL, Port Contract Department of SYMS and Business Development Department in MOL. These departments deal with the port service contract and port investment in shipping companies, and they know LYGP and RZP very well. All the 20 feedbacks are received, for each index, the two highest and the two lowest are ignored in calculation and the final score is the average of the rest 16.

1.3 Structure of The Research

Chapter 1 introduces the background of the topic selected and the

framework of this research.

Chapter 2 fixes basic theories on which this research is established, and get the valuable information, knowledge and methods which can be referred from previous foreign and domestic research.

Chapter 3 builds up the Port Competitiveness Assessing System (PCAS).

Chapter 4 gives the comparative analysis of port competitiveness between LYGP and RZP via PCAS

Chapter 5 carries out the quantitative comparison of port competitiveness between LYGP and RZP via Principal component analysis (PCA)

Chapter 6 proposes some suggestion for LYGP to raise its competitiveness.

Chapter 2 Literature review

2.1 Basic concepts

2.1.1 Explanation of industrial competitiveness

Research of industrial competitiveness refers to the process of evaluating and analyzing competitiveness level in virtue of data which can demonstrate competitiveness factors of industry. When talk about research, it is always based on understanding what industrial competitiveness is. The precondition of competitiveness is the existence of competition. No competition, no competitiveness in economic relations. So, we should first study the competition, competitiveness, industrial competitiveness and relationships between them, then a proper definition of industrial competitiveness can be proposed.

1. Competition

What is competition? Competition is the act of striving against another force

for the purpose of achieving dominance or attaining a reward or goal, or out of a biological imperative such as survival. Competition is a term widely used in several fields, including biochemistry, ecology, economics, business, politics, and sports. Competition may be between two or more forces, life forms, agents, systems, individuals, or groups, depending on the context in which the term is used.

Generally speaking, competition is the extension of a characteristic which almost all humans share. The characteristic is that people always like comparing themselves with others and they always hope that the result of comparison is they are better, they can excel or they boast greatest potential. This generalized competition lie in most aspects of human activities, such as economy, politics, ideology, culture etc, and it companies with human beings all through the history. Competition is the contest of strengths, the strongers can survive, develop and dominate, the weekers will be eliminated. Only these who can adapt themselves to the changes of outside world survive, which is the essence and general rule of competition.

Although competition can be found in almost all aspects of human society, economic competition is always the keynote of all kinds of these competition, most of which can come down to economic competition or at least related to it. When people talk about competition, they usually refer to the competition occurring in region of economy, which happens in various areas between different individual economic entities who fight and contend for better production and rendition situations to survive and develop.

Lenin gave competition a brief and clear definition: “This relation between

isolated producers working for a common market is called competition", which indicates that competition is an economic relationship in essence. Definition by Marx is that competition is the internal nature of capital. Its essential characteristic is to appear as the reciprocal action of all capital: it is an internal tendency appearing as imposed from outside. To sum up, competition essentially reflects the socioeconomic relationships between rivals.

2. Industrial competitiveness

From the traditional point of view, economists take industrial competitiveness as comparative advantages enterprises take in the aspect of possessing factors of production, such as labor, capital and natural resources. Based on statistical analysis, they also pointed out that internal innovation and efficiency are main reasons of advancement of industrial competitiveness. Professor Bao Changhuo and Professor Xie Xinzhou proposed that industrial competitiveness is enterprises' ability of sustainable development in healthy circles in process of competition. Enterprises, as independent economic entities, achieve this sustainable development by taking a better situation in the distribution of limited market resources through optimizing factors of production they possess and have an organic exchange with outside environment.

With industrial economy gradually turning to Knowledge-based Economy, industrial competitiveness is no longer only comparative advantage in factors of production, intangible factors, such as information, knowledge and innovation are taken as important measures. Ability of sustainable

development becomes the core of competitiveness.

Different people understand industrial competitiveness from various perspectives, some from the standpoint of a whole nation and some from a single enterprise; some from the result of comparison of competitiveness and some from factors which influence competitiveness. This paper focus on assessing competitiveness of individual enterprises, it is based on competing practice of single enterprises, emphasizing particularly on enterprises' own survival and development but putting aside how much goodwill enterprises can bring about to whole nations. In the analysis of competitiveness, we should not only consider the result of competitiveness which enterprises can reflect, but also take reasons of these results into account.

This paper takes industrial competitiveness as a synthetical concept composed of significations of many different aspects, which involve enterprises' ability of market penetrating and value creating as well as enterprises' inner factor structure and process of management operation. It is more of dynamic development than only static comparison. The key of industrial competitiveness analysis is rooted in distinguishing basic essential factors lying in competition. According to positioning and objective of specific research, this dissertation defines industrial competitiveness as enterprises'(as independent economic entities) comparative ability against their rivals in occupying market share, creating value and maintaining healthy development, all these are carried out in process of configuring, creating and arranging resources organically and properly in competing market environment.

The above description contains four meanings:

(1) Industrial competitiveness is a kind of comparative ability or comparative productivity, which is always related with comparison with other enterprises. Competitiveness is based on competition between different enterprises.

(2) Industrial competitiveness is formed in enterprises' business process. Only through different sectors of this process, such as resource configuring, strategy planning, product designing, marketing, procuring and managing, competitiveness can be demonstrated.

(3) Industrial competitiveness can be mainly embodied as enterprises' ability to occupy market, create profit and develop sustainably. These abilities decide whether capital circulation and reproduction can be smoothly accomplished. Almost all enterprises are pursuing profit which is taken as enterprises' radical mission, so value or profit creating ability weighs a lot in judging competitiveness. In the current times of Knowledge-based economy, ability of innovation and creativity decides whether development is sustainable.

(4) The deep-seated reason of competitiveness is differentiation of competing resource and capability between enterprises.

Furthermore, industrial competitiveness has four basic characters.

(1) Efficiency. Competition is a contesting process between different entities, the ones who can get the advantage in acquiring valuable resources and better competiting position are more competitive, so the primary character of industrial competitiveness is efficiency or serviceability, that is to say to enhance enterprises' efficiency and performance.

(2) Comparativeness. Competitiveness is a relative concept. One single entity alone, competitiveness is meaningless. Only in comparison competitiveness can be reflected, one is better or worse than another or others, then we can find the comparative strength and weakness.

(3) Dynamic process. Competitiveness does not stand alone, it is always closely related with the whole internal and external environment. It is very common that strength and weakness switch to opposite side when situation changes from time to time. Some previous competitive enterprises may lose their advantage if they can not adapt themselves to these new changes.

(4) Competitiveness. A lot of different factors compose the assessing system used to judge and compare competitiveness. The system works as a whole, only one or several factors picked out from the system are not enough to give accurate and all-around measures.

Enterprises, as independent social entities, must keep all kinds of communication with outside world, and on this basis, they arrange their inside production and management. So, they are always in some specific system which consists of the external macroscopical environment and internal operational system. Since enterprises' survival, development and

almost all other activities are based on this system, research on competitiveness should always be related to this specific system, it is meaningless to talk about isolated competitiveness.

The external macroscopical environment consists of governmental policy, social stability, national security, international relationships and so on. Since this paper focuses on microcosmic measurement on individual enterprise's competitiveness, as to a single enterprise, the external environment is immutable, they can not change the external environment for their purpose, but only can adjust themselves to get used to it and make better use of it. Besides, it can be regarded that enterprises of same industry in same country are facing with nearly identical external macroscopical environment. So, in this paper, situation of macroscopical environment is taken as a constant and not included in the research.

The internal operational system can also be divided into two sub-systems: business system and management system. Business system creates value and profit, in which competitiveness can be directly reflected by these physical quantitive data. Management system plays the role as a supporting system. Effects of management system is demonstrated indirectly through the performance of business system. The two systems do not exist isolatedly, they mutually affect each other. All the factors used to measure competitiveness in this paper are sorted from internal operational system.

2.1.2 Explanation of port competitiveness

1. Definition of competitiveness

According to above analysis, we can see that port, as a specific competiting entity, its competitiveness's meaning is very similar to that of industrial competitiveness, or we can judge it is a specific industrial competitiveness related to the port industry. Thereafter, this paper defines port competitiveness as ports'(as independent economic entities) comparative ability against their rivals in occupying market share, creating value and maintaining healthy development, all these are carried out in process of configuring, creating and arranging resources organically and properly in competing market environment. According to characteristics of external environment in which ports exist, competitiveness of a port can be influenced by its geographical position, development of transport system within its hinterland, economic strength of its hinterland and the city in which the port lies, natural qualification, government policy, efficiency of custom clearance, construction of infrastructure, development of its integrated feeder system, cost control, effectiveness of management, clients' satisfaction to its service, potential opportunities and challenge, etc.

2. Meaning of research on port competitiveness

In the times of economy globalization, especially with China entering WTO and transfer of focus of global economy development, more and more countries take the Asia-Pacific region, especially China, as the burgeoning

target market and a perfect place for investment. This situation makes the international trade of China develop drastically and thereafter expand the demand of marine transport, which brings about great opportunity for development of port industry in China. In this sense, ports in China face the competition not only from domestic of regional rivals, but also from ports from different countries around the world. Under the influence of Matthew Effect, a lot of ports are increasing investments and adjusting their development strategy to ensure they can get better positions in current and future competition and acquire more market share. So, competition between ports is fierce now and will become more and more fierce.

In this situation, research on port competitiveness is very important. The importance can be demonstrated in four specific aspects:

(1) Research on port competitiveness can drive ports pay more attention on resource configuration, and have a comprehensive and organic organization of internal resources and external resources to make greatest use of these resources.

(2) Research on port competitiveness can promote the structure optimization of ports' organization and improvement on strategying to strengthen coordination, communication and control inside a port and promote efficiency and effectiveness of management.

