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Research on development strategy of Rizhao Port industrial cluster

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RESEARCH on DEVELOPMENT STRATEGY of RIZHAO PORT INDUSTRIAL CLUSTER

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Abstract

In the environment of total economy growth and economic structure changes, industrial cluster has become an important economic organization. Port industry cluster means that introduce a product the concept of industrial cluster to port services industry, which can give full play the advantages of cluster. With the opening of the coastal cities, the competition in the port sector is increasing fierce, only emphasizing the ability of port operations and throughput capacity can not meet the current competitive environment. Port industrial cluster development has become effective development model under the new economic forms. Therefore, Rizhao should make full use of its unique port advantages to foster industrial clusters which can help reduce costs, improve quality, optimize the industrial structure and layout and promote port industrial upgrading so as to boost economic development in Rizhao.

The main contents of this paper are as follows:

Firstly, analyze the research background and significance of port industrial cluster and compare the research of industrial clusters and ports industry cluster studied by domestic and foreign scholars. And summarize an overview of writing ideas.

Secondly, describe the meaning of the port industry cluster formation mechanism, structure and cluster effects and qualitative analyze four stages of port industrial clusters development.

Thirdly, analyze correlation degree between port throughput and port industry using improved gray slope correlation degree model to illustrate the feasibility of port industry cluster development; select Rizhao city and national port industry output as indicator using E-G index model to determine SCI index of port industries in order to the level of agglomeration. Combine quantitative analysis of correlation degree and agglomeration degree to explore the development stage of industrial clusters of Rizhao port. Based on this, determine the mode of development of industrial clusters

Rizhao port and future development strategy combining with STOW analysis.

Fourthly, according to the construction and development of Rizhao port, put forward some suggestions to provide a theoretical basis and guidance for all types of enterprises and government departments in planning and decision-making.

Lastly, propose shortage during the study and the direction of future research.

Key words: Industrial clusters, Industrial correlation degree, Industrial agglomeration degree, Cluster development

Content

1 Introduction

1.1 Research Background and Significance

1.1.1 Research Background

With the development of economic globalization, in the interaction between globalization and regionalization competition, industrial clusters have become a main force, a phenomenon of the world economy and a new approach of development in various industries. The world economy and the trade activities in the era of globalization generated new demand for shipping. After accession to the WTO, China’s opening area is increasingly extended and external trade is enlarged rapidly, industrial clusters of port face chances and challenges. At the same time, experience in cluster development over the past decades showed that port industrial clusters’ superiority is increasingly more important for developing advantages of industrial cluster and improving regional competitiveness. With the process of economic globalization and information technology, industrial cluster theory has become the focus of governments, industry and academia. And industrial cluster theory also has become today's international highlights and theme of industrial development.

Industrial cluster can promote scale effect and integration of resources, which can lower costs, accelerate industrial upgrading and form the lasting competitive advantage. Port industrial cluster is the result that applying industrial cluster theory into port services. Meanwhile, competition in the port sector is increasingly fierce so that only emphasizes the ability of port operations and throughput capacity can not meet the current competitive environment. Therefore, it is practical significance to in-depth study the development of port industry cluster and co-ordinate the relationships between enterprises and port industry cluster.

Rizhao port is the emerging coastal ports with the birth of China's reform and

opening up and is one of the 20 main hub ports which are focused on development along the coast of China. After nearly 20 years' construction, Rizhao Port has developed into a modern enterprise group which includes cargo handling, harbor construction, machinery manufacturing and real estate development. Rizhao Port has unique natural conditions and obvious region advantages. Port is located in the middle of China's coastline, port's east is adjacent to Yellow river, north and south links to Qingdao Port and Lianyungang port respectively. The port is suitable for the construction of various types of professional deep-water berths including 20 to 30 tons of large deep-water dock, from this point, Rizhao port is actually a natural deep water port. The port is growth Port which pursues scale. Regional economic has significant effect on port economic. Regional industrial policy efforts to support the growth of the size of the port become a key factor in growing port development. Therefore, the port faces stress and challenges. It is necessary to discuss and study industrial clusters of Rizhao port.

1.1.2 Research Significance

It is very important to study the development of Rizhao port industrial cluster. Firstly, port- businesses related to port is concentrated in industrial cluster geographically, which can make the port get more services and more resources. As a result, it can improve the efficiency of port services; Secondly, there will be ship cargo agents within the region of port industry, which can promote specialization port size clusters and provide specialized market information and enhance competitiveness of Rizhao port; Thirdly, development of the port industry cluster can increase port function and to some extent, the reduction of transaction costs within the port industry cluster can improve the development and growth of port industry cluster; At last, port industrial cluster can provide more favorable atmosphere of innovation for Rizhao port. Promote the exchange and absorption of knowledge and technology within the industry, reduce the innovation cost of enterprises, help form a rational division of labor across regions, the allocation of resources among industries that complement

each other to achieve win-win situation. Therefore, it is important for the development of Rizhao port to study the development of port industry cluster.

1.2 Literature Review

1.2.2 Recent Research on Port Industry Cluster

Until now, many scientists in China and abroad have done a lot of research and study on the theory of industrial cluster and apply the theory into port industry cluster. Moreover, some scholars have made some achievements.

First, there are quite a lot of researches on basic theory of industry cluster. Wu Jiebing, et al. (2007) introduced definition and classification relating to industry cluster, they reviewed the theory of industry cluster from three respects of agglomeration mechanism, synergistic effect and cluster effect after Marshall. They attempted to find new development and mixture of industry cluster theory. Yung-Lung Lai, et al. (2013) explored the effects of special resources and relationships among cluster firms on innovation performance, and focuses on knowledge management as the mediator for investigation. At the same time, there are some researches on industry cluster which is applied into air industry, software and so on. Natalija Kulakova(2014) studied the issues-business clusters formation in Latvia. The author analyzed the chances and challenges during the formation of business clusters in Latvia.

Second, researches on port industry cluster are abundant. Wang Ling (2005) studied port internal competition based on port industry cluster. The author applied the theory of industry cluster into port cluster and internal competition, proposed that encourage internal competition using implementation path and discuss how to improve efficiency of port industry cluster. Gao Qin (2008) studied the complexity of port industry cluster and how to coordinate the relationship among port enterprise. Wang Erdong (2010) discussed development pattern of port industry cluster and proposed three types of development pattern. The author analyzed the port industry cluster pattern of foreign port, such as Singapore and so on and learned some significant knowledge which can be applied into Chinese port industry cluster. Ping Deng, et al. (2013) studied the relationship between ports and regional economy from logistics perspective that provided support for policy makers in their strategic port related decisions.

Third, some methods and models are applied into the study of port industry cluster. Wang Erdong (2010) used improved gray correlation degree slope model to analyze correlation between port industries and port and analyzed the degree of geographical concentration of each port industries using Locational Quotient. Yung-Lung Lai, et al. (2013) used regression analysis and correlation analysis to study the relationship among industrial clusters. Ping Deng (2013) tested a hypothesized model concerning ports and their regional economy using structural equation modeling approach.

1.2.2 Existing Problems

Although there are many papers studying industry cluster, some problems still exist.

First, many methods employed are theoretical analysis - qualitative analysis such as Jiang He, M. Hosein Fallah's article (2011). Only a small amount of papers (Yung-Lung Lai, et al.2014, Ping Deng, et al.2013) adopted quantitative analysis.

Second, detailed analysis of each port is far from enough, most papers analyzed port industrial cluster in macro respect. However, different port have different conditions, each port should be analyzed respectively according to detailed situations.

Third, there are some difficulties to analyze detailed port industrial cluster quantitatively because some data is vary with the development of regional economy. Therefore, it is practical to study this problem periodically.

1.3 Research Contents and Technology Roadmap

This paper analyzes the current situation of Rizhao port using SWOT matrix analysis. Firstly, analyze the advantages and disadvantages of Rizhao port industry cluster and find the chances and challenges during development. Meanwhile, analyze development strategy using SWOT; Secondly, analyze the relevance and concentration degree of Rizhao port industry using improved Grey Relational Model

and E-G index model respectively. In a short, this paper adopts method that combination of qualitative analysis and quantitative analysis. At last, draw a conclusion that the rational industrial structure of Rizhao port industry cluster.

Research ideas (figture 1.1)