(3) Research on port competitiveness can help ports find weakness of their own, and know the gap between other ports, then they can, according to market situation and customers' requirements, adopt proper strategy to

bridge the gaps and develop in a correct direction.

(4) Research on port competitiveness can accelerate ports' inside reform and promote innovation, which will help ports attract more investment both for the port itself and the city that the port belongs to. So improvement on port competitiveness can help competitiveness of city in which port lie upgraded.

2.2 Research on related literature

2.2.1 Research on foreign literature

Foreign scholars started their detailed study on port competitiveness from the 1960's. Before that, the research on port issures was scattered and trivial. Most economists at that time only took ports as a part of shipping, and they put their emphasis on the study of relationship between ports and transport by ships. In the 1960's, some literatures that investigated ports roundly appeared, and some of them got touch with port competitiveness.

In the 1970's, brutish economist Kenyon and his colleagues extended their research on port competitiveness to labor cost, productivity, accessibility of ports and so on. In 1978, Mayor pointed out that the technical changes in shipping industry made shipping companies long for economy of scale for sure. They got it by putting general cargoes within a special region together to handle them at one port or two to enhance the productivity, and Mayor,

for the first time, called these ports load center. In the developed countries of our time, containers and multimodel transport greatly expand port's attractiveness, lots of cargoes are handled at the ports which are thousand of kilometers away from them. Multimodel transport closely ties sea, train and highway together, and makes them interdependent. Some ports benefit from governmental deregulation to strengthen their cooperation with train and hence consolidate their regional advantage. In 1987, British economist Hoare, after he analyzed main British ports, made the judgment that the hinterland of different ports were actually overlapped, and the competition between interrelated ports is in essence the competition on mixed hinterland, but not on direct hinterland as what were considered before. In 1990, British economist Slack, with a view to the change and development of container inland transferring center under the background of multimodel transport, explained the inner drive of the trend of cargo centralization within a port region.

With the development of containerized transport, many articles about the research on containerization began to appear on various magazines. The most professional and elaborate one of them is《Saminoron Container Terminal 1985 Antwerp》, which is composed by United Nations Conference on Trade and Development and Antwerp port engineering consultant company. This book systematically and incisively dissertated the requirement of containerized transport on modern ports and other issues that container terminals face, such as cost, pricing, investment, operation, etc. 《City Port Industrialization and Regional Development Spatial Analysis and Planning Strategies》, composed by B.S.Hoyle and D.A.Pinder, mainly discussed the relationship between port's layout and the development of

regional economy, and explained the industrial functions that modern ports have to possess.

United Nation Conference on Trade and Development pointed out, in its report of 《Third Generation Port and Challenge》, that port's role as a point that connects sea transport and other models of transport has now weakened, but it becomes more important in arranging international trade and being a strategic unit. Port is a main tache in integrated transport chain and the pillar. The ability of a port to provide all-round and efficient logistics service is the main factor to judge whether a third generation port is competitive enough.

2.2.2 Research on domestic literature

The research on port competitiveness started relatively later in china. In the late 1980's and the early 1990's, port economy began to be separated from other subjects and became a independent one. Some monograph and teaching materials on this subject have been released, which contributed a lot to the development of port economy in China.

In the early 1990's, Shanghai Maritime University, for the first, conducted research on port competitiveness, and they summarized six key factors that composed the port competitiveness. These six factors are port's location, inland transport, efficiency of operation, price of service, economic stability and utilization of IT technology.

Professor Xie Shileng proposed his point of view on the development of hardware condition of port. He pointed out that modern ports develop in two main different methods, the first one is to make use of current ports more reasonably and renovate current port facilities, the second one is to construct new ports. For most ports of middle and large scale, both of the above methods are needed.

Form the above review, we find that port competitiveness research is a relatively new field in China, the scope and extent of research is still very limited. According to the above introduction, it can be seen that port is a very complex system and it connects to many other subjects and fields. There are lots of factors that influence port competitiveness, and all of these together compose a complicated system which is not static but dynamic, and keeps changing all the time. With economic development and technical progress, some new factors exist, some old factors become less important and some factors never need to be considered. In this sense, this paper takes the actual situation with which LYGP is currently confronted as the priority, through PCAS builded up in next chapter, will give a relatively objective evaluation on LYGP's competitiveness.

Chapter 3 Buildup of Port Competitiveness Assessing System

3.1 Principles for design PCAS

1. Scientificalness

Both theory and practice should taken into consideration in the design of PCAS, and PCAS should to an abstract description of objective reality. Many factors are involved in the research of port competitiveness, so the key in the design of the assessing system is to get an accurate understanding of its characteristics, extract useful information from all these factors that can reflect port competitiveness, and find the most important and representational ones from them. So, the design of PCAS must comply with the principle of scientificalness, definition and the meaning of every single index should be clear and differentiable. An assessing system with ambiguous index is not qualified.

2. Systematicness

Port competitiveness is influenced by factors in many different aspects.

Some factors take independent effects, and some factors, combined together, influence port competitiveness jointly. So, only to take one or several factors into consideration is not enough to give an all-around evaluation of port competitiveness. It is very important for the design of PCAS to be taken in a systematic view.

3. Feasibility

Design of PCAS should comply with the principle of feasibility. It is meaningless to build up a “gorgeous” assessing system whose index is hard to be evaluated or data for its index is very difficult to be collected.

4. Dynamicness

Port competitiveness is a dynamic process of development. When design the assessing system, not only currently demonstrated competitiveness but also potential competitiveness that can be reflected in the future should be taken into consideration. In this sense, an excellent assessing system should also have the function to evaluate port competitiveness in the long term.

3.2 Analysis of main factors contributing to port competitiveness

Competition between ports is actually the comparison of competitiveness of different ports, the one who is more competitive will win the competition. To evaluate and compare competitiveness of different ports quantitively, it is

very necessary to analyze the factors which influence port competitiveness. A large number of factors are involved in evaluation of port competitiveness, and in general, all of them can be categorized in four main primary aspects, which are Internal condition of the port, External situation of the port, Capability of management and business operation and Capability of strategic competition and sustainable development.

3.2.1 Internal condition of the port

Internal condition of a port consists of its natural conditions, infrastructure and the conditions of its equipment and facilities.

Natural conditions of a port are the premise for it to acquire a better position in the competition. All the ports who become the centers of international shipping unexceptionally have great natural conditions, they must be in the geographical position which is near to the international base courses, they must have deep channels to cater for bigger and bigger vessels, and the good weather condition in the port region which is suitable for cargo handling is also indispensable.

Besides, infrastructure and conditions of its equipment and facilities also have great influence on port competitiveness. Infrastructure refers to the storage ability of yard and warehouse and the capability of the port's berth to serve different sizes and different types of ships. When talk about conditions of port's equipment and facilities, not only the quantity of

equipment such as cargo loading and discharging cranes and yard piling machines, but also their quality must be taken into consideration. These hardware conditions are the index that ship owner and cargo owner care most when they decide whether to choose the service of this port.

3.2.2 External situation of the port

External situation of the port mainly refers to the ability of port's feeder system, social environment of port region and economic development of port's hinterland.

Port's feeder systems have a direct influence on port's ability to gather and distribute cargoes, and it is a very important factor to decide the scale of hinterland of the port.

A good social environment of port region is one of the decisive factors for a port to attract vessels' call. The financial, insurance and commercial environment of the port region will affect the operation mode that port will choose, port's development and the positioning of port's social role, and hence influence port competitiveness. The current successful ports in the world, such as Hong Kong, Singapore and so on, unexceptionally have reasonable and convenient port policies, and are rapid and efficient in custom clearance.

Different ports lie in different regions and have different hinterland

economy situation. So, the requirement for type and scale of transport are different. All these will influence the location effect of a port.

3.2.3 Capability of management and business operation

Capability of management and business operation can be further divided to volume of freight handled, port service, port security, port informationization and economical performance.

The volume of cargo throughput reflects current situation of port's handling capability and is also a demonstration of port's strength. The growth rate of cargo throughput reflects the trend and developing velocity of cargo throughput, representing the potential ability of port's development.

Service level has a direct influence on whether clients will choose the service of this port. As to clients, especially carriers, cargo-handling efficiency is closely related to their profit. Besides, port security will also affect competitiveness of a port. It is impossible for clients to take the port where accidents and mistakes keep happening as their choice.

3.2.4 Capability of strategic competition and sustainable development

Capability of strategic competition mainly contains human resources of port, ability of cooperation with other ports, public promotion of port's service

and skill of capital operation.