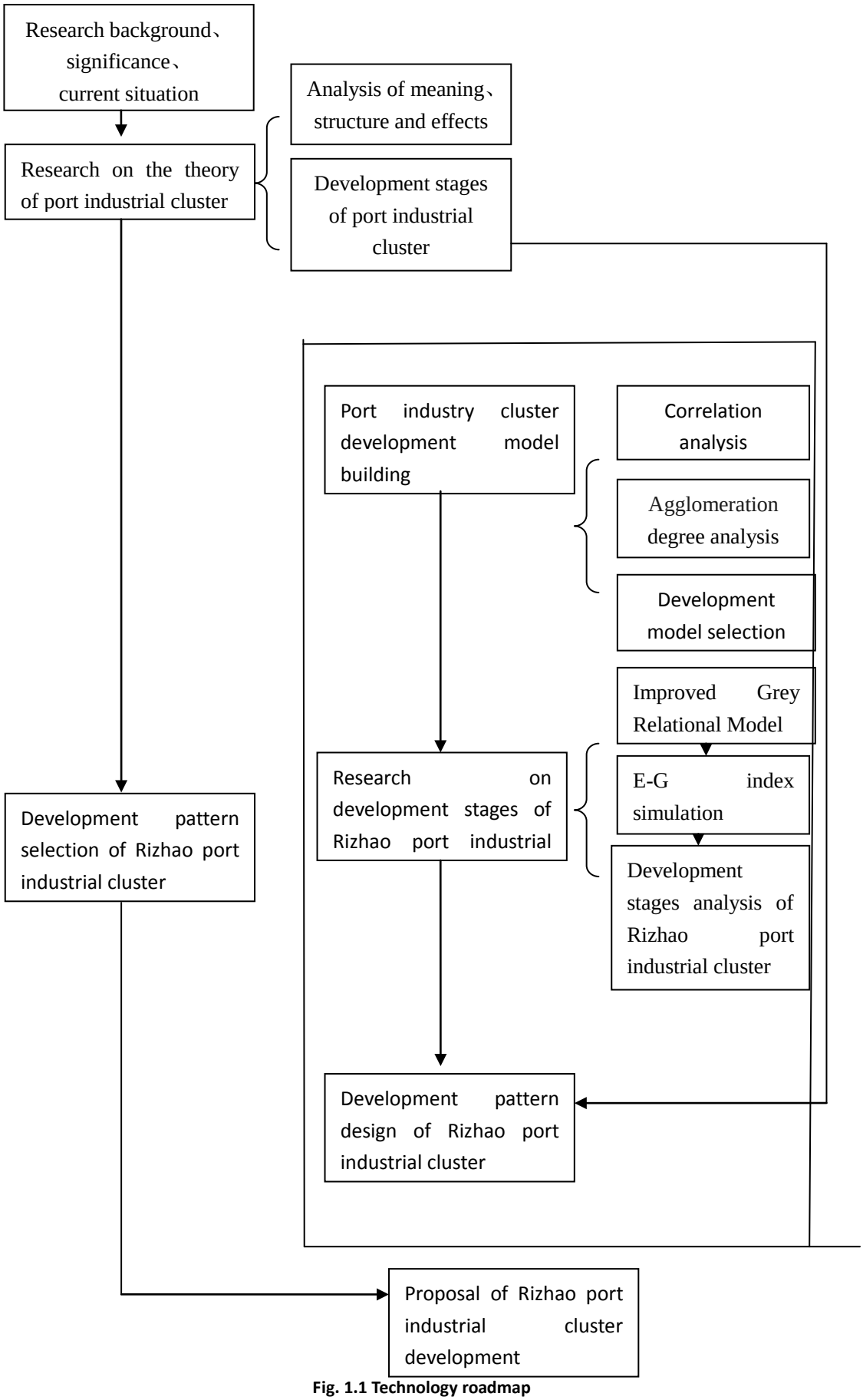

Fig. 1.1 Technology roadmap

2. Research on Port Industry Cluster Theory

2.1 Research on Industrial Cluster Theory

From the perspective of institutional economics, industrial cluster is intermediate between a pure industrial organization of markets and business organizations; From the perspective of organizational ecology, industry cluster is characterized by a kind of biological communities and enterprise development ecosystem; From the the perspective of regional economics, industry cluster is a regional innovation network.

2.1.1 The Concept of Industrial Clusters

Many scholars in the study of the process of industrial clusters, made a number of explanation for industrial clusters, so far there is no uniform definition of industrial clusters. More representative explanation which is explained by Michael Porter professor of Harvard University is that clusters are used to define a particular area, the interrelated companies and research, accumulation in the form of research institutions, such as the geographical. Downstream industries cluster usually includes companies with complementary products manufacturer, specialized infrastructure providers and to provide training, education, information, research, technical support of other agencies. For example: university, vocational training providers, technical standards bodies. Many clusters also include members of the Chamber of Commerce and other groups covered by the cluster organization.

In fact, the discussion on industrial clusters, although resulting in a variety of different professional perspective discussed are not the same, the essence is the same. In this article, we define it as: industrial cluster is within a certain geographical area, a large number of closely related businesses and industry as well as related support agencies, highly interactive, shared resources, specialization and the ability to form a strong, sustainable competitive advantage of a cluster. From the view of industrial

point, industrial clusters including a number of industrial competition plays an important role, interrelated industries and other entities industrial clusters often extend down to the sales channels and customers, and the sides extended to manufacturers of complementary products, as well as Industrial clusters often extend down to the sales channels and customers, and the sides extended to manufacturers of complementary products, as well as skills related to technology or investment industry companies. In addition, industrial clusters also include the provision of specialized training, education, government and other institutions of research and technical support information.

2.1.2 Characteristics of Industrial Clusters

The first basic concept of industrial clusters is from Marshall’s understanding of industrial area. Marshall defined the industrial district as an admission by a common history and a limited region, small and medium enterprises actively interact with the convergence of business and social groups, which think that the industrial area has the following six characteristics: (1) Homologous with the local community's values system and collaborative environment for innovation; (2) Production of vertical linkages enterprise group; (3) The optimal configuration of human resources; (4) Industrial area ideal market: the market is not perfectly competitive; (5) Competition and cooperation coexist; (6) Characteristics of the local credit system.

With the development of economy and technology characteristics of industrial clusters are constantly deepen understanding. Rabellotti think cluster has four main features: (1) Composed mainly by Small and medium enterprises, and gather in the space, with specialized features on the industry. (2) Economic actors associated with a strong individual, cultural and social backgrounds convergence, resulting a common, can be universally accepted code of conduct, though some clearly visible between them, while others are more hidden and have played a certain role. (3) Based on the exchange market or non-market behavior, to promote goods, services, information and personnel and other production factor mobility, a strong backward, forward,

horizontal and labor contact. (4) The behavior of economic entities that local public, private network within the cluster plays a supportive role. Some other scholars also summarized the industrial cluster agglomeration characteristics.

Industry cluster features can be summarized as follows:

(1) Geographic concentration

Industrial clusters emphasis that medium and small enterprises are main components, which does not mean that there is no presence of large multinational companies. From a dynamic perspective, with the growth of some medium and small enterprises, industrial clusters occur naturally in large enterprises. In the context of globalization, industrial clusters area often become superior location that big business, foreign multinationals compete. A large number of small and medium enterprises are the basis of the existence and development of large enterprises. Industrial clusters performed that small and medium enterprises in the large cities and suburban areas or small cities gather in groups, space, highly intensive economic activities. Enterprises are concentrated in geographic clusters to generate economic basis, also the foundation for the cluster as a regional economic phenomenon, the geographic concentration is a relative scale.

(2) Professionalism and self-reinforcing

Individual enterprises within the cluster are always concentrated in a limited production of products and processes, the formation of specialized features. Specialized division is related to the divisibility of production technology and vertical separation production organization. Industrial clusters can be seen as a regional system of flexible production. As the adoption of technology environments such as CAD, CAM, CIMSDENG, the production and operation methods of a large number small and medium enterprises moves toward flexibility. Relationships between inside the enterprise and outside the enterprise organizational structure and other enterprises have scalability characteristics with external technical changes and increased competition in the market conditions.

Self-enhancement feature of clusters derives from positive feedback mechanism of external economies. Once the cluster formation and it will be able to take

advantage of regional innovation through the environmental advantages of its external economies of scale and external economies of scope, which not only promotes new enterprises cluster derivatives, but also enhances the attractiveness of the cluster outside companies entering. Therefore making the size of the cluster expand and accumulating the advantages continuously, which reflect a self-reinforcing process of "path dependence" and "accumulation of causality".

(3) Enterprise networking

Enterprises within clusters take shape a local network through the production system, there is a forward, backward and horizontal linkages among suppliers, manufacturers, sales agents and customer. A variety of formal and informal collaboration networks formed according to long-term contact between enterprises and local governments, universities or research institutions, financial institutions, intermediary service organizations which support each other, which can reduce the average labor cost of production products, enhance the ability that acquiring knowledge and accumulating knowledge. Such cooperation network includes enterprise networks, labor market networks and regional innovation networks. Various actors within the network conduct goods, services, information, labor, and other trade or non-trade transactions, exchange and interaction, learning from each other and cooperate closely, jointly promote the development of continuous innovation and enterprise zone with formal or informal relationship.

(4) Enterprise embeddedness

Enterprise network in industrial clusters has embeddedness which means that a variety of network relations and corporate events clusters are based on the local social structure that is local ownership. Enterprises in industrial cluster have the same or similar businesses socio-cultural background and institutional environment, the enterprise's economic behavior is deeply rooted in a common circle or embedded in language, background knowledge and trading rules. Common social and cultural environment generate understanding and mutual cooperation. Social capital forming from mutual trust and satisfaction makes many companies be bonded together, which not only enhances the whole cohesion but also makes enterprises deeply rooted in the

local business. The strength of embeddedness is closely related to the stability of industrial cluster and its sustainable development.

(5) Cluster innovation

Mature industrial clusters have good knowledge transfer mechanisms, which can speed up the dissemination of technical knowledge and enable enterprises to learn new technology easier and lower cost. Small and medium enterprise clusters obtain a competitive advantage, a very important reason lies in the close exchanges between enterprises, based on trust and cooperation and efficient knowledge transfer speed and efficiency. Transferring knowledge to relevant enterprises and then by its member companies to imitate and improve the competitiveness of Small and medium enterprises in clusters according to specialization and collaboration among enterprises. Industrial clusters tend to have good technical learning and diffusion mechanism, Study inside cluster is the dominant way of technological learning of enterprises in cluster. Strong business of clusters aimed at export-oriented high-tech knowledge carrying out outside learning, while those disadvantaged businesses learn in the knowledge in whose subsequent diffusion in cluster. Forming a virtuous flow external to internal diffusion of knowledge and promoting the overall technical capabilities to improve the cluster, which can make clusters continue to grow dynamically.

(6) Cluster opening

The formation and evolution of industrial clusters and obtaining cluster competitive advantage rely on frequently ordered interaction, communication, organizational learning and knowledge innovation among these enterprises in the industrial cluster. In order to look for new partners to open up new markets, to expand regional innovation space to obtain the knowledge and to complement distance resources to complete the cluster reasonable external links, various actors in industry cluster networks have comprehensive, multi-level connection to the main field of industrial clusters. Industrial clusters must achieve the optimal allocation and utilization of "two resources, two kinds of markets," with characteristic of openness.

(7) Dynamic evolution

Clusters are in a constant dynamic evolution from lower to higher and from the

simple to the complex. It is to be subjected to a whole process from the growth, the development to maturation. From industry linkages between the regional various entities, industrial clusters only have the mechanical network characteristics in primary stage; In advanced stage, industry contact emphasis more on information and knowledge of non-physical contact which is not only the product of a linear chain relationships, it is a non-linear relationship between innovation chain.

2.1.3 Advantages of Industrial Clusters

(1) Achieving a variety of resource sharing and reducing industry costs

Industrial clusters can achieve sharing and proliferation of infrastructure, labor, information and knowledge and industrial space cluster itself can bring external economic, which can save industry cost significantly and promote industrial production flexibility. Information and knowledge sharing can promote industrial clusters innovation and the formation of social network. Industrial clusters allows more refined division of labor within the cluster enterprises, improve the degree of specialization of enterprises; At the same time, the concentration and correlation within clusters enterprises so that the intermediate scale character of investment and labor market regulation can give full play to the role of mode effects, the division of labor and economies of scale which will promote efficiency and increase output. This kind of high degree specialization production is very conducive to improving productivity and technological innovation, so as to promote the development of enterprises, and cooperative relationship is very stable and transaction costs is small among enterprises, thus can share scale economies even scope economies.