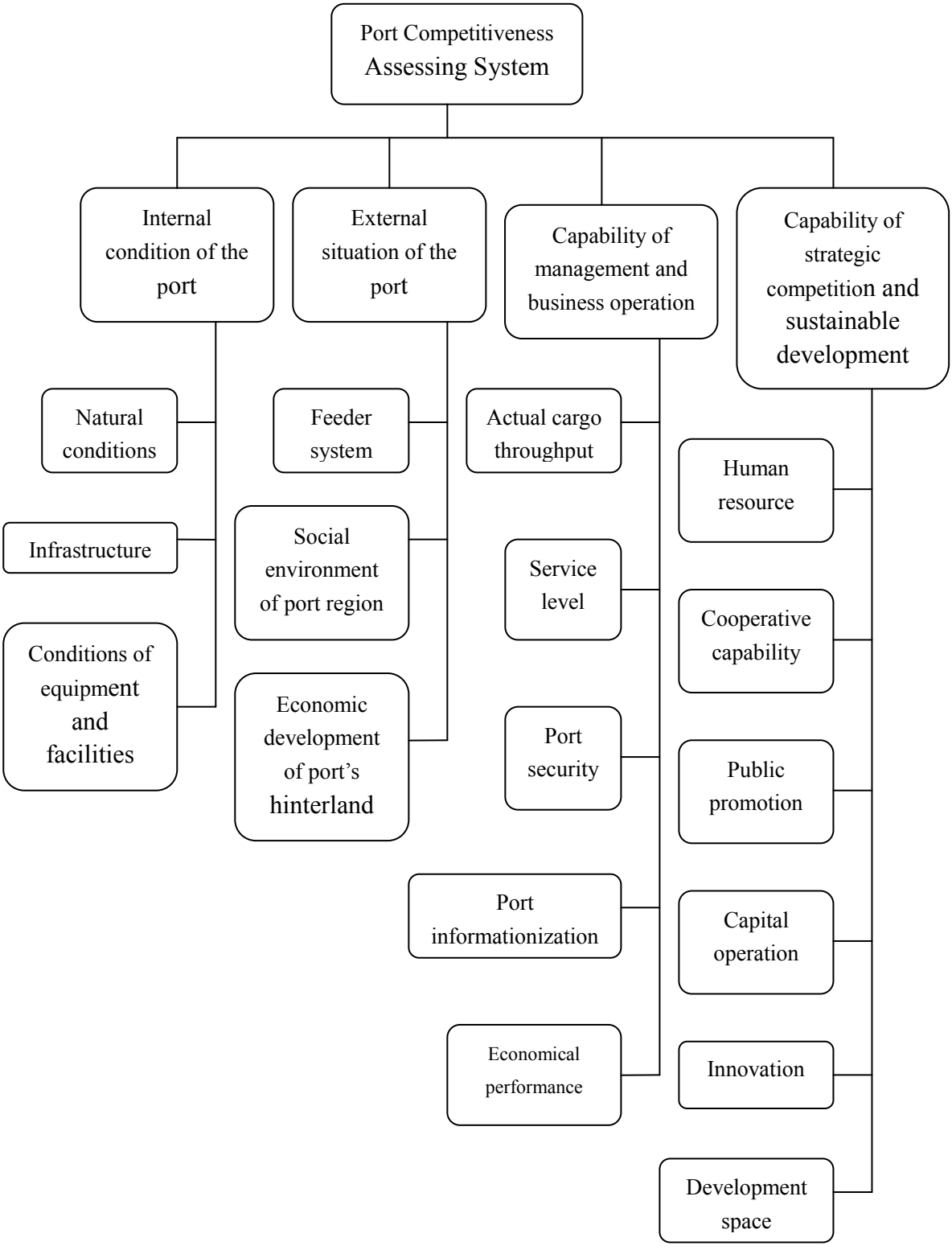
Capability of sustainable development refers to ports' ability to excel from the competition with other ports and to keep the established advantage for a relatively long period of time. Development space and innovation are two decisive factors to judge capability of sustainable development.

3.3 Buildup of PCAS

First of all, this paper sets the above mentioned four main influential factors which are Internal condition of the port, External situation of the port, Capability of management and business operation and Capability of strategic competition and sustainable development as the first-class indexes in the PCAS.

Since the concepts of above four first-class indexes are to broad, it is difficult to describe and evaluate them objectively and scientifically, we need to divide the first-class indexes into more detailed second-class indexes in following Table 3-1.

Table 3-1 Second-class indexes of PCAS



On basis of Second-class Indexes, we further divide the indexes who are still too abstract to be described into the elaborate Third-class Indexes, and at the same time, those Third-class indexes who are too trivial and not easy to be quantitively described will be eliminated from the PCAS. After all above finished, the final assessing system will be as the following Table 3-2.

Table 3-2 Port Competitiveness Assessing System

First-class indexes	Second-class indexes	Third-class indexes	Explanation and description
Internal conditions of the port	Natural conditions	Water depth of port's channel	Water depth at the most shallow point in port's channel
		Water depth alongside the quay side	Water depth alongside the quay side while low water
		Weather condition of port	Annual number of days suitable for cargo handling
	Infrastructure	Number of berths	Total number of berths in operation
		Cargo handling capacity	Designed cargo handling capacity
		Total acreage of yard and warehouse in ports	To reflect cargo storage capacity of ports
	Conditions of equipment and facilities	Total number of equipment and facilities	To reflect cargo storage capacity of ports
		Quality of equipment and facilities	Qualitative index, extent of modernization of equipment and facilities compared with other ports
External situation of the port	Feeder system	Ability of feeder system	Qualitative index, port's ability to gather and distribute cargo compared with other ports

	Social environment of port region	Governmental support	Qualitative index, supports(such as policy and finance)from government compared with other ports
		Condition of custom clearance	Qualitative index, efficiency and convenience of custom clearance compared with other ports
		Development of related industries	Qualitative index, development of related industries(such as cargo forwarder, quarantine, pilot service)compared with other ports
	Economic development of port's hinterland	Economy scale of hinterland	Qualitative index, economy scale of hinterland compared with other ports
		Economic potential of hinterland	Qualitative index, economic potential of hinterland compared with other ports
Capability of management and business operation	Actual cargo throughput	Cargo throughput	Cargo throughput in 2005
		Growth rate of cargo throughput	Average growth rate of cargo throughput in latest three years
		Container throughput	Container throughput in 2005
		Informationization in management	Qualitative index, port's ability to use IT in management compared with other ports

	Port informationization	Development of E-commerce	Qualitative index, port's ability to use E-commerce in commercial activities compared with other ports
Capacity of strategic competition and sustainable development	Innovation	Utilization of new equipment and technology	Qualitative index, port's ability to use modern equipment and technology compared to other ports
		Logistics extending ability	Qualitative index, port's ability to provide integrated logistics service compared with other ports
		Agility	Qualitative index, port's ability to make quick and wise response to change in market compared with other ports

Chapter 4 Comparative research of LYGP's competitiveness based on PCAS

Port competitiveness is a kind of comparative capability or comparative productivity, which is always based on the comparison with other ports, it is meaningless to talk about the competitiveness of a single port alone. In this sense, this paper choose RZP whose geographical position is very close to LYGP, dominant cargo supply is similar to that of LYGP, and more important, hinterland overlaps with that of LYGP as the counterpart to carry out research on port competitiveness of LYGP.

4.1 Lianyungang Port Versus Rizhao Port

LYGP and RZP are mutual rivals.

Both of LYGP and RZP have limited direct hinterland, most of the cargo they served comes from their indirect hinterland. Since LYGP and RZP are very close in geographical position, it is almost inevitable that their indirect hinterlands overlap with one another. What is more, the main cargo categories handled by the two port are very similar. So, the competition on

indirect hinterland and its main cargo supply between LYGP and RZP are unquestionably intense.

Hinterland of LYGP is the belt-like region alongside the Longhai-Lanxin railway, almost all cities spreading on both sides of Longhai-Lanxin railway are contained in hinterland of LYGP. This belt-like hinterland is composed of Lianyungang City, Xuzhou, Suqian in Jiangsu Province, north part of Yancheng and Huaian, southwest part of Shandong Province, region along north side of Huaihe River in Anhui Province, central and north region of Henan Province, south part of Shanxi Province, central and south part of Shangxi Province, central and south part of Ningxia Municipality Region, north Sichan Province, Gansu Province, Qinghai Province and Xinjiang. From the structure of cargo resources, it can be seen that vast majority of cargo served by LYGP come from the indirect hinterland mentioned above. The economy scale of its direct hinterland is limited and in low development level. It is very difficult for LYGP to get enough from its direct hinterland.

Hinterland of RZP mainly contains Rizhao City, south part of Shandong Province, north part of Jiangsu Province, nouth part of Henan Province, south part of Shanxi Province and central part of Shangxi Province. Cargos coming from south part of Shandong Province take up 70% of the total cargo volume handled by RZP. Cargo resources out of Shandong province concentrate in south and southeast part of Shanxi Province and north part of Henan Province. Bulk cargos coming in and out of west region of China via RZP increases every year, but the direct hinterland's(Rizhao City) support is limited.

Since LYGP and RZP have very similar indirect hinterland and main cargo supply, the rapid development of RZP forms great and direct threat to LYGP. The development of RZP contributes a lot to the economic growth of Rizhao City, and thriving Rizhao City in turn supports more to development of port. In this situation, RZP caught up and surpassed LYGP very soon.

4.2 Comparative Analysis of Internal Conditions of The Two Ports

4.2.1 Brief Introduction of Internal Condition of the two ports

1. Lianyungnang Port

LYGP is located on west bank of the Pacific Ocean and in the northeast of Jiangsu Province. It is on seashore of the Yellow Sea of China. As east end of Longhai-Lanxin Railway and east start point of the New Euroasia Continental Land Bridge, LYGP is the biggest sea port in Jiangsu Province and also one of the main pivot ports in the east coast of China. LYGP is backed by Yuntai Mountain and faces West and East Lian Islands. All these mountains and islands around LYGP make it a natural unfreezing port. The man-made 6.7 km long West Levee, connects the continent and Lian Islands from its west end and cover the distance of 2.5 km between them. Yuntai Mountains, Lian Islands and the West Levee are linked together and a 30 square kilometer port region is formed within them. The total length of

shoreline in port region is 40.6 km, 23.9 km of them is natural commercial shoreline, industrial shoreline is 2 km, urban and tour shoreline is 6.1 km and the left 8.6 km is reserved for further development.

As the east start point of the New Euroasia Continental Land Bridge, development of LYGP is tightly lined to landbridge transport. LYGP has become the most convenient and economical port for west region of China and even for central asia countries. Lianyungang and Rotterdam are two ends of NECBwhose length is 2,000 km shorter than Siberia landbridge. NECB goes across 7 countries and can serve more 30 countries and regions. The existence of NECB is a very precious fortune for development of LYGP.