(2) Conducive to technological progress and diffusion

In modern economic growth, the contribution rate of total factor productivity is increasing, technological progress and institutional change role in the economic growth performance was very evident. In developed countries, economic system is relative stable, technological progress becomes the only engine for long-term economic growth, thus research on technological progress and technology diffusion

theory has become an important aspect of growth. Technological progress comes from technological innovation and technological innovation comes from technological innovation system. For the regional economy, industrial cluster is an important innovation system. Industrial cluster is not only conducive to enterprise innovation, but also forming a new innovation model - clusters innovation. Therefore, industrial clusters can accelerate technological progress and continue to provide the driving force for economic growth. For technology diffusion, industrial clusters have more obvious advantages. Enterprises in cluster have geopolitical proximity and close connection so that technology diffusion is very fast among enterprises within cluster. The rapid spread of technology can make enterprise update equipment in time and adopt new technology. Adjusting factor inputs portfolio can generally improve productivity and output of enterprise, thereby increasing the total amount of the regional economy and market competitiveness and promote regional economic growth.

(3) Attract economic resources outside the region and enhance regional economic reality

Industrial cluster is an organized focus of industry capital, labor, technology and entrepreneurs, development speed is very quickly, so it is bound to be attractive for the enterprises and organizations outside cluster. If the conditions are allowed, related businesses and organizations will migrate to the cluster region. The most prominent in reality is the industry clusters attract foreign investment: whether developed or developing countries, regional foreign investment are very obvious, cluster policies can reduce the cost and risk of foreign investment, is very important for the region to attract investment. Geographical and industry concentration of foreign investment can effectively promote the development of regional industrial clusters, and even foster new industrial clusters, which will have a dual role in promoting regional economic growth. Industrial clusters provided some European cities the impetus for economic concentration and implementations and played a very important role in the city economic development. Promoting economic growth through industrial clusters has become one of the major long-term policies of the European continent most urban

growth strategy. Singapore, Hong Kong, Shanghai and Beijing and other cities use industrial cluster strategy to attract foreign direct investment and accelerate economic development in the region.

To sum up, industrial clusters can take advantage of scale economies and labor division and attract external resource flows to the region and have a great role in promoting economic growth in many aspects. Meanwhile, the region's economic growth will also affect the development of cluster. If the regional economic is prosperity, it will be conducive to the development of all aspects of the region, must also conducive to the development of industrial clusters. If the regional economic is recession, it will have a great impact on industrial cluster. Overall, industrial clusters and regional economic growth complementary and mutually reinforcing, in the development process in the region should also be fully realized industry clusters and regional economic co-development.

2.2 The Basic Research on Theory of Port Industrial Clusters

In the era of the integrated logistics and open economy, port has become an important hub for international logistics system and an important carrier of various markets, which has an increasingly important role in the development of the regional industry. As an important hub for international land and sea logistics channels and nodes, port will certainly bring a lot of information about production and consumption related to logistics and then become the carrier of the development of the market system. From the perspective of factor markets, port is usually the regional center of personnel, information, technology and financial. From the view of market point, port is usually a regional trade center, especially some large specialized markets relying on the port to form. To sum up, either from the view of supply or the view of demand from, port has the advantages developing industrial clusters. However, as a system, port industrial cluster need to continue to develop under the influence of many factors. Therefore, it is necessary for us to research port industrial cluster theory .

2.2.1 The Meaning of Port Industrial Clusters

Literally can be seen, the port industry cluster is the results introducing the concept of industrial clusters into port services. Port industrial clusters have become the world's universal law of port development, with the continuous development of modern port functions. It is inevitable that port leading industry and related industries gather to form the port industry cluster. Port cluster has the general characteristics of industrial clusters. Some companies and organizations that concentrate on a specific geographical location can generate a symbiotic effect each other and can produce effects of scale economies and external economic. There is division competition and collaboration within the cluster, the companies inside clusters can share common resources and taking advantage of resources to reduce business transaction costs, while having the ability to adapt to external changes. Professor Belgium Haezendonck E at the University of Antwerp firstly proposed the theory of port industrial cluster. She defined port industrial cluster as that a series of independent businesses engaging in port-related services are gathered in the same port area, and uses almost the same competitive strategy to gain relative to the cluster outside the united competitive advantage.

Port industrial cluster attracts cargo and ships to the port with different specialization, such as the combination of airworthiness jianghai channel, deepwater shelter anchorage and port equipment scale economy, to make the cargo reach a limited number of ports or port group, all economic activities consist of goods handing, good storage and shipping, these activities include terminal cargo handing, diversion and tug boat as well as ships and cargo to the port. Port cargo handing, transportation and logistics activities quite closely relate in together, all located in the port area of cargo handing, transportation and logistics activities are part of the port cluster. Another special associated with port cargo and ship manufacturing companies are also included in the port industry cluster, they are the important consumer of the port import and export, and they are located in the port cluster in order to reduce transport and logistics costs. Some trading activities closely related with port storage

and transportation functions are also included in the port cluster.

To sum up, in this paper we give the following definition of the port industrial cluster: port industrial cluster includes representative port industry such as transportation manufacturing industry, general-purpose equipment manufacturing industry, oil and fuel manufacturing industry; and port shipping industry such as transportation storage postal; as well as modern service industry such as the financial industry, information software service industry, wholesale and retail. At the same time, education, scientific research institutions and related auxiliary agencies are also essential. Among them, the port industry mainly includes the demolition shipyard, petrochemical industry and manufacturing industry; port shipping industry mainly includes shipping, port handing, storage and logistics etc. Services industry includes traditional service, for example, wholesale and retail, accommodation and catering, and modern service industry such as finance, insurance and consulting.

2.2.2 Formation Mechanism of Port Industry Cluster

The phenomenon of port industrial cluster appeared very early in the word, for example, the Netherlands Rotterdam port, London port and other ports which associated with powerful port efficiency and port economy, attracting many port related industry around it. The formation of the port industrial cluster promotes the development of regional economy and port city. Some ports in our country, such as Shanghai port, Shenzhen port, Qingdao port, which with its excellent geographical location, favorable port conditions and traffic facilities, perfect highway network, as well as the strong economic convergence, so those ports industries are relatively developed, there are a large number of port related industries gather in the port city central business district, thus emerging the embryonic form of port industrial cluster. On the formation of industrial clusters, many experts have been studied, although the angle is not consistent, but the main formation factors are port external economies scale, port business specialization, port area endowment effect, agglomeration economies and non market factors. Therefore, the port industrial cluster is a

comprehensive outcome, different areas and different intensity will have different formation mechanism of cluster.

(1) External economies infiltrate effect

Port cluster and the external economies of scale are closely related, port industry economy formation is a process which the port industry and hinterland economy mutual influence and mutual penetration. The development of economic trade must have a entire logistics supply chain, which form raw materials to production, circulation processing, distribution, and even the reverse recovery. The port as an important node of the international trade and transportation, by means of the port handing, storage, distribution, transportation and processing to produce the spatial agglomeration, accessing to external economies of scale benefits.

(2) Industrial specialization and division and cooperation of enterprises

The formation of industrial clusters is generated from specialization of port industry. Port provides a full range of services from arrive to leave and transportation of goods and ship. It includes ports, ship-related industries such as cargo, shipping agents, port transportation services, ship repair, etc. in addition to the handling, storage, and transport and all services are launched around the harbor. So its core business has obvious specialized features.

(3) Industrial agglomeration

Industrial agglomeration is an important phenomenon of modern regional economic growth. The same industry and related industries gather together and through the formation of the geographical proximity of competition on the downstream business cooperation between enterprises and in parallel, resulting in agglomeration benefits. Port-related services businesses spontaneously gathered in or around port logistics park and have a broad correlation among them which constitute a complete industry groups to provide services to ship and customers.

(4) Regional endowment

Regional endowments generate competitive advantage, which lead to the formation of industrial clusters. With its unique harbor often natural and geographical conditions and good water depth, a good collection and distribution systems and high

loading efficiency to attract more favorable cost to ship and cargo port, and the port processed, and then transported to the landlocked country or transshipment to other ports. Cargo and ship's options of call port are limited largely due to favorable port location and geographical conditions, such as good seaworthy condition and adequate water depth berth conditions. Of course, one of the factors favorable inland accessibility is also very important.

(5) Infrastructure conditions and loading and unloading efficiency

Good collection and distribution systems and high handling efficiency can reduce freight costs. At low prices to attract ships and goods to Hong Kong, easy access to intermediate products, or processed at the port, and then transported to the landlocked country, or transshipment to other ports. Therefore, in order to form a high-efficient port industry cluster, the ports must also have good conditions with good land waterway conditions including road transport and rail transport.

(6) Government policy-oriented non-market factors

Government policy-oriented non-market factors play an important role in the process of formation of port industrial clusters. Many port cities have made the policy of port promotes city and Long-term planning. And adopt policy or designated Bonded Port Free Trade Zone to attract ports and related companies settled.

In summary, the formation mechanism of the port industry cluster is multifaceted. External economies of scale, specialized port operations, port areas endowment effect, agglomeration economies and non-market factors constitute competitive advantage, which play an important role in forming of port industry cluster. In addition, the government's regional development strategy will have a direct impact on the economic development of the port hinterland indirectly affect the formation, development and upgrading of the port industry cluster.

2.2.3 Port Industrial Cluster Structure and Effects Analysis

(1) Port industrial cluster structure

Port industry cluster is essentially port-oriented industries supporting a large

number of companies and organizations related gathering in space, which form a strong, sustainable competitive advantages situation. This chapter divides industries into the port leading industry and port-related industry whose structure diagram shown in figure 2.1:

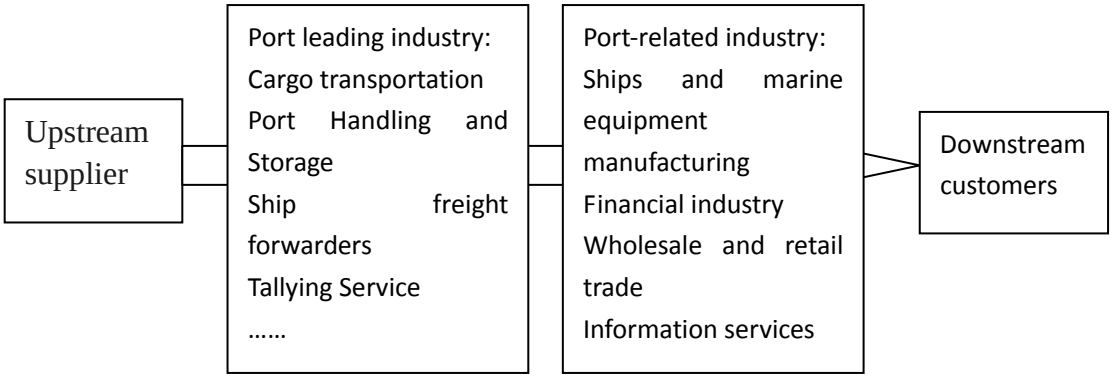

Figure 2.1 The Components of port industry cluster

An important factor in the formation of industrial clusters is geographically concentrated and port industry has inherent clustering so as to achieve cost and competitive advantages. In addition, a large number of port-related industries are constantly closer to the urban core area in order to chase a good business environment. With the development of information technology, gathering regional of port industry will continue to shift from the port to the port city downtown core area, which could be extended to sectors of the economy where the port of the city. Therefore, we can divide port industry cluster into three levels which is shown in figure 2.2 according to different geographical scope:

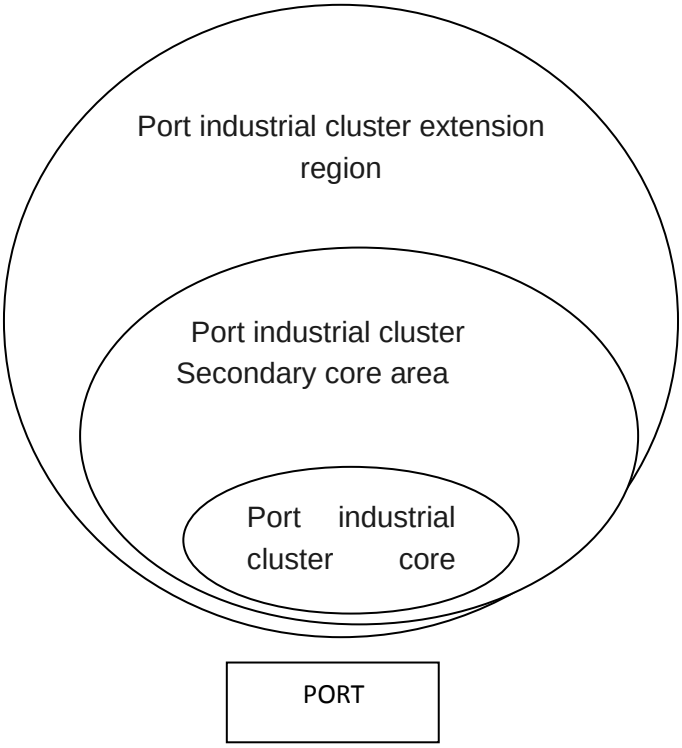

Figure 2.2 Three levels of port industrial cluster

First, industry cluster core area

The generation of port industry cluster depends on convenient transportation conditions of port and its core area is the distribution of cargo working area - center harbor and the core area provides services for ship docking, cargo handling and transshipment. Therefore, the geographical location of the core area is around the port area within a certain range. Port industrial cluster core area gathers a large number of ports leading industries, companies in which provide services for goods and ships. The cluster effect of port industry cluster core area is strongest, which is the basis of improving port competitiveness.

Second, Secondary core area of industrial clusters

The basic function of the modern port is not simple transportation, it emphasis that it is a logistics node and it becomes an important meeting point of the economy and trade. Therefore, the second core area of the port industry cluster is the main accumulation of a large number of port-related industries, such as ship and marine

equipment manufacturing, port construction and port engineering industry, inland inter-modal transportation, marine oils, electrical and mechanical equipment wholesale and retail trade, shipping-related finance and insurance, information services, education and training research institutions. A large number of port-related industries in the second core area of industrial clusters surround the core area, which provides various ancillary services and technical support for port leading industry. In addition, this area has industry organizations within clusters and offices within industry organizations, they play an important role in improving the relationship structure within clusters. Enterprises in secondary core area needs a good business environment so that they will not be located in the port area's geographical location but at the heart of the commercial district of the port city.

Last, Industry cluster extension region

With the development and improvement of industrial cluster core area and secondary core area, some port-led service industries relying on raw materials supply and transportation industries will gather at the port outskirts of the city and even the hinterland of the port city gradually receiving radiation effects of industrial clusters, providing and enjoying a low-cost, high-quality and convenient services. For example, iron and steel, chemicals, electronics and other industries are associated with the accumulation in the hinterland of the port forming port industry cluster extension region. To sum up the port industry cluster structure and hierarchy analysis above, this paper is to explore the port industrial cluster from the view of geographical area regarding port as the core, sub-cluster core area and the area with the port extension relevance and the sum of all industries combined effect of the stable.

(2) Port industrial cluster effect analysis

First, enhance regional competitiveness

Constructing port in the coastal region, industry cluster can effectively utilize regional resources gathering handling, storage, distribution, transportation and processing in space and form cluster effect to achieve benefits brought by scale economy. Industrial clusters not only integrate capital labor, natural resources and other general input elements but also give full play to the function of entrepreneurship.

Upon formation of the cluster, it will attract material, technology, human resources, finance and various ancillary services especially industry-specific resource by its advantages.

Second, expand the regional industrial scale, stimulate new business growth

The cluster effect can promote the competitiveness of enterprises to form or enhance and transmit mechanism through competitive so that it can promote and strengthen the competitive advantage of the entire region. Within the cluster area, port-related industries employing are more likely to perceive the product, service or supply chain improvements, which stimulate the growth of new businesses and further expand the scale of the port industry cluster.

Third, promote the integration of regional logistics industry

Integration of regional logistics industry not only is an important part of regional economic integration but also can promote regional industrial layout optimization. The integration of regional logistics industry is important nodes between in the internal and external connect regions and international logistics. Port logistics and port city economic promote mutually and develop commonly. Port logistics functions located in the whole supply chain regarding port as a link to attract the related logistics and service industries, which can play advantages of resources and scale. Port logistics enterprises have become the bearer of modern third party logistics, ports, ships, agents, port industry, commerce, trade, finance, insurance and services are gathered together to participate in the full range of supply chain management. Port industrial cluster can effectively reduce product costs, improve logistics efficiency, reduce market risk, form economies of scale and enhance independent innovation capability. Development of port logistics industry cluster can effectively promote the growth of foreign trade, promote the development of urban services and industry and promote local economic development.

Fourth, promote lingang economic development

Port industrial cluster not only is competitiveness of a region, but also provide a large number of jobs. It drives the rapid development of the local urban transport, hotels, exhibition, commercial and other tertiary industries and tourism. Port

industrial cluster in many areas constitutes a unique characteristic of the regional economic framework. Relying on port advantages and developing port-based industry cluster is the key to promote economic development in the port. Port industries take advantage of the port radiation function to develop lingang industry related to hinterland economy, which will benefit for the industrial structure optimization and rational allocation of production factors in the urban agglomerations forming a new industrial layout.

Fifth, promote economic growth in the hinterland

Industry cluster plays important role in promoting local economic development and the whole country's economic development and port industry cluster play more important role in promoting the regional economy. Port economy is a combination of terrestrial economy and marine economy with a strong extraversion so that port economy has more radiation effects on hinterland economy. The generation of port economic is a procession of mutual interaction and penetration between port and hinterland economy. Economic development in the hinterland is bound to from imported raw materials, to production, distribution, processing, distribution, distribution, and even reverse the recovery of the entire logistics supply chain.

Last, accelerating the conversion of technology innovations

Due to geographical proximity, close business contacts and exchange of information fast, with any major technological innovation potential and market prospects on the market, companies in the cluster are synchronized to absorb almost digested innovations such enterprises to quickly learn and imitate to realize their own updates and upgrades. At the same time, enterprises spread technological innovation to other companies within the region to making them improve technology so that they can not only transform technological innovations into mutual integration between production efficiency technology, but also inspire a lot more advanced technological creation and make enterprise having different core ability to become port technology alliance.

2.3 Development Stage Analysis of Port Industry Cluster

The port industry cluster development first began in the construction of the assignments section. With the improving of the port cargo distribution capacity, port area to form the growth pole, continuous development of port operation ability and service ability, form the core area of the cluster. After through the commercial and industrial agglomeration grow step by step, become the main area of the cluster. Followed by the cluster core continuously radiated outward, makes the port industry cluster to expand their reach, So have the core and the existence of the extension cluster, The development of the port industry cluster become more mature. Port industry cluster of space-time evolution stages can be summarized as the following four processes: start-up stage - Embryonic stage- formation stage – extension stage which is shown in the table 2.1

Table 2.1 The stage of port industry cluster development

stages	Formation process	Space evolution process
Start-up stage	The ability to form port operations, port infrastructure, industries and enterprises gather	Focus on nurturing core competencies port, a stronghold of the development phase
Embryonic Period	Port operations capability, driven to a large number of related companies began to gather around the port or ports. Formed a complete industrial chain of the port.	Development of industrial areas concerned, a transitional phase
Formation stage	The formation of industrial clusters with a port through mass diffusion, structures and systems of industrial clusters shape.	Stage of industrial development zone

Maturation and expansion stage	In addition to port-related industry clusters, but also the formation of industrial clusters with port	Industrial development deepening stage

2.3.1 Start-up Stage

This stage belongs to the startup stage. Generally speaking, government chooses good natural conditions as port construction sites and regards initial infrastructure construction as a trigger of port industrial cluster formation, for example, the number of berth, transport capacity of port area and surrounding, dredging, etc, which aims to form port cargo hub, draw supply, promote the upgrading of port throughput capacity. This phase focuses on the development of port operations capabilities. Each port industry has not yet formed the scale, a stronghold of the development period.

2.3.2 Embryonic Stage

(1) Port throughput capacity upgrades

After completion of basic port infrastructure, it will have a huge gathering force attracting related businesses (mainly for port operations business) gather in the port area, the port hinterland radiation effects growing, attracting both inside and outside the cargo area gathering harbor, port capacity rapidly upgrade.