2. Rizhao Port

RZP locates in the middle of the 18,000 coasts in China. The Yellow Sea is in RZP's east, Qingdao Port in its north and LYGP in its south. RZP is also close to Japan and Korea on the other side of Yellow Sea. The Yanshi Railway connects Rizhao to countrywide railway network. Three main highway lines link Rizhao to other parts across the country. Up to now, more than 50 countries and regions around the world have been open to navigation traffic with RZP. With Lanxin Railway in China and Tuxi Railway in Kazakhstan connect together and get into practice, RZP is now in its way to become an international center port.

RZP lies in the concave of the intersection where North Jiangsu Riffle and Shandong Peninsula come across one another, so it is always in the status of

being protected by surrounding continent and island. There is no typhoon directly assaulting RZP in the history and no destructive earthquake happened. RZP is a ice free port with deep water, more than 100 specialized deep water berths of different kinds can be built in here, including 200,000~300,000 ton berth. It is suitable to build RZP into a modern logistics center.

4.2.2 Detailed Comparison of Internal Conditions of The Two Ports Based on PCAS

1. Comparison of natural conditions of two ports

The length of LYGP's channel whose bottom is covered by silt is 20.35 km and the depth of it is 11.5 m. The outer channel is 12.35 km long and 11.5 m deep, bottom width of it is 160 m, bottom width at bends is 160 m~270m. Tidal range at LYGP is 3.69 m, 15,000 toner can sail in and out of LYGP with high tide. Annually average temperature in LYGP is 14℃, highest temperature appears in August and the average temperature in this month is 25.8℃; lowest temperature appears in January and the average temperature in this month is 0.6℃. Generally, LYGP is an unfreezing port, some times cat ice appears in January, but it will not influence sailing of vessels. The hazy weather of LYGP is from March to June, about 20 foggy days every year. But most fog happens from 3 AM to 10 AM, and port handling will not be affected. Under the protection of west and east Lian Island and the West Levee, the weather condition in LYGP is mild, which is suitable for

cargo handling all year round.

RZP has two channels, the one heading to the coal wharf whose bottom is covered by sand is 2.4 km in length, 200 m in bottom width and 15 m in depth, the other one heading to the general cargo wharf is 4.072 km in length, 180 m~190 m in bottom width and 14.5 m in depth. Tide in RZP regular semidiurnal tide, the highest tide level is 4.73 m, the lowest tide level is 0.59 m and the average tidal range is 2.98 m. The annually average temperature of RZP is 12.5 ℃, highest temperature in history is 37.5 ℃, lowest temperature in history is －14.5 ℃, but the low temperature does not make sea water freeze, RZP is a ice free port. The hazy weather in RZP appears from February to July, 90% foggy days happen in this period, annually average thick weather is 26.5 days. About 300 days in a year are suitable for port handling operation.

Comparison of natural conditions of two ports is as following Table 4-1

Table 4-1 Comparison of natural conditions of two ports[1]

Second-class indexes	Third-class indexes	LYGP	RZP
Natural conditions	Water depth of port's channel	11.5 m	15 m
	Water depth alongside the quay side	15 m	24 m

[1] Date resources: www.jctrans.com, www.rzport.com, www.lygport.com.cn, http://lyg.gov.cn, http://ghj.rizhao.cn

	Weather condition of port	365 days	300 days

2. Comparison of infrastructure of the two ports

During recent years, LYGP puts a lot of attention and energy in the construction of port infrastructure. Currently, LYGP has a total number of 34 berth of various kinds specialized to serve coal, ore, container, wood chip, corn and dangerous cargo, and 29 of them are with the capacity over 10,000 ton. The total length of berth's shore line is 7073 m, the area of warehouse is 99,991 ㎡, and the total area for storage is 1,167,152 ㎡. The designed annual handling capacity is 40 million tons. Composed by the three main sub-ports of Old Port, Miaoling Port and Xugou Port, LYGP has become a large-scale and multi-functional seaport mainly serving transport of foreign trade.

Five main sub-ports that are EAST RZP, CENTRAL RZP, WEST RZP, Lanshan Port and North Lanshan Port compose RZP. RZP has a total number of 39 berths, 33 of them are with the capacity over 10,000 ton, the designed cargo handling capacity for RZP is 70 million ton. East RZP has 11 commercial berths and 10 of them with capacity over 10,000 ton. There are 2 150,000 ton coal berths and 10 coal yard in this port, the storage capacity for coal is 3.5 million ton and the total cargo handling capacity of this port is 33 million ton. Central RZP has 8 commercial berths, one of them is a 20,000 ton berth whose designed handling capacity is 1.8 million ton constructed especially to serve oil products. West RZP has 2 commercial berths, one of them is 40,000 ton chip berth and the other one is

15,000 general berth, cargo handling capacity of West RZP is 1.34 million ton. Lanshan Port has 7 commercial berths, four of them with 10,000 ton-odd berths, and its designed cargo handling capacity is 4.8 million ton. North Lanshan Port has one 100,000 ton bulk cargo berth whose handling capacity is 11 million ton, two 50,000 ton general berths whose handling capacity is 5 million ton, two 50,000 ton crude oil berths with handling capacity of 1 million ton, one 300,000 ton berth with handling capacity of 20 million ton.

Comparison of infrastructure of two ports is as following Table 4-2

Table 4-2 Comparison of infrastructure of two ports

Second-class indexes	Third-class indexes	LYGP	RZP
Infrastructure	Number of berths	34	39
	Cargo handling capacity	40 million	70 million
	Total acreage of yard and warehouse in ports	1.17 million ㎡	1.02 million ㎡

3. Comparison of conditions of equipment and facilities between the two ports

LYGP has nearly 500 sets of equipment and facilities of different kinds; they can be used to handle various sorts of cargoes. The maximum lifting capability on shore is 150 ton and maximum lifting capability on water is 200 ton. Not only typical cargo handling but also some special operation can

be satisfied. The only set of 1 million ton corn handling line in China that is used both for loading and discharging is brought about by LYGP. Coal, wood chips, ore, fertilizer and liquefied chemical products can be handled in LYGP. In 2005, the construction of two five generation container berths have been completed, equipped by two advanced bridge cranes and 10 gantry cranes, LYGP's ability to serve containers has been further strengthened.

RZP has 580 sets of equipment and facilities of all kinds. Its coal handling facilities with high productivity are imported from Germany. There are four rotary dumpers each with discharging velocity of 3,600 tons per hour, five stacking machines each with stacking velocity of 3,600 tons per hour, three loading gantries each with loading velocity of 6,000 tons per hour and eight reclaimers each with handling velocity of 3,000 tons per hour. The 250,000 ton ore wharf is equipped with 3 discharging gantries each with discharging capability of 2,500 tons per hour. Besides, RZP also have great power to serve container, corn, alumina, wood chips and liquefied chemical products.

Comparison of conditions of equipment and facilities between the two ports is as following Table 4-3.

Table 4-3 Comparison of conditions of equipment and facilities between two ports

Second-class indexes	Third-class indexes	LYGP	RZP
Conditions of equipment and	Total number of equipment and facilities	495	580

facilities	Quality of equipment and facilities (1~9)[2]	4.8	4.3

4.3 Comparative Analysis of External Situation of Two Ports

4.3.1 Brief Introduction of External situation the two ports

1. Lianyungang Port

The object to construct LYGP is to serve the Longhai-Lanxin Railway. The vast area covered by the 4131 km long Longhai-Lanxin Railway, usually called Longhai-lanxin economic belt is the hinterland of LYGP. This railway passes across east, central and west parts of China, connects Xinjian, Ningxia, Qinghai, Gansu, North Sichuan, Southeast Shanxi, Henan, North Anhui, South Shandong and North Jiangsu and covers the area of 360 million square km. This broad area takes up one third of China and has a population of 300 million. The great demand and consumption of this huge hinterland offer LYGP the opportunity for its quick development.

2. Rizhao Port

Hinterland for RZP is spacious; its direct hinterland contains south part of Shandong Province, north part of Henan Province, south part of Hebei

[2] Quantitative index, score from 1 to 9, 1 the worst, 9 is the best, the rest can be deduced by analogy, author gets the scores from feedback of questionnaire sent to CSCL, MOL, PIL and SYMS.

Province and south part of Shanxi Province. This region has a population of 80 million and a area of 180,000 square km. The indirect hinterland of RZP contains most of the central and northwest part of China, including Gansu Province, Ningxia, Xinjiang and so on. RZP is a important channel for China to implement its "West to east coal flow and North to south coal flow" strategy and West China development strategy.

From the global vision, RZP's direct hinterland south part of Shandong Province lies in the intersection of Pacific economic circle and Euroasia Continental Land Bridge economic belt, it is valuable for international development. Foreign and domestic companies can rely on RZP to expand market in west China and Asia-pacific region.

4.3.2 Detailed Comparison of External Situation of The Two Ports Based on PCAS

1. Comparison of ability of feeder system of the two ports

LYGP has a integrated feeder system. The Longhai-Lanxin Railway that starts from Lianyungang and goes across the China mainland, the coastal railway that is being constructed, Lianhuo highway and Tongsan highway join together in Lianyungang. These railway and highway trunk lines passing Lianyungang give LYGP the advantage as an important transport center. But now, LYGP still has some problem in its feeder system and the problem mainly reflects in railway. For the first thing, the railway is not

capable enough. Since 1999, the dependence on railway increases every year. The development of railway itself gradually cannot catch up with the development of LYGP, and transport demand surpasses the capacity of railway system. For second, railway system is still not in a smooth operation, wagon supply cannot satisfy the demand. The cooperation between nodes of land bridge needs to be improved, the delay in cargo distribution happens from time to time.

Feeder system of RZP is very convenient. The Yanri Railway goes across Xinxiang, Xian and finaly reach Alataw Pass in Xinjiang. The network formed by Jinghu railway, Jingjiu railway, Jingguang railway, Jiaozhi railway and Tongpu railway parallels with Longhai-Lanxin railway and connects RZP to east China, central China and northwest China. At the same time, RZP also has an effective highway feeder system; the Rizhao-Dongming highway connects the Lianhuo highway in construction that will head to Sanmenxia, Xian and Xinjiang. Besides, Shandong segment of Tongjiang-Sanya highway and the 17 km long port highway that is especially constructed for feeder system have been completed. All of them contribute a lot to the development of RZP.

Comparison of ability of feeder system of the two ports is as following Table 4-4.

Table 4-4 Comparison of ability of feeder system of the two ports[3]

Second-class indexes	Third-class indexes	LYGP	RZP

[3] Quantitative index, the source of score is same as Table 4-3

Feeder system	Ability of feeder system(1~9)	5.2	6

2. Comparison of economic development of the two ports' hinterlands

The corn output of LYGP's hinterland is over 100 million tons, which takes up one quarter of total output of China. The cotton and oil plants output are respectively two fifties and one third of countrywide amount. There are abundant mine resources in LYGP's hinterland. Nearly 100 different kinds of these mines are worth of exploitation, and half of them have the highest reserves in China, which include coal, crude oil, natural gas, salt, aluminum, zinc, iron, manganese, chrome, gold, silver, nickel and so on. In LYGP's hinterland, the proved coal reserves are over 300 billion tons that takes up 50% of countrywide reserves. The crude oil reserves are about 200 billion tons that takes up over 40% of countrywide reserves. The natural gas reserves is over 8,000 billion cubic meters which is the highest in China.

Moreover, the ability of LYGP's hinterland to exploit and process these mines is very high. The abundant mine resources, equivalent productivity to process these resources and affluent labor consist indispensable conditions for the prosperity of LYGP's hinterland as well as cargo support for fast development of LYGP. It can be found that more than 80% of the cargos handled by LYGP come from its indirect hinterland out of north Jiangsu Province. In this sense, LYGP depends mainly on its indirect hinterland.

RZP's hinterland extends to south Shandong Province, north Henan Province, south Shanxi Province, etc. The ample resources, such as coal

(Southwest Shandong coalfield、south Henan coalfield, Jiaozuo coalfield)、crude oil (Zhongyuan oilfield)、building materials (cement, stone) and agricultural products, provide formidable backup for development of RZP.

The reserves of coal in hinterland of RZP scatters in the area of nearly 600,000 square km. There are 8,000 coalmines in this region, 30 of them are national-owned large mines, 12 of them with annual productivity about 10 million tons, and the gross productivity of coal in this region is 420 million tons. At the same time, the large amount of steel plants in Shandong Province, Hebei Province, Henan Province and Shanxi Province constitute great demand of iron ore. It is estimated that over 50 million tons iron ore need to be imported to RZP's hinterland. The mode of iron-in-and-coal-out in operation of RZP makes a economical circle between coal and iron ore flows.

But compared with developed region, the economy scale of RZP's hinterland is still not large enough and the per capita level is low. For example, per capita GDP of south Shandong Province is only 61% of that of whole Shandong Province, and 39.16% of that of the east coastal region of China.

Comparison of economic development of the two ports' hinterlands is as following Table 4-5

Table 4-5 Comparison of economic development of the two ports' hinterlands[4]

Second-class indexes	Third-class indexes	LYGP	RZP
Economic development of port's hinterland	Economy scale of hinterland (1~9)	5.3	4.9
	Economic potential of hinterland (1~9)	6.4	5.9

3. Comparison of social environment of port region between the two ports

Development of LYGP gets great support from government of Lianyungang City and Jiangsu Province. To build LYGP into a international hub port, government of Jiangsu Province set up a special team directly led by provincial government to optimize development plan and establish supporting policy for LYGP. With the support of government of all levels, related departments of the port cooperate with each other to enhance service level of LYGP. The "one stop" custom clearance and "5+2" working day system make the efficiency of custom clearance of LYGP greatly improved.

Government of Rizhao City attaches great importance to development of RZP, and the strategy of "priority of port development" is established in Rizhao. Almosr all the best resources in Rizhao are saved for development of RZP. The supports from Rizhao government and other related departments such as custom, frontier inspection station and quarantine station help RZP to build up an attractive environment for its current and potential clients.

[4] Quantitative index, the source of score is same as Table 4-3

Comparison of social environment of port region between the two ports is as following Table 4-6

Table 4-6 Comparison of social environment of port region between the two ports[5]

Second-class indexes	Third-class indexes	LYGP	RZP
Social environment of port region	Governmental support (1~9)	7.5	7.3
	Condition of custom clearance (1~9)	7	7.3
	Development of related industries (1~9)	5.7	4.8

4.4 Comparative Analysis of The Two Ports' Capability of Management And Business Operation

4.4.1 Brief Introduction of Capability of Management And Business Operation of the two ports

1. Lianyungang Port

LYGP was first established in 1933. After over 70 years' construction, it has become one of the pivot ports along the coast of China.

[5] Quantitative index, the source of score is same as Table 4-3

In recent years, the development of LYGP is extraordinary fast. During the period of the tenth five-year plan, LYGP accumulatively completed the investment of 3.5 billion yuan to build three new berths, extend one berth, reconstruct three berths, upgrade capacity of eleven berths and finish the project of 70,000 ton port channel through which fifth generation container ship and 150,000 bulk vessel can go in and out of port with high tide. Up to the end of 2005, LYGP has 34 commercial berths, 29 of them are 10,000 ton odd berths. The ground area of port has been increased by 1 million square meters. EDI system has been upgraded and big progress has been made in the construction of port informationization.

According to analysis of cargo throughout of LYGP, it can be found that coal, iron ore, fertilizer, alumina and container are the main cargo sources for LYGP. In recent years, the above cargoes always take up more than 70% of LYGP's total throughput.

2. Rizhao Port

Construction of RZP started in 1982. In 2003, RZP (group) Co.,Ltd was established. The current assets of RZP are 12 billion Yuan. RZP has 39 commercial berths, and the designed cargo handling capacity of RZP is 70 million tons. In 2005, cargo throughput of RZP reaches 84.21 million tons. After more than 20 years' construction, RZP has become a modern group cooperation with business of cargo handling, port construction and machine production.

RZP has ten main cargo sources, which includes coal, iron ore, container,

corn, liquefied chemical products, alumina, coke, cement, wood chips and steel, and its auxiliary cargo sources are nonmetal ore, fertilizer and general cargoes of all kinds.

4.4.2 Detailed Comparison of The Two Ports' Capability of Management And Business Operation Based on PCAS

1. Comparison of cargo throughput of the two ports

In 1999, the cargo throughput of LYGP exceeded 20 million tons for the first time. Cargo throughput in 2003 was 37.5 million tons. In 2004, cargo throughput reached 43.52 million tons and container throughput was 501,000 TEUs. In the past 2005, LYGP made a surprising progress, the record of cargo throughput was changed to 60.16 million tons which is 38% higher than the figure of 2004, and the record of container throughput was rewritten as 1 million TEUs which is increased by 100% than that of the previous year. It took LYGP 55 years to reach its first 10 million tons and 11 years to climb to the 20 million tons, but from 20 million tons to more than 60 million tons, LYGP used 5 years to achieve it.

Because LYGP is located in middle of coal production region and coal consumption region, it enjoys the advantage of short transport distance and low transport cost. In the tenth five-year plan, coal throughput of LYGP grows up steadily. In 2005, LYGP's coal throughput exceeded 20 million tons.

The completion of the project of 70,000 ton port channel and 100,000 ton bulk wharf greatly enhance LYGP's ability to handle iron ore. In 2005, throughput of iron ore was over 4 million tons.

Alumina imported through LYGP mainly come from Australia and America. The demand for alumina of aluminum plants scattering alongside Longhai-Lanxin railway will not be less than 3 million tons per year. Alumina throughput of LYGP in 2005 was 3.5 million tons.

Container business started in LYGP since the early 1990's but develops very quickly. Container throughput in 2005 surpassed 1 million TEUs.

Cargo throughput of RZP in 2003 was 45.06 million tons, it was increased by 13.36% in 2004 and reached 51.08 tons. In the just past 2005, the increasing rate blowout to 64.9% and cargo throughput went up to 84.21 tons.

The designed coal handling capacity of RZP reached 45 million tons in 2004, the handling process is strictly controlled by central computer and every detail is monitored and managed by the controlling room.

The current discharging capacity of ore is 50 million tons, and will reach 60 million tons in the future. The advanced management method adopted by RZP in the process of discharging greatly reduces the waste, minimizes pollution and assure the quality of ore.

RZP has 3 modern container berths, and the depth of water at quay side are respectively 16 m and 17 m. The designed container handling capacity of RZP is 1.5 million TEUs. Container business started a little bit later in RZP than other ports, but the development is very quick. In 2005, container throughput of RZP was 200,000 TEUs.

Comparison of cargo throughput of the two ports is as following Table 4-7.

Table 4-7 Comparison of cargo throughput of the two ports[6]

Second-class indexes	Third-class indexes	LYGP	RZP
Actual cargo throughput	Cargo throughput	60.16 million tons	84.21 million tons
	Growth rate of cargo throughput	25.64%	39.13%
	Container throughput	1 million TEUs	0.2 million TEUs

2. Comparison of the two ports' informationization

The informationizational construction of LYGP started from 1982. Up to now, an Integrated Port Operational Information Syetem has been completed in LYGP. The port chose the application of Office Automation and information release via website to realize informationization in the field of port management.

RZP began from the basic automation, gradually optimizing the utilization,

[6] Data source is same with Table 4-1

management and integration of its Production Management Information System. In 2001, the buildup of port data base helped RZP realize integration of several Management Information System. Besides, the Integrated Information Inquiry System and Client Information Service System have been developed to raise RZP's service level.