(2) Port industrial cluster has taken shape

With the enhancement of port capacity, at this stage industries with a strong linkage effects will gather around the port. As the core of growth pole, driven forward the development of the port associated with the transport, entry and lateral development department after forming a long chain. Formed production systems around port operations and relevant companies complement each other.

(3) Cluster effect appears gradually

Port-related businesses in the same geographical space coordinating closely achieved good economic effects. The strength of the leading sectors is further

strengthened. Achieving mutual symbiosis among industries and cluster effect is more obvious.

2.3.3 Formation Stage

(1) Port industry massive proliferation

On the one hand, port operations capability has been greatly improved and large-scale industrial diffusion formed port industrial zone; On the other hand, various industry chain has matured forming a well-functioning network system, which provide convenient conditions for accelerating industrial agglomeration and diffusion. At the same time, supporting commercial services around the harbor are forming gradually.

(2) High-end services industries integrate into clusters and improved personnel training system

Finance, insurance, legal and other high-end services strengthen ties with other port-related industries and have complete training system. A large number of training institutions train personnel for the industrial clusters, technological innovation emerged frequently. This stage occurs industrial area system surrounding the port, port industrial cluster has clearly manifested, in the area of industrial clusters development stage.

2.3.4 Maturation and Expansion Stage

(1)Port industrial cluster formation

Port industrial cluster continuing to be improved can the formed its own cluster and from the port area to the industrial surroundings is also greatly accelerated. A large number of manufacturing companies gathered in the area around the port due to competitive advantages of formation of industrial clusters ports and convenient traffic conditions and formed port industrial cluster. Port industry clusters can bring a lot of cargo demand for port industry clusters and promote the development of the port industrial clusters.

(2) Specialization within the industry, enhance the external influence

Internally, the industrial division of labor and more closely link within cluster, the cluster is in an orderly state under benign, there have been relationships contained within the cluster organization to coordinate all sectors within the enterprise cluster.

(3) Modern service industry moves to mature, development of industrial clusters tend to be perfect

Finance, insurance, legal, and high-end services industries develop rapidly, which is close to port other industries. Port industrial cluster development tends to be perfect, which has great economic and industrial structure and economic contribution to systemic is improved greatly.

2.4 Development of Rizhao Port Industry

This paper select and regard port industry, port shipping industry, and port services as the main research object. The three main industries are following:

(1) Port industry: Transportation equipment manufacturing, communication equipment, computers and other electronic equipment manufacturing, chemical materials and chemical products manufacturing, oil processing, coking and nuclear fuel processing industry.

(2) Port shipping industry: transportation, storage and postal services.

(3) Port services: Wholesale and retail trade, financial industry, information transmission, computer services and software industry.

Rapid development of Rizhao port and expanding of port-scale need the support of inner port industry. Exchanges and cooperation, information sharing, allocation of resources, rational use and configuration of equipment and rational allocation of yard can low the cost of port and enhance the core competitiveness, which can promote the rapid development and expanding of port industry.

Rizhao port industrial cluster zone provide one-stop service ship docked, loading and unloading of cargo and cargo transshipment, which relying on strong carrying capacity of port berth, powerful cargo handling capacity, broad port hinterland and

convenient logistic services. The core areas of port are terminal operations district and cargo handling area, which gather a large number of port leading industries including handling and logistic company for cargo handing and transshipment services, ocean shipping company for shipping service, fuel company for provision of oil for ships and equipment, oil processing company providing crude oil service, customer box company providing container handling services, barge company provide ship berthing services, construction group provide terminal building and dredging services, supervision company providing project supervision services, materials corporation providing material procurement service, which are all the basis of enhancing port competitiveness for Rizhao port.

3. Rizhao Port Industrial Cluster Development Mode Selection

Under the background of economic globalization, the port is not just the traditional transportation hub. Its industrial feature develops quickly and derives other industries constantly, which have promoted the formation of the port industry. The trend not only booms port economy but also enhances the status of port. According to the discussion of previous three chapters about the theory of port industry and development current situation of Rizhao port and analysis of advantages and disadvantages, the chapter aims to build model and to analyze Rizhao port industrial clusters empirically. At last, proposed strategy for the future development of Rizhao port industrial clusters.

3.1 Analysis Model of Port Industrial Cluster Development Mode

3.1.1 Modeling Ideas

Firstly, calculate and analyze relevance between port industry and port, according to the strength of relevance between port industry and port, infer port industrial development model that Rizhao port can choose and choose leading industries, second core industries and port extended industries that qualify for Rizhao port.

In this article, analysis of industry association aims that analyze the relevance between every port industry and port, which get the possibility of every port industry that become part of Rizhao port industrial clusters. Only becoming cluster, can we analyze the development mode of industrial cluster. In other words, the formation of port industrial cluster is the precondition of development mode analysis. After ensure that Rizhao port industrial cluster can form industry, analyze the degree of

concentration of various industries, industry concentration degree is the important sign that measuring the level of development of industrial clusters. After calculate the concentration degree, we can clear that the level of port industry development, further infer the development stage of Rizhao port industrial cluster. Therefore, analysis of concentration degree of port industrial cluster is the basis of mode selection of port industrial cluster. At the same time, it is the preparation for putting forward proposal of Rizhao port industrial cluster development.

3.1.2 Port Industry Correlation Analysis

Research in reality, there are many methods of industrial association. According to the definition of the port industry in this paper, involved in related industries are more statistical information is imperfect, so a direct investigation or expert investigation are difficult to obtain objective data. This paper adopts an improved gray correlation model analyzing the association between pillar industries of Rizhao and Rizhao port.

Gray correlation is used to describe the amount of system factors closely related to the degree of inter and is a measure of the change in momentum of the system. It is an important part of gray system theory. In general, trend of quantified system can be characterized by trend of sequence and each sequence’s trend is always changing at a certain magnitude and trend. Therefore, the closeness of the relationship between the system sequences shows the similarity between the two changes in the size of similar magnitude and trends, which is the manifestation of gray association between distinct and mutual restraint. Changes of order of magnitude can be measured by displacement difference (distance between points) and trends can be measured by a first or second order slope. So using displacement difference and slope difference to represent correlation degree, which is the basic idea of many correlation models. Among the correlation models, several typical correlation models are Tangs correlation model, generalized absolute correlation model, T-correlation model, gray slope correlation degree model, B-type correlation model, improved correlation model

and so on which are all applied in varying degrees in socio-economic and production practices. However, these models have a certain degree defects such as having no uniqueness, no symmetry, the discussion of the negative correlation is small, can not meet the parallel and consistency due to imperfect gray correlation theory system. This paper constructed a new slope similar gray correlation model based on the differences degree of slope of reference sequence and comparative sequence, this correlation calculation model reflects the negative correlation and positive correlation relationship and can meet parallel and correlation. This paper selects port throughput and port industrial added value as the primary analysis indicators. The new gray slope similar correlation model can be divided into the following steps:

(1) Create a system characteristic sequence

Establish the fundamental matrix: $X = \left[X_0, X_1, ..., X_m \right]^T$;

Set up $X_0 = \left[x_0(1), x_0(2), ..., x_0(n) \right]$ as system sequence characteristic, and set up

$$X_1 = \left[x_1(1), x_1(2), ..., x_1(n) \right];$$
$$X_2 = \left[x_2(1), x_2(2), ..., x_2(n) \right];$$
$$\bullet$$
$$\bullet$$
$$\bullet$$
$$X_m = \left[x_m(1), x_m(2), \ldots, x_m(n) \right];$$

as relevant factors sequence. Regarding X_0 which reflect reference data series of system behavior characteristics as port throughput indicator. Regarding $X_1, X_2, ..., X_m$ as number indicators of each port industry, system features sequences and related factors sequences are not equivalent sequences. Set up m as the number of selected industries and as the number of comparison sequences. Set up n as the data number of reference number columns, in other words, the number of data of each industry indicators.

(2) Dimensionless processing can make comparability among various sequences

It is difficult to compare the data between X_0 and $X_1, X_2, ..., X_m$ because their dimensions are different. Therefore, it is necessary to eliminate the dimension of data,

and make the data become comparable data sequence. There are three kinds of raw data in Gray correlation analysis: the mean, initial value conversion, standardization conversion. None of the three kinds of dimensional treatment methods is better, this paper selected mean conversion treating data.

Basic matrix: $X^{'}=\left(X_0^{'},X_1^{'},...,X_m^{'}\right)^T$

$$X_0^{'}=\left[X_0^{'}(1),X_0^{'}(2),...,X_0^{'}(n)\right]=\left(\frac{X_0(1)}{\overline{X_0}},\frac{X_0(2)}{\overline{X_0}},...,\frac{X_0(n)}{\overline{X_0}}\right);$$

$$X_i^{'}=\left[x_i^{'}(1),x_i^{'}(2),...,x_i^{'}(n)\right]=\left(\frac{x_i(1)}{\overline{X_i}},\frac{x_i(2)}{\overline{X_i}},...,\frac{x_i(n)}{\overline{X_i}}\right),i=1,2,...,m$$

And $\overline{X_i}=\dfrac{\sum_{j=1}^{n}X_j^{'}}{n}$, means that the mean of the statistical indicators of all data in addition to the statistical indicator itself.

(3) Calculated correlation coefficient of reference number and comparison columns

$$\Delta_0(k)=x_0^{'}(k+1)-x_0^{'}(k),k=1,2,3,...,n-1; \quad (4\text{-}1)$$

$$\Delta_i(k)=x_i^{'}(k+1)-x_i^{'}(k),k=1,2,3,...,n-1; \quad (4\text{-}2)$$

$$R_i=\max_k x_i^{'}(k)-\min_k x_i^{'}(k); \quad (4\text{-}3)$$

$$R_0=\max_k x_0^{'}(k)-\min_k x_0^{'}(k); \quad (4\text{-}4)$$

$$\xi_{0i}(k)=\operatorname{sgn}_k\frac{1}{1+\left|\dfrac{|\Delta_i(k)|}{R_i}-\dfrac{|\Delta_0(k)|}{R_0}\right|},k=1,2,3,...,n;i=1,2,...,m; \quad (4\text{-}5)$$

And $\operatorname{sgn}_k=\begin{cases}-1,\text{若}\Delta_0(k)\Delta_i(k)\prec 0\\ 1,\text{若}\Delta_0(k)\Delta_i(k)\geq 0\end{cases}$ correlation symbol function. $\xi_{0i}(k)$: Gray correlation coefficient between port throughput and each port industry.

(4) Correlation degree calculation

Correlation coefficient represents the correlation level between comparison sequence and reference number columns so there is more than one value. Data information is too decentralized to compare entirely. Therefore, it is necessary to centralize all correlation coefficients of all each moment (each point of the curve) to

become one value – mean value. The formulation of correlation degree is as following:

$$\xi_{0i} = \frac{\sum_{k=1}^{n-1} \xi_{0i}(k)}{n-1} \tag{4-6}$$

ξ_{0i} is the correlation degree of X_0 and X_i, in other words, the correlation degree of port throughput and port industry. At last, determine the correlation degree of m industries and port throughput.

(5) Sorting correlation degree

Sorting correlation degree calculated in descending order, for example, if $\xi_{01} \succ \xi_{02}$, industry 1 and port throughput sequence is more similar to a greater relevance, conversely, a small association.

3.1.3 Agglomeration Degree Analysis

Since the industrial cluster is a kind of agglomeration behavior of many enterprises in a supply chain a certain area, there must be an agglomeration degree problem, which is to be called industrial agglomeration degree. Industry agglomeration degree is an index evaluating whether the phenomenon of industrial clusters exist, the size of agglomeration degree can reflect development level and development stage of industries inside area. Industrial agglomeration degree can reflect whether industrial cluster is formed in the area and the development level of cluster directly. To judge whether there is a regional industry cluster and agglomeration level of industry cluster through a series of indicators. Its essence is to use the cluster's influence in the cluster to measure. Industries with high agglomeration degree give full play to the combined effect of the cluster saving industry costs and accessing more profits. Conversely, a industrial clusters with low agglomeration degree have cluster phenomenon only in space, which can not generate agglomeration effects.

Many methods including Huffington Dyer coefficient, information quotient,

location quotient can measure port industry agglomeration degree which is a quantitative concept. Duranton and Oveman (2002) think that an ideal port agglomeration indictor should have the following five characteristics: (1) Agglomeration indictor indexes of different industries should have comparability. (2) Excluding the impact of market concentration degree on industrial agglomeration. (3) Unbiased on scale and space. (4) Any test of industrial agglomeration can report the significances of results.

The Herfindahl Index originally is a kind of indictor measuring market structure and market competition and monopoly relationship. The advantages of Herfindahl index is simple calculation, H index takes scale of the industry and the total number of industrial enterprises into account. And can more accurately reflect the degree of centralized industrial area. But its shortcoming is that it does not consider the spatial distribution of other industries, it is difficult to compare among different industries.

Calculation formulation:

$$H = \sum_{k=1}^{n} M_i^2 = \sum_{k=1}^{n} \left(s_i^k \Big/ T_i \right)^2, k = 1, 2, 3, \ldots, n \qquad (4\text{-}7)$$

And T_i represents the total size of the port industry market of i area, S_i^k represents the scale (employment or output) of k industry of i area, $M_i = S_i^k \Big/ T_i$ represents market share of j industry, n represents total number of industry. If $H = 0$, it means that there are numerous similar size companies of the industry; If $H = 1$, it means that industry is concentrated in an enterprise. From the formulation, H index is that assign a weight to market share of each firm within an industry, the weight can instead market share, which is in line with reality due to a big company need to be given a big weight.

Location quotient is also known as the specialization rate, and is quantitative tool analyzing the industry's efficiency and effectiveness, often used to identify industrial clusters, to determine the strength of relative concentration of an industry within a specific area. This method can not only analyze the concentration degree of industry in a particular region, but also judge the development level of industry by the size of

location quotient. The larger the location quotient value, the higher the development level of industry.

Location quotient index:

$$LQ_{ij} = \frac{e_{ij} / e}{E_j / E} \tag{4-8}$$

And, LQ_{ij} represents regional output agglomeration coefficient, e_{ij} represents industrial added value of j industry in i area, e represents Gross Domestic Product (GDP) of i area, E_j represents nationwide j industrial added value, E represents the country's GDP. In comparison, location quotient calculation is relatively simple, but still relatively coarse.

Regional Gini coefficient to some extent make up for the disadvantages of Herfindahl index Dyer, its economic meaning is similar to original Gini coefficient, that is closer to 0 indicates a more balanced geographical distribution industries; closer to 1 , indicates that the industry is relatively concentrated geographic distribution. Regional Gini coefficient considered that regional acreage can affect geographic concentration degree, and regarding the geographical distribution of the entire industry as a basis for comparison, which can make that the degree of concentration of different industries can be compared. Therefore, Regional Gini coefficient is a relative concentration index. However, regional Gini index only takes into account the degree of regional industry cluster, ignoring the organizational status of different industries, their size differences and geographical area, so it often contain false components when express industry concentration degree.

There are errors in cross-industry comparison due to regional differences and industrial organization using Gini coefficient G to indicate agglomeration levels of different industries. Ellision and Glaeser (1997) constructed E-G index making up for the shortcoming of regional Gini Coefficient partly. They created a business location selection model, the main idea is that the enterprise location choice based on the profit-maximizing decisions, a key element of this model is a natural advantage,

technology spillover and localization. They recognized that the market concentration can not be used to accurately measure the degree of geographic concentration, in order to avoid such errors, E-G index excluding the impact of market concentration in order to eliminate differences in enterprise scale industrial agglomeration degree. So it can measure the agglomeration of industrial geographical distribution more accurately. This article quoted the formula of industry agglomeration index established by Ellision and Glaeser directly. Suppose that there are n sub-industries which are divided into M general geographic area within a given industry, then

$$SCI = \frac{\sum_{i=1}^{M}(p_i - q_i)^2 - \left(1 - \sum_{i=1}^{M} q_i^2\right)H}{\left(1 - \sum_{i=1}^{M} q_i^2\right)(1 - H)} \tag{4-9}$$

And, SCI represents spatial agglomeration index, H represents Herfindahl Dyer index, p_i represents the proportion of the industry output within i area in country's total industrial output value. q_i: GDP proportion within i area in national GDP. When $SCI \prec 0.02$, it means a low concentration level of the industry; When $0.02 \prec SCI \prec 0.05$, it means region distribution of industry is in balance. When $SCI \succ 0.05$, it means region distribution of the industry is more concentration. Of course, instead of using a number of companies in a particular industry employment in the industry may be not accurate, because some areas may gather a few large enterprises but have more share of employment, thus showing a more robust clustering. Therefore, this article has selected employment of the industry as data.

According to the availability of data related to port industry, the paper selected E-G index which is indictor measuring the degree of agglomeration.

3.1.4 Port Industry Development Pattern Selection

Select appropriate port industrial cluster development model according to correlation degree and agglomeration degree between port throughput and port industry.

Only when the correlation degree between port throughput and port industries correlation is higher, can we be able to select the cluster development model. If the correlation degree of certain ports and port industry is low, it can not form the corresponding cluster, it will not be analyzed from the perspective of cluster. According to the concentration degree of port industry, we can determine clearly the development evolution stage, so that we can choose the right development model.

When the agglomeration degree of port shipping industry is higher than that of other industry, we should select port industrial cluster development model mainly in shipping industry. Port shipping industry oriented shipping center model means that port economic development focuses on port shipping industry cluster development, which focuses on the development of port symbiotic industries including port shipping industry, port handling industry, warehousing, trade and logistics. At the same time, strengthen the development of the shipping industry and port services. Similarly, when a high degree port industrial or service industry, we should choose temporary workers or the services industry as the core of the industrial cluster development model. Port-based industrial clusters in the manufacturing center model refers to the economic development of the port port-led industrial clusters, focusing on the development of port dependent industries including the petrochemical industry development model, steel, manufacturing, processing industry. Service-based development model refers to port service-oriented economic development, which is based on the consolidation of traditional services, focusing on the development of port-related industries including finance, insurance and legal. On the basis of the analysis above, we should combine with the foreign port industrial cluster development success stories, choosing the right industrial development model, to achieve a successful transition cluster.

Three major port industrial cluster development model are shown in Table 3.1

Table 3.1 the comparison of development model in port industrial cluster

Development model	Development conditions	Leading Industry	Development Goals

Port-based industrial clusters in the manufacturing center model	Has some industrial base; national policy support	Petrochemical, equipment manufacturing, processing industry and other port industries	Manufacturing Center
Port shipping industry cluster-based shipping center model	A very privileged location; liberal trade policy	Shipping industry, trade, warehousing, logistics and other port and shipping industry	Shipping center; Trade Center
Modern service-oriented financial center development model	Manufacturing relocation, port industrial transformation and upgrading; City functions may be raised	The financial industry, ship trading, insurance and other modern services	Financial center; Information Center

3.2 Study of Rizhao Port Industry Cluster Development Stage

On the basis of the first two chapters for the industry concentration degree of correlation and model analysis, this chapter will collect industry data and analyze the port industry correlation degree and agglomeration degree empirically based on Rizhao port industry development conditions. Analyzing the agglomeration degree of Rizhao port industry can provide selection basis for development mode development stage of Rizhao port of industrial clusters.

3.2.1 Correlation Analysis of Rizhao Port Industry Cluster Based on Grey Relational Model

After collecting data, we can get throughput of Rizhao port and industrial added value of Rizhao from 2005 to 2012, which are as shown in Table 4.2.