Comparison of the two ports' informationization is as following Table 4-8

Table 4-8 Comparison of the two ports' informationization[7]

Second-class indexes	Third-class indexes	LYGP	RZP
Port informationization	Informationization in management (1~9)	5.7	5.2
	Development of E-commerce (1~9)	5.3	4.9

4.5 Comparative Analysis of The Two Ports' Capacity of Strategic Competition and Sustainable Development

4.5.1 Brief introduction of Capacity of Strategic Competition and Sustainable Development of the two ports

1. Lianyungang Port

[7] Quantitative index, the source of score is same as Table 4-3

Although develops very quickly in recent years, the 30 square km port basin always restricts its further development. Coal wharfs, ore wharfs, corn wharfs and container wharfs crowd in the port basin, and the layout of these wharfs are unreasonable. This arrangement also imposes negative effect on environment of Lianyungang City.

To improve this situation, after investigation and research, LYGP proposes the strategy of extending “one body” and stretching “two wings” to form new port layout as “One Body and Two Wings” .

Extending “One body” refers to depending on the existing port, strengthening its current advantage and putting the development of container transport as the priority to optimize configuration of existing resources. Stretching “Two Wings” means breaking through the limit of current port basin, targeting to sustainable development, taking Guanhekou Port as the south wing and Haitou Port as the north port to establish the relationship of mutual complements between “one body” and “two wings”.

Now, LYGP is steadily striding forward to the target of cargo throughput of 100 million tons and container throughput of 3 million TEUs in 2008.

2. Rizhao Port

The long-term target of RZP is to set up its status as the modern international logistics center. According to its long-term plan, 166 berths can be constructed in RZP and the cargo throughput of RZP can get to 580 million tons.

During the nest five years, RZP will invest 10.2 million Yuan to continue the construction of 7 projects and start to build 300,000 ton crude oil berth and other 14 new projects. RZP will consolidate its advantage on the existing ten cargo sources, and at the same time, put great effort to develop new cargo sources such as LNG[8], LPG[9] and fertilizer. It is estimated that cargo throughput of RZP will exceed 100 million tons in 2006. Till the end of the eleventh five-year plan, both of RZP's cargo handling capacity and its cargo throughput will surpass 200 million tons and container throughput will reach 1.5 million TEUs. At that time, ore throughput of RZP will be the highest in China and its cement throughput will be the highest in the world. Besides, the plan to build RZP into the distribution center for coal, ore and crude oil will help RZP to establish its status as a world logistics center.

4.5.2 Comparison of Logistics Extending Ability of The Two Ports

Development of integrated logistics in LYGP is in constant progress and the construction of a logistics center with the area of 450,000 ㎡ has been completed. In addition, the relatively advanced information system and efficient custom clearance provide LYGP great advantage for it to develop integrated logistics. But only these are still not enough to meet the requirement of modern logistics. LYGP still has to make great efforts to improve the logistics equipment, apply new logistics technology, promote standardization, upgrade traditional port industry, and expand value-added

[8] LNG, Liquefied Natural Gas
[9] LPG, Liquefied Petrol Gas

logistics service.

In the process of developing integrated logistics, RZP depends on its existing resources, utilizing its wharfs, warehouses and yards as logistics facilities to attract domestic and foreign logistics companies to carry out their logistics service in the port. Besides, RZP plans to build a distribution center on the basis of its warehouses and yards to provide warehousing, cargo processing, packing and distribution service by itself. In the long term plan, RZP wants to set up a third party logistics company to provide all-around logistics service.

The comparison innovation of the two ports is as following Table 4-9

Table 4-9 The comparison innovation of the two ports[10]

Second-class indexes	Second-class indexes	LYGP	RZP
Innovation	Utilization of new equipment and technology (1~9)	6.3	6.1
	Logistics extending ability (1~9)	5.4	5.1
	Agility (1~9)	7.6	7.7

[10] Quantitative index, the source of score is same as Table 4-3

Chapter 5 Comparative Analysis of Port Competitiveness Between LYGP and RZP Based on PCA

5.1 Introduction of PCA

Principal component analysis (PCA) is a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. The objective of PCA is to reduce the dimensionality (number of variables) of the dataset but retain most of the original variability in the data. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.

PCA is a bilinear modeling method that gives an interpretable overview of the main information in a multidimensional data table.

The information carried by the original variables is projected onto a smaller number of underlying ("latent") variables called principal components. The first principal component covers as much of the variation in the data as

possible. The second principal component is orthogonal to the first and covers as much of the remaining variation as possible, and so on.

By plotting the principal components, one can view interrelationships between different variables, and detect and interpret sample patterns, groupings, similarities or differences.

Large data tables usually contain a large amount of information, which is partly hidden because the data are too complex to be easily interpreted.

PCA is a projection method that helps visualize all the information contained in a data table.

PCA helps find out in what respect one sample is different from another, which variables contribute most to this difference, and whether those variables contribute in the same way (i.e. are correlated) or independently from each other. It also enables to detect sample patterns, like any particular grouping.

Finally, it quantifies the amount of useful information - as opposed to noise or meaningless variation - contained in the data.

5.2 Process of calculation

Step 1: Data Standardization

The first step is to standardize the original data. The matrix of original data is:

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{pmatrix}$$, M is the number of dimensions, and n is number of variables.

Because the units of measurement of variables are different, the original data need to be standardized, the formula of standardization is:

$$Z_{ij} = \frac{x_{ij} - \overline{x_j}}{S_j}$$ (Formula 5-1),

In this formula, $\overline{x_j} = \frac{1}{m}\sum_{i=1}^{m} x_{ij}$ (Formula 5-2) and the Variance is: $S_j = \sqrt{\frac{1}{m-1}\sum^{m}(x_{ij} - \overline{x_j})^2}$ (Formula 5-3), i=1,2,3⋯⋯m, j=1,2,3⋯⋯n.

Step2: Covariance Matrix

We build the Covariance Matrix of the above matrix of original data.

$R = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix}$, r_{kj} is covariance of data k and data j:

$r_{kj} = \frac{\sum_{i=1}^{m} Z_{ik} Zij}{m-1} = \frac{1}{m} \sum_{m-1}^{m} \frac{(x_{ik-} \overline{x_k})(x_{ij} - \overline{x_j})}{S_k S_j}$ (Formula 5-4),

and $r_{ii} = 1$, $r_{kj} = r_{jk}$.

Step 3 Eigenvector and Eigenvalue

From the eigenfunction $\left|R - \lambda I\right| = 0$ (Formula 5-5), we can get its non-negative eigenvalue, and these eiganvalue can be arranged as: $\lambda_1 \geq \lambda_2 \geq \lambda_3 \cdots \geq \lambda_n \geq 0$.

We can calculate the eigenvector $L_t (L_t = l_{t1}, l_{t2}, \cdots, l_{tn})$ for eigenvalue λ_t by $(R - \lambda_t I) L_t = 0$ (Formula 5-6), t=1,2⋯,n.

Step 4: Principal Components

The formula $y_t = l_{t1} Z_1 + l_{t2} Z_2 + \cdots l_{tn} Z_n$, t=1,2⋯,n (Formula

5-7) is used to calculate the value of different components. y_1 is the value of the first component, y_2 is the second component, so on so forth. The information carried by components decreases one by one.

We use the formula $a_t = \frac{\lambda_t}{\sum_{t=1}^{n} \lambda}$ (Formula 5-8) to calculate the contribution of y_t. If the total contribution of the first k components $y_1, y_2, \cdots, y_k (k \prec n)$ is $\frac{\sum_{t=1}^{k} \lambda_t}{\sum_{t=1}^{n} \lambda} \geq \mu$ (Formula 5-9), then these first k components are Principal Components. In this paper, this paper set it as $\mu = 0.85$

Step 5: Final evaluation

The evaluation A is $A = \sum_{t=1}^{k} a_t y_t = \sum_{t=1}^{k} \left(\lambda_t / \sum_{t=1}^{n} \lambda_t \right) y_t$ (Formula 5-10), $y_t = l_{t1} Z_1 + l_{t2} Z_2 + \cdots l_{tn} Z_n (t = 1, 2, \cdots, k)$, and

$$a_t = \frac{\lambda_t}{\sum_{t=1}^{n} \lambda} .$$

5.3 Data Input

The original data for PCAS from above analysis in Chapter 4 is collected in the following Table 5-1

Table 5-1 Data for PCAS

First-class indexes	Second-class indexes	Third-class indexes	LYGP	RZP
Internal conditions of the port	Natural conditions	Water depth of port's channel	11.5 m	15 m
		Water depth alongside the quay side	15 m	24 m
		Weather condition of port	365 days	300 days
	Infrastructure	Number of berths	34	39
		Cargo handling capacity	40 million tons	70 million tons
		Total acreage of yard and warehouse in ports	1.17 million ㎡	1.02 million ㎡
	Conditions of equipment and facilities	Scale of equipment and facilities	495	580
		Quality of equipment and facilities	4.8	4.3
	Feeder system	Ability of feeder system	5.2	6

External situation of the port	Social environment of port region	Governmental support	7.5	7.3
		Condition of custom clearance	7	7.3
		Development of related industries	5.7	4.8
	Economic development of port's hinterland	Economy scale of hinterland	5.3	4.9
		Economic potential of hinterland	6.4	5.9
Capability of management and business operation	Actual cargo throughput	Cargo throughput	60.16 million tons	84.21 million tons
		Growth rate of cargo throughput	25.64%	39.19%
		Container throughput	1 million TEUs	200,000 TEUs
	Port informationization	Informationization in management	5.7	5.2
		Development of E-commerce	5.3	4.9
Capacity of strategic competition and sustainable development	Innovation	Utilization of new equipment and technology	6.3	6.1
		Logistics extending ability	5.4	5.1
		Agility	7.6	7.7

5.4 Comparison of Port Competitiveness Between LYGP and RZP Based on PCA

According to the above description of PCA, we first input the original data into a matrix with 2 dimension and 22 variables.