Tab.3.2 the Rizhao port throughput and the added value of port industry from 2005 to 2012

Unit: million tons, 100 million yuan

Port industry	2005	2006	2007	2008	2009	2010	2011	2012
Port throughput	8420.6	11007.2	13063.3	15102.2	18131	22596.7	25260.3	28098
Transportation Equipment Manufacturing	70.32	102.96	191.78	330.61	410.89	420.31	492.54	510.69
Communications equipment, computers and other electronic equipment manufacturing	69.43	126.61	160.89	210.42	248.86	253.13	277.51	283.36
Chemical	132.15	281.6	401.47	521.14	547.42	580.02	598.8	600.2

materials and chemical products manufacturing								
Petroleum processing, coking and nuclear fuel processing industry	11.1	15	16.67	9.31	3.89	6.31	9.29	9.78
Transportation, storage and postal services	11.65	12.17	15.98	17.78	19.18	21.26	20.65	17.55
Wholesale and retail trade	44.85	53.16	71.63	90.36	100.72	170.28	246.57	315.25
Financial Industry	32.02	41.51	49.82	53.03	81.98	100.16	114.65	144.48
Information transmission, computer services and software industry	23.97	29.7	37.13	30.09	31.15	35.48	50.61	60.04

Source: Rizhao Statistical Yearbook, National City Statistical Yearbook

According to the calculation above, we can get the correlation degrees which are as follow(table 3.3):

Tab.3.3 The correlation degree between Nantong port industry and port throughput

Port industry	Correlation degree
Transportation Equipment Manufacturing	0.878
Communications equipment, computers and other electronic equipment manufacturing	0.705
Chemical materials and chemical products manufacturing	0.917
Petroleum processing, coking and nuclear fuel processing industry	0.478
Transportation, storage and postal services	0.926
Wholesale and retail trade	0.916
Financial Industry	0.906
Information transmission, computer services and software industry	0.682

We can draw conclusions from table 3.3:

(1) Regarding transportation, storage and postal services as the representative of port shipping industry is closely correlated with the port throughput

Transportation, storage and postal services industries are represented harbor symbiotic industries which have closer relationship with port throughtput. The correlation degree is 0.926.

(2) Port industry such as Transportation Equipment Manufacturing and Chemical materials and chemical products manufacturing is closely correlated with port

throughput

From table 4.3 we can see that there is high correlation level between port throughput and port industries especially Transportation Equipment Manufacturing and Chemical materials and chemical products manufacturing which is second only to port shipping industry.

(3) The correlation degrees between Service industries and throughput are all greater than 0.9

Traditional service industry represented by Wholesale and retail trade and modern service industry represented by financial industry whose correlation degree with port throughput are all close to 1 showing a high correlation degree, which fully shows the possibility of having to play a cluster effect.

We can infer that Rizhao port industrial clusters have the basic conditions generated by these industries can be developed as a port dependent industries and generate agglomeration effects.

3.2.2 Agglomeration Analysis of Nantong Port Based on E-G Index Model

According to the correlation degree, we can get the leading industries. Then we will measure the agglomeration in order to provide quantitative analysis and guidance. When Ellision and Glaeser determine Herfindahl index, classified the scale of enterprise according to population census data released by the Government, and then calculate the sum of squares of the market share. China has no detailed statistics distributed enterprise employees, we can not follow their methods to determine the Herfindahl index. This article calculated the Herfindahl index using Rizhao port industrial output and national ports industrial output value, may be the possible accuracy is not high enough. However, it does not prevent us to evaluate and compare the agglomeration degree for Rizaho port industry.

Tab.3.4 Total output value of Rizhao port industry

Unit: million tons, 100 million yuan

Port	2005	2006	2007	2008	2009	2010	2011	2012

industry								
Transportation Equipment Manufacturing	70.32	102.96	191.78	330.61	410.89	420.31	492.54	510.69
Communications equipment, computers and other electronic equipment manufacturing	69.43	126.61	160.89	210.42	248.86	253.13	277.51	283.36
Chemical materials and chemical products manufacturing	132.15	281.6	401.47	521.14	547.42	580.02	598.8	600.2
Petroleum processing, coking and nuclear fuel processing industry	11.1	15	16.67	9.31	3.89	6.31	9.29	9.78
Transportation, storage and postal	11.65	12.17	15.98	17.78	19.18	21.26	20.65	17.55

services								
Wholesale and retail trade	44.85	53.16	71.63	90.36	100.72	170.28	246.57	315.25
Financial Industry	32.02	41.51	49.82	53.03	81.98	100.16	114.65	144.48
Information transmission, computer services and software industry	23.97	29.7	37.13	30.09	31.15	35.48	50.61	60.04

(1) Calculate Herfindahl Index of 2005-2011

$$H=\sum_{k=1}^{n}M_i^2=\sum_{k=1}^{n}\left(s_i^k/T_i\right)^2, k=1,2,3,...,n$$

Using the data of table 4.4 to calculate H index,

$$\begin{aligned} H &= \left[H(2005),...,H(2012)\right] \\ &= (0.188, 0.199, 0.204, 0.202, 0.212, 0.214, 0.206, 0.196) \end{aligned}$$

From the results, we can see that these H indexes are close to 0.2, which shows a higher concentration level of Rizhao port industry.

Herfindahl index is calculated according to the formula, we can calculate the 2005-2011 Herfindahl index value for each port industry, as shown in Table 3.5.

Tab.3.5 The H index of Rizhao port industry

Port industry	2005	2006	2007	2008	2009	2010	2011	2012
Transportation Equipment Manufacturing	0.0175	0.0148	0.0267	0.0467	0.0635	0.0462	0.0487	0.0512

Communications equipment, computers and other electronic equipment manufacturing	0.0167	0.0226	0.0198	0.0199	0.0177	0.0163	0.024	0.0189
Chemical materials and chemical products manufacturing	0.0632	0.2244	0.1235	0.0757	0.093	0.097	0.0765	0.125
Petroleum processing, coking and nuclear fuel processing industry	0.0005	0.0006	0.0004	0.0003	0.00005	0.00007	0.00003	0.00001
Transportation, storage and postal services	0.0058	0.0040	0.0035	0.0044	0.0056	0.0042	0.0046	0.005
Wholesale and retail trade	0.0928	0.0436	0.0335	0.0237	0.0231	0.0314	0.0376	0.0378
Financial	0.00367	0.0032	0.0044	0.0034	0.0039	0.0061	0.0043	0.0058

Industry								9
Information transmission, computer services and software industry	0.0011	0.002	0.00039	0.0003	0.0003 5	0.0044	0.0006	0.0005

(2) E-G index analysis

Analyze agglomeration degree of Rizhao port industries using E-G index model. In order to ensure consistency of data, regarding port industry annual production as data analysis object. Because some data is not released, we select data from the year 2005 to 2011. Rizhao port and the national industrial production value are as follows:

Tab.3.6 The added value of Rizhao Port industry and GDP

Units: 100 millions yuan

Port industry	2005	2006	2007	2008	2009	2010	2011
Transportation Equipment Manufacturing	70.32	102.96	191.78	330.61	410.89	420.31	492.54
Communications equipment, computers and other electronic equipment	69.43	126.61	160.89	210.42	248.86	253.13	277.51

manufacturing							
Chemical materials and chemical products manufacturing	132.15	281.6	401.47	521.14	547.42	580.02	598.8
Petroleum processing, coking and nuclear fuel processing industry	11.1	15	16.67	9.31	3.89	6.31	9.29
Transportation, storage and postal services	11.65	12.17	15.98	17.78	19.18	21.26	20.65
Wholesale and retail trade	44.85	53.16	71.63	90.36	100.72	170.28	246.57
Financial Industry	32.02	41.51	49.82	53.03	81.98	100.16	114.65
Information transmission, computer services and software industry	23.97	29.7	37.13	30.09	31.15	35.48	50.61

GDP of Rizhao	426.5	505.87	629.58	773.14	864.66	1025.08	1214.08

Tab.3.7 The added value of Port industry and GDP of country

Units: 100 millions yuan

Port industry	2005	2006	2007	2008	2009	2010	2011
Transportation Equipment Manufacturing	12628.54	16265	21679	26038.93	32718	44592.55	48678.43
Communications equipment, computers and other electronic equipment manufacturing	24085.71	29240	35187	38503.12	38962	48264.83	57896.36
Chemical materials and chemical products manufacturing	9444.61	11407	14515	17792.91	18397	24682.86	30768.96
Petroleum processing, coking and	10794.36	13531	15879	20158.73	18810	25955.84	32467.76

nuclear fuel processing industry							
Transportation, storage and postal services	10666.2	12183	14601	16362.5	16727	19132.2	21098.4
Wholesale and retail trade	13966.2	16531	20938	26182.3	28985	35746.1	43765.3
Financial Industry	6086.8	8099.1	12338	14863.3	17768	20980.6	23654.65
Information transmission, computer services and software industry	4768. 0	5329.2	6705.6	7859.673	8164	8881.95	9876.67
GDP of China	184937.4	216314	265810	314045.4	340902.8	401512.8	473104.0

Source: Rizhao Statistical Yearbook, National City Statistical Yearbook

$$SCI = \frac{\sum_{i=1}^{M}(p_i - q_i)^2 - \left(1 - \sum_{i=1}^{M} q_i^2\right)H}{\left(1 - \sum_{i=1}^{M} q_i^2\right)(1 - H)}$$

Table 3.4, Table 3.5 data into SCI expression to calculate the spatial agglomeration index of Rizhao port industry as shown in Table 4.8:

Tab.3.8 SCI of Port industry of Rizhao from 2005 to 2011

Port	2005	2006	2007	2008	2009	2010	2011

industry							
Transportation Equipment Manufacturing	0.0174	0.0156	0.0293	0.0480	0.0668	0.0514	0.0632
Communications equipment, computers and other electronic equipment manufacturing	0.0174	0.0236	0.0206	0.0195	0.0206	0.0182	0.0196
Chemical materials and chemical products manufacturing	0.0652	0.1275	0.1406	0.1320	0.1067	0.1025	0.1254
Petroleum processing, coking and nuclear fuel processing industry	0.00036	0.00028	0.00021	0.000025	0.000036	0.000058	0.00004
Transportation, storage and postal	0.0056	0.0037	0.0029	0.0042	0.0036	0.0046	0.0055

services							
Wholesale and retail trade	0.0788	0.0446	0.0345	0.0244	0.0238	0.0321	0.0298
Financial Industry	0.0064	0.0046	0.0034	0.0038	0.0042	0.0058	0.0067
Information transmission, computer services and software industry	0.0024	0.0008	0.0012	0.00036	0.00026	0.00034	0.0043

(3) Calculate the mean value of space agglomeration index of Rizhao port industry from 2005 to 2011

Tab.3.9 The average agglomeration index value of Port industry from 2005to2011

Port industry	average agglomeration index value
Transportation Equipment Manufacturing	0.0417
Communications equipment, computers and other electronic equipment manufacturin	0.0200

g	
Chemical materials and chemical products manufacturing	0.114
Petroleum processing, coking and nuclear fuel processing industry	0.00014
Transportation, storage and postal services	0.0043
Wholesale and retail trade	0.03829
Financial Industry	0.0050
Information transmission, computer services and software industry	0.0013

Form the results above, we can see that:

Firstly, agglomeration effect port industry clusters is more prominent. Port spatial agglomeration index is higher. Representatives of industry are transportation equipment manufacturing, communications equipment, computers and other electronic equipment manufacturing and chemical materials and chemical products

Secondly, agglomeration index of port shipping industry is not high. Industry to transportation, storage and postal services as the representative of port shipping industry spatial concentration index is less than 0.02 indicating that the level of industry concentration is not high. Since the construction of the Rizhao land transport roads, railways and other late, coupled with the city's urban transport planning lacks prospective land layout, collection and distribution system is not perfect, modern logistics development associated with port economic underdevelopment. The development of modern logistics industry is the most important industry in the current development of the port of Rizhao.

Lastly, modern service industry index is not high, the traditional service industry index is the average level

Form the results we can see that modern service industry cluster has not been perfect, Rizhao need to strengthen the development of shipping finance, finance, insurance, ship brokers, arbitration and other modern services to improve agglomeration advantages.

In short, scale effects of industrial clusters have initially appeared, Rizhao port basic functions have been improved, modern services, port and shipping industry cluster development is still not mature enough.

3.3 Rizhao Port Industry Cluster Development Strategy Pattern Design

Undertake evolution experience, give full play to the advantages of the manufacturing base at home and abroad on the port industry cluster development, the gradual transition to the port and shipping industry as the core of the port industry clusters, efforts to modern service-oriented financial center model of development, which will be the main line of Rizhao port industrial clusters development.

In addition, the use of government macro-control forces and strengthen planning and guidance on economic development and industry to undertake. Government guidance and strategic planning as the development of industrial clusters external environment, in the three modes port industrial cluster should be somewhat involved.

Rizhao Port Development Strategy Design is shown in figure 4.2

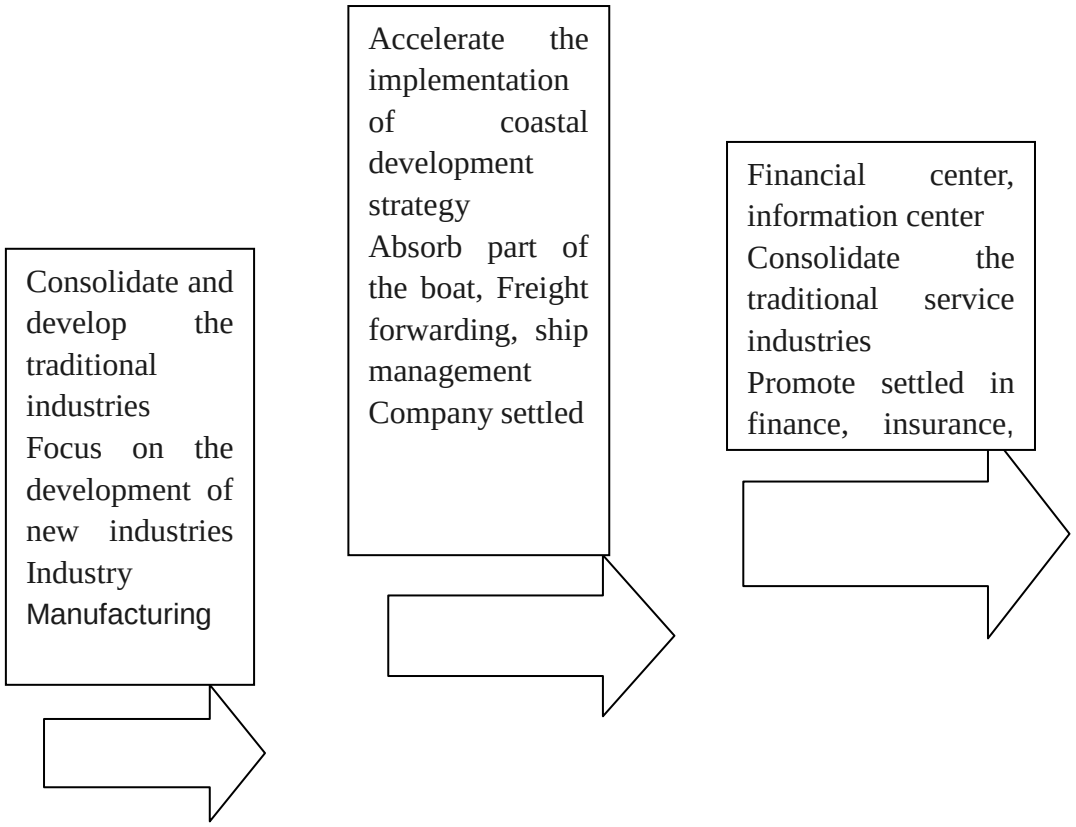

Figure 3.2 The design of Rizhao port industry cluster developing pattern

4 Recommendation of Promoting the Development of Rizhao Port Industrial Clusters

The goal of research on port industrial clusters is to study the interaction of industrial clusters to accelerate the development of port and to enhance the competitiveness of the region and promote economic development in Rizhao. The enhancement of Rizhao economic competitiveness can improve realization and completion of industrial clusters increasing the degree of concentration of the industry. Combining the results of qualitative and quantitative analysis for Rizhao port industrial clusters and the referring port industry cluster development experience at home and abroad to make rational layout planning for the development of Rizhao port industrial clusters, which can speed up Rizhao port industrial clusters forward to a mature stage. We should make full use of social resources to make no efforts to foster the port industry clusters, which can reduce industry costs, improve quality, optimize the industrial structure and layout and promote the development of the port industry so as to contribute to the development economic of the whole Rizhao.

4.1 The Aspects of Port Industry

We can see from Quantitative and qualitative analysis of the text, the main source of economic growth of Rizhao is from the second and third industries. We should In the next few years, around the industrial linkage, focus on shipbuilding, ship configuration manufacturing, container manufacturing and other main industries continue to consolidate the status of traditional industries, optimizing the internal structure of the secondary industry, efforts to promote marine economy of scale, efficiency improvement

4.2 The Aspects of Port Shipping Industry

(1) Improve Shipping industry infrastructure

(2) Enhancing agent, handling, distribution, warehousing and other functions

4.3 The Aspects of Modern Port Services

(1) Improve the financial and insurance system, and gradually transition to the modern service industry cluster

From the spatial concentration index of Rizhao port industrial clusters, financial industry as a representative, the agglomeration degree of modern services have shown low level. Combining Rizhao port industry cluster future development strategy, we should focuse on the development of modern service industry. Financial industry is an important component of the port industry cluster, typical of the modern service industry and the future evolution direction of Rizhao port industrial clusters.

(2) Promote the development of modern service industry, build information platform

Port and industrial park is the intersection point of different modes of transportation, Shippers, freight forwarders, shipping companies, shipping, wholesale and retail sectors, land transport companies, warehousing companies, customs, commodity inspection, banking, insurance, they release their information in different ways. Target of information construction is carried out through e-commerce logistics information network, and realize the whole process of visualization, automation, intelligent, making the port transportation, handling, storage, packaging, distribution, distribution, distribution processing and information services, which can be achieved a portal service making information flow of port industry cluster transfer in the most efficient way. Therefore, information construction can reduce logistics costs and achieve a seamless link among industries and ultimately improve the entire port industry cluster overall competitiveness.

Establish professional services information platform, publish international market conditions, trends and price trends, and then coordinate the response of

international trade barriers and trade disputes. Secure the right to speak and price of international markets so as to enhance the development of port industry and shipping industry. And enhance service capabilities and amplify technology and brand spillover benefits.

(3) Increase the introduction of high-end talent and encourage innovative mechanisms

Personnel training and scientific research institutions provide technical support for the port industry cluster. Industrial agglomeration is inseparable from capital, labor, land and other production factors and entrepreneurs, the formation of industrial agglomeration elements needs optimized industrial cluster. Lacking of high-end talent is not only the disadvantage of Rizhao port industrial development but also a stumbling block to the development of modern service industry. Give full play to the role of existing universities and research institutions and make port industry cluster associate with personnel training. In addition, Rizhao should strengthen cooperative relationships with other universities in Shandong Province and establish professional training institutions.

5 Conclusions and Outlook

5.1 Conclusions

Rizhao port industry cluster development is a long-term and ambitious project, Rizhao should focus on forward-looking, long-term development of various industries and strategic planning based on current development. Rizhao port focuses on modern service industry promoting port industry cluster to mature. The paper analyzed the current development situation of port industry on the basis of review of industry cluster theory. Studied Rizhao port various industries using correlation model and calculation method of agglomeration degree and ultimately put forward suggestions for sustainable development of port industry, the main findings are as follows:

(1) Defined port industrial clusters and expounded their theories and content, further studied the formation mechanism structure effects of port industrial clusters, which are basis for analysis later.

(2) Analyzed development situation of Rizhao port industry qualitatively. This paper analyzed strengths, weaknesses, opportunities and threats of Rizhao port industry using SWOT method.

(3) Identified the development stage of Rizhao port industrial clusters and designed develop strategic patterns. The paper determined the correlation level between port throughput and port industries using improved gray slope correlation degree model, which shows that Rizhao port has basic conditions for the development of industrial clusters. Subsequently, using E-G index model based on the use of the Herfindahl index to determine the size of port industrial agglomeration degree. We can draw a conclusion from the analysis above that Rizhao port industrial cluster is in the formative stages of the cluster agglomeration.

(4) Propose strategies and recommendations

The paper provided some guidance and theoretical basis for the development of

all types of enterprises and government departments.

5.2 Outlook

(1) Rizhao port industrial agglomeration is still in its infancy, the degree of concentration of the port industry is not the same as a direction for the symbiotic nature of the port of industrial clusters between the stability and the future industry can be studied.

(2) Various stages of development for the port industry cluster, conduct policy research, industrial cluster strategy for the implementation of the port area to provide policy support, the policy in this direction, and did not give specific solutions

(3) There is the reality of the port industry cluster system a lot of uncertainty, even for models affected by random factors after the disturbance, what will change its inherent complexity, or that there will be another new phenomenon, are worth we went further study.

In conclusion, our study for the local port industry cluster is limited. With the continuous development of China's port industry clusters and perfect, no matter what, I believe in the practice of many scholars and entrepreneurs, China's port industry will be healthy and orderly, long-term sustainable development long way to go.

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