Table 5-2 Original Data

	Z1	Z2	Z3	Z4	Z5	Z6
LYGP	11.5	15	365	34	40000000	1170000
RZP	15	24	360	39	70000000	1020000

Z7	Z8	Z9	Z10	Z11	Z12	Z13	Z14
495	4.8	5.2	7.5	7	5.7	5.3	6.4
580	4.3	6	7.3	7.3	4.8	4.9	5.9

Z15	Z16	Z17	Z18	Z19	Z20	Z21	Z22
60160000	25.64%	1000000	5.7	5.3	6.3	5.4	7.6
84210000	39.19%	200000	5.2	4.9	6.1	5.1	7.7

Then the data is standardized as:

Table 5-3 Standardized Data

	Z1	Z2	Z3	Z4	Z5	Z6
LYGP	-0.7071	-0.7071	0.7071	-0.7071	-0.7071	0.7071
RZP	0.7071	0.7071	-0.7071	0.7071	0.7071	-0.7071

Z7	Z8	Z9	Z10	Z11	Z12	Z13	Z14
-0.7071	0.7071	-0.7071	0.7071	-0.7071	0.7071	0.7071	0.7071
0.7071	-0.7071	0.7071	-0.7071	0.7071	-0.7071	-0.7071	-0.7071

Z15	Z16	Z17	Z18	Z19	Z20	Z21	Z22
-0.7071	-0.7071	0.7071	0.7071	0.7071	0.7071	0.7071	-0.7071
0.7071	0.7071	-0.7071	-0.7071	-0.7071	-0.7071	-0.7071	0.7071

Because the calculation involved in PCA is very complicated, this paper use the software MATLAB to solve this problem and the result is as following

Table 5-3.

Table 5-4

Eigenvalue	$\lambda_1 = 22$	$\lambda_2 = 0$	$\lambda_3, \cdots, \lambda_{22} = 0$
Contribution	100%	0	0
Accumulated Contribution	100%	0	0

Since the contribution of the first component reachs 100%, this paper choose only this component in the evaluation, and the credibility is 100%.

The Eigenvector of the first component is:

L1 (0.2132 -0.0876 -0.2540 -0.0709 -0.1137 -0.0470 0.0000 -0.0000 0.0000 -0.0000 -0.0000 -0.0000 0.2860 0.1565 -0.1815 0.0196 0.0000 0.7071 0.0260 -0.4030 -0.2349 0.0659),

The evaluation can be calculated through the formula of $A = Z * L_1 * \lambda_1$ (Formula 5-11), and the final score is as following Table 5-4 Evaluation Score.

Table 5-5 Evaluation Score

Ports	LYGP	RZP
Evaluation Score	-3.3166	3.3166

From the above score of evaluation, it can be found that LYGP is in the inferior position in the competition with RZP. From the detailed

comparative analysis in Chapter 4, we can see that the biggest reason for LYGP to lag behind is its inherent defect in the natural conditions. In the aspect of port software development, such as utilization of advanced equipment, port informationization and logistics extending ability, LYGP has the comparative advantage. It is impossible for LYGP to improve its natural conditions, so LYGP needs to make more efforts to further develop its port software conditions before the completion of projects with better natural conditions to bridge the disparity in natural conditions.

Chapter 6 Suggestions Proposed For LYGP To Improve Its Competitiveness

6.1 Improve The Internal Conditions of LYGP

1. Fasten the construction of deep-water channel

It is important and urgent for LYGP to improve its channel condition to acclimatize itself to the fast growth of cargo throughput and the trend of ship enlargement.

LYGP is now rebuilding its existing 70,000 ton channel into a 150,000 ton channel. When this project is completed, the current 70,000 ton channel with water depth of 11.5 m, bottom width of 160~180 m and length of 20.35 km will become a 150,000 ton channel with water depth of 16.5 m, bottom width of 230 m and length of 33.7 km. The project needs the investment of 1.108 billion Yuan and will be financed by government of Jiansu Province and Lianyungang City.

3. Attract investment from various sources to fasten the port construction

Because of the huge amount of capital needed in port construction and the long period to recover the investment, LYGP has to develop more financing channels, such as setting up joint venture, sharing stock and leasing, to relieve the capital burden on itself.

To get more support from the central government, LYGP should position itself as the port that serves the development of the west region and institute preferential policies to attract investment from the west region in the port construction.

6.2 Make Sufficient Use of The External Resources

1. Exploit the economic potential of hinterland, develop more cargo sources

Governments at all levels can help the north part of Jiangsu Province to attract investment from foreign organizations and large enterprises through various channels to narrow the gap between the direct hinterland of LYGP and the developd regions. By doing this, the potential of its direct hinterland can be exploited to provide LYGP stable cargo supply.

2. Improve the feeder system

LYGP has to improve its feeder system by developing the integrated and

three-dimensional transport combined with railways, highways and waterways progressively. Improve the efficiency of the operation of East Longhai line and to enhance transport capacity based on the electrification alterations of East Longhai Line. Complete the construction of highway network in north Jiangsu Province as soon as possible and open the Xinxu canal to make full use of the advantage of the water transport.

6.3 Enhance the Capability of Management And Business Operation

1. Management Innovation

The first is to set the port enterprise as center, promoting system innovation. LYGP has to establish system of parent and subsidiary companies in accordance with the criterion of modern enterprise and form a new mode with clear property rights, distinguished interests and responsibilities to build itself into a cargo-handling based integrated port enterprise with diversified business; The second is to set the goal of efficiency, and explore the port privatization. Through port privatization, and on the basis of the protection of national interests and the public interests, the port can use the power of private enterprise to manage the operation in a competitive environment to accomplish the goal of raising production efficiency, improving service quality, reducing production costs and increasing profit.

2. Informationization improvement

Scientific progress and technological innovation is an important factor in the development of the port, the port's informationization level is an significant measure of its competitiveness. Therefore, LYGP must put informationization construction on an important position, making use of information technology, network technology for terminal operations, real-time management of container and machinery equipment and improving the efficiency of terminal production.

3. Development of modern logistics

LYGP should take development of logistics as a center to strengthen technological innovation, and the target of logistics is to serve foreign and domestic enterprises and enhance profitability. LYGP should make full use of the continent bridge to fasten the construction of basic logistics facilities such as the network of feeder system, warehouse, and information channel. Finally, it will be built into a modern regional logistics center with reasonable layout, diversified functions, advanced facilities and high efficiency.

6.4 Strength the Capacity of Strategic Competition And Sustainable Development

1. Market exploitation

To adapt to the requirement of the development of logistics service market,

LYGP must thoroughly change its mode of production and operational concepts. It must transform from the single and separated function to provide only marine cargo handling or warehousing to the mode of provide the entire logistics service from raw materials to finished products and to the final consumption. LYGP can use its own warehouses and freight yard to build a distribution center first, and gradually carry out logistics service with full function.

2. Intelligence cultivation

Talent is the most valuable resources of an enterprise, the development of human resources management is closely related to the survival and prosperity of an enterprise. LYGP should truly speed up the cultivation of construction personnel, marketing personnel, management personnel and logistics personnel with specialized knowledge and skill.

3. Image building

First, it is necessary to strengthen the public promotion of Lianyunang Port to attract more cargo sources. Television, newspapers, magazines, the Internet, letters, pamphlets, posters, and other ways can be used to publicize advantages on port policies to attract cargo owners, freight forwarders and ship agents to come to the service of LYGP; Second, strengthen communication with government departments at all levels to establish a harmonious and relaxed market environment, policy environment and the media environment.

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Appendix 1 Questionnaire

Scoring for qualitative indexes (1~9)

Index	Explanation	LYGP	RZP
Quality of equipment and facilities	Qualitative index, extent of modernization of equipment and facilities compared with other ports		
Ability of feeder system	Qualitative index, port's ability to gather and distribute cargo compared with other ports		
Governmental support	Qualitative index, supports(such as policy and finance)from government compared with other ports		
Condition of custom clearance	Qualitative index, efficiency and convenience of custom clearance compared with other ports		
Development of related industries	Qualitative index, development of related industries(such as cargo forwarder, quarantine, pilot service)compared with other ports		

Economy scale of hinterland	Qualitative index, economy scale of hinterland compared with other ports		
Economic potential of hinterland	Qualitative index, economic potential of hinterland compared with other ports		
Informationization in management	Qualitative index, port's ability to use IT in management compared with other ports		
Development of E-commerce	Qualitative index, port's ability to use E-commerce in commercial activities compared with other ports		
Utilization of new equipment and technology	Qualitative index, port's ability to use modern equipment and technology compared to other ports		
Logistics extending ability	Qualitative index, port's ability to provide integrated logistics service compared with other ports		
Agility	Qualitative index, port's ability to make quick and wise response to change in market		

Appendix 2 Programme in MATLAB

1. Main programme

```
%Principal Component Analysis
function A = PCA (X, m, n)
% X is sample matrix
% m is the number of evaluating schemes
% n is the guidelines

% u is critical value
u = 0.85;

% Standardization
Z = zeros(m,n);
for j = 1:n
    % xj is the average of the jth guideline
    xj = sum( X(:,j) );
    xj = xj / m;

    % Sj is the standard difference of the jth guideline
    Sj = sum( (X(:,j)-xj).^2 );
    Sj = Sj / (m-1);
    Sj = sqrt (Sj);
    for i = 1:m
        Z(i,j) = ( X(i,j) - xj ) / Sj;
    end
```

```
end
Z

% Computing relative coefficient matrix
r = zeros (n,n);
for k = 1:n
    for j = 1:n
        if k<j
            r(k,j) = sum( Z(:,k).*Z(:,j) );
            r(k,j) = r(k,j) / (m-1);
        elseif k>j
            r(k,j) = r(j,k);
        else
            r(k,j) = 1;
        end
    end
end

% Computing eigenvalues and eigenvectors
[V,D] = eig(r);

for i = 1:n
    if D(i,i)<0
        D(i,i) = 0;
    end
end
```

```
%Sorting the square differences
for i = 1:n-1
    imax = i;
    for ii = i:n
        if (D(imax,imax)<D(ii,ii))
            imax = ii;
        end
    end
    % swap
    dbuff = D(i,i); D(i,i) = D(imax,imax); D(imax,imax) = dbuff;
    vbuff = V(:,i); V(:,i) = V(:,imax); V(:,imax) = vbuff;
end

% Computing square difference contributing rate
dsum = sum(diag(D));
asum = 0;
a = zeros(n,1);
for t = 1:n
    a(t) = D(t,t) / dsum;
    asum = asum + a(t);
    % max contributing rate?
    if asum > u
        break;
    end
end

% Computing compositive guidelines
```

```
y = zeros(m,t);
for i = 1:t
      y(:,i) = Z*V(:,i);
end

% Computing final evaluating value
A = y*a(1:t);
a
V
return;
```

2. Application programme

```
% Principle Component Analysis Application

% 1,Read in Sample Matrix
fid = fopen ('DATA.txt');
X = fscanf (fid, '%g\t%g',[2 22]);
fclose(fid);
X
% 2,Analysis Results
%for i=1:2
%       X(i,16) = 1 / X(i,16);
%       X(i,9) = 1 / X(i,9);
%       X(i,6) = 1 / X(i,6);
%end
A = PCA(X,2,22)
```

Appendix 3 Result of calculation

X =

1.0e+003 *

Columns 1 through 10

0.0115 0.0150 0.3650 0.0340 4.0000 0.1170 0.4950 0.0048 0.0052 0.0075
0.0150 0.0240 0.3000 0.0390 7.0000 0.1020 0.5800 0.0043 0.0060 0.0073

Columns 11 through 20

0.0070 0.0057 0.0053 0.0064 6.0160 0.0256 0.1000 0.0057 0.0053 0.0063
0.0073 0.0048 0.0049 0.0059 8.4210 0.0391 0.0200 0.0052 0.0049 0.0061

Columns 21 through 22

0.0054 0.0076
0.0051 0.0077

Z =

Columns 1 through 10

-0.7071 -0.7071 0.7071 -0.7071 -0.7071 0.7071 -0.7071 0.7071 -0.7071 0.7071
0.7071 0.7071 -0.7071 0.7071 0.7071 -0.7071 0.7071 -0.7071 0.7071 -0.7071

Columns 11 through 20

-0.7071 0.7071 0.7071 0.7071 -0.7071 -0.7071 0.7071 0.7071 0.7071 0.7071

```
    0.7071   -0.7071   -0.7071   -0.7071    0.7071    0.7071
-0.7071   -0.7071   -0.7071   -0.7071

  Columns 21 through 22

    0.7071   -0.7071
   -0.7071    0.7071


a =

    1.0000
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0


V =

  Columns 1 through 9

    0.2132   -0.0876   -0.2540   -0.0709   -0.1137   -0.0470
```

0.0000 -0.0000 0.0000
0.2132 -0.0876 -0.2540 -0.0709 -0.1137 -0.0470
0.0000 -0.0000 0.0000
-0.2132 -0.2112 0.1230 0.0885 0.0446 0.0170
0.5793 0.3920 -0.5034
0.2132 0.2112 -0.1230 -0.0885 -0.0446 -0.0170
0.0236 0.1066 0.2515
0.2132 -0.2670 -0.0658 0.0225 -0.1572 -0.0827
0.0000 0.0000 0.0000
-0.2132 -0.2112 0.1230 0.0885 0.0446 0.0170
0.0608 -0.5817 -0.0828
0.2132 0.2112 -0.1230 -0.0885 -0.0446 -0.0170
-0.3295 -0.3104 -0.7745
-0.2132 -0.2112 0.1230 0.0885 0.0446 0.0170
-0.6267 0.2556 0.0869
0.2132 -0.0294 0.0323 -0.3369 0.3707 0.1626
-0.0000 -0.0000 0.0000
-0.2132 -0.2112 0.1230 0.0885 0.0446 0.0170
0.0724 -0.5212 0.1738
0.2132 -0.0467 -0.0316 -0.0787 0.4457 0.1527
-0.0000 0.0000 -0.0000
-0.2132 0.2670 0.0658 -0.0225 0.1572 0.0827
-0.0000 0.0000 0.0000
-0.2132 0.2522 0.0767 0.0341 0.0109 0.0299
-0.0000 0.0000 -0.0000
-0.2132 -0.0501 -0.3228 -0.0648 -0.0122 -0.7862
0.0000 0.0000 -0.0000
0.2132 -0.2641 -0.0419 0.0291 -0.1562 0.0153
-0.0000 -0.0000 0.0000
0.2132 0.1691 0.0978 0.4887 0.1106 0.0403
-0.0000 0.0000 -0.0000
-0.2132 -0.2112 0.1230 0.0885 0.0446 0.0170
-0.3918 0.2515 -0.1975
-0.2132 -0.0539 -0.3348 -0.0502 -0.5482 0.5160
-0.0000 -0.0000 0.0000
-0.2132 0.2404 -0.0035 -0.0651 -0.1422 -0.0469
0.0000 -0.0000 0.0000
-0.2132 -0.0792 0.0561 -0.7214 0.0802 0.0499
-0.0000 -0.0000 0.0000
-0.2132 0.5005 -0.2366 0.0555 0.0752 0.0375

-0.0000 0.0000 -0.0000

0.2132 0.2122 0.6794 -0.1978 -0.4528 -0.1922 0.0000 0 0

Columns 10 through 18

-0.0000 -0.0000 -0.0000 0.2860 0.1565 -0.1815 0.0196 0.0000 0.7071

0.0000 -0.0000 -0.0000 0.2860 0.1565 -0.1815 0.0196 0.0000 -0.7071

0.2963 -0.1365 0.0897 0.0251 -0.0140 -0.0333 0.0176 0.0000 -0.0000

0.6135 0.1680 0.6143 -0.0251 0.0140 0.0333 -0.0176 -0.0000 -0.0000

-0.0000 -0.0000 0.0000 0.0501 -0.0974 0.0615 -0.0298 0.7071 -0.0000

-0.2427 -0.1596 0.6510 0.0251 -0.0140 -0.0333 0.0176 0.0000 -0.0000

0.2180 -0.0432 -0.0549 -0.0251 0.0140 0.0333 -0.0176 -0.0000 -0.0000

0.2820 -0.5565 0.0473 0.0251 -0.0140 -0.0333 0.0176 0.0000 -0.0000

0.0000 0.0000 -0.0000 0.0503 -0.7204 0.2497 0.0329 0.0000 -0.0000

0.5848 0.2255 -0.3966 0.0251 -0.0140 -0.0333 0.0176 0.0000 -0.0000

-0.0000 0.0000 0.0000 -0.6028 0.3399 -0.0769 -0.0765 -0.0000 0.0000

-0.0000 0.0000 0.0000 -0.0501 0.0974 -0.0615 0.0298 0.7071 -0.0000

-0.0000 0.0000 0.0000 0.3269 -0.0304 0.2453 -0.6129 -0.0000 -0.0000

-0.0000 -0.0000 0.0000 -0.3301 -0.2408 -0.0466 -0.1912 -0.0000 0.0000

0.0000 0.0000 -0.0000 0.1033 -0.0452 0.0832 0.0211 -0.0000 0.0000

-0.0000 0.0000 0.0000 0.0103 -0.3763 -0.6968 -0.1709 -0.0000 0.0000

-0.0889 0.7518 0.1680 0.0251 -0.0140 -0.0333 0.0176 0.0000 0.0000

```
    0.0000    0.0000   -0.0000   -0.3988   -0.2302   -0.0621
-0.1971   -0.0000   -0.0000
    0.0000   -0.0000   -0.0000    0.0029   -0.1856   -0.1036
0.6911    0.0000    0.0000
    0.0000    0.0000   -0.0000    0.1577    0.0489   -0.5291
-0.1475   -0.0000    0.0000
   -0.0000    0.0000    0.0000    0.0948    0.0615    0.0297
0.0385   -0.0000    0.0000
         0   -0.0000         0   -0.2040    0.0093   -0.0186
-0.0822   -0.0000         0
```

Columns 19 through 22

```
    0.0260   -0.4030   -0.2349    0.0659
    0.0260   -0.4030   -0.2349    0.0659
    0.0084   -0.0854   -0.0719    0.1131
   -0.0084    0.0854    0.0719   -0.1131
    0.3858    0.3581   -0.1202    0.1967
    0.0084   -0.0854   -0.0719    0.1131
   -0.0084    0.0854    0.0719   -0.1131
    0.0084   -0.0854   -0.0719    0.1131
    0.0007   -0.2609   -0.0640    0.1348
    0.0084   -0.0854   -0.0719    0.1131
   -0.0036    0.0388   -0.4682    0.1088
   -0.3858   -0.3581    0.1202   -0.1967
   -0.0054    0.1284   -0.5318   -0.1998
   -0.0998   -0.0881   -0.0446    0.0014
   -0.8301    0.3062   -0.1281    0.1954
   -0.0299    0.0733   -0.0302   -0.0097
    0.0084   -0.0854   -0.0719    0.1131
    0.0028   -0.1199   -0.0358   -0.0015
    0.0115    0.1796   -0.5258   -0.1960
   -0.0180    0.2780    0.0929    0.0231
    0.0045    0.0751    0.0433    0.7844
   -0.0059   -0.2125   -0.1041    0.2489
```

```
A =
   -3.3166
    3.3166
```