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The research on site selection of dry port cluster of Shanghai port

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The Research

On

Site Selection of Dry Port Cluster of Shanghai Port

By

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DECLARATION

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

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

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Abstract

Title of Research Paper: The Research on the Site Selection of Shanghai Port

Degree: Master of Science in International Transportation & Logistics

Dry port cluster is a maturity or third stage of dry port industry. Dry port cluster is a hub-and-spoke network of dry ports, in which a hub dry port connected with neighboring subsidiary dry ports links with a seaport. So far, a portion of experts gradually begin to recognize the imperfection of operating dry ports separately and a few worldwide seaports are pondering over and designing the establishment of dry port cluster. It is observed that the dry port cluster will be popular in the foreseeable future.

The modern port competition has been evolving into the competition of supply chain in which the ports participate. Aiming to develop into the worldwide shipping center, Shanghai Port is supposed to establish its own dry port cluster in order to upgrade its service level. Therefore, it is fairly meaningful to research on site selection of dry port cluster of Shanghai port.

The research is to discuss about the latest situation of dry port, ponder over the feasibility of establishing dry port cluster for Shanghai port, analyze the profits and risks of this project and screen out the approximate positions as dry ports of Shanghai port and finally choose the most suitable one as the pivot in a dry port cluster.

The Analytic Hierarchy Process is utilized in the site selection of dry port cluster.

The factors of policy, economy, logistics level, population, geography and rivalry will be taken into consideration.

Key Words: Dry Port, Dry Port Cluster, Shanghai Port, AHP, Site Selection

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List of Abbreviation

HDB	**Hub Dry Port**
SDB	**Subordinated Dry Port**
VMI	**Vendor Managed Inventory**
ERP	**Enterprise Resource Planning**
B/L	**Bill of Lading**
EDI	**Electronic Data Interchange**
GDP	**Gross Domestic Product**
AHP	**Analytic Hierarchy Method**
M & R	**Maintenance & Repair**
EDI	**Electronic Data Exchange**
AP	**Autonomous Prefecture**
3G Port	**Third Generation Port**
4G Port	**Fourth Generation Port**
RFID	**Radio Frequency Identification**
MMP	**Maximum Membership Principal**
SLA	**Second-Level Appraisal**

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1. Introduction

1.1 Background of Research

Since the 21st century, the dry port has been flourishing all over the world as a vital logistics node. The main reason is that coastal ports compete for the market through building a logistics platform in the inland areas whose governments intend to bridge with the outside world. (Notteboom & Rodrigue, 2005).

As time develops, the operation of single dry port gradually exposes its demerits and faces with unprecedented threats. Therefore, coalition operation of nearby dry ports are fiercely promoted by port authority, economists and logistics practitioners due to its economics of scale, cost effectiveness, environmental friendliness.

China witnesses the port fever and fierce port competition in the latest decade. Despite the advanced infrastructure, Shanghai port needs to improve its soft power, especially the seamless docking of logistics among vessels, ports and inland areas, and high-level informationization & network. The construction of dry port cluster enables Shanghai port to improve its competitiveness, upgrade its service level, attain ever-increasing throughput and attract investment from various aspects, thus maintaining its leading position in the domestic and keeping up with the advanced world level.

1.2 Literature Review

As mentioned, the issue of dry port has attracted the global scholars' attentions due to its brand-new concept and successful practices. Nevertheless, the study on the dry port is still on the trail and exploratory stage, furthermore the framework of theory needs to be improved. In the recent decade, Quantity of literature concerned springs

up. Woefully, the majority of them are superficial and theoretical rather than systemic and quantitative.

The present literature falls behind the times mainly at two aspects. On the one hand, dry port cluster is a newly-created notion despite that the glossary ‘dry port’ has appeared for approximately two decades. The industry is entering into the era of dry port cluster. Recent literature is hard to come up with the rapid port development. On the other hand, a minority of literature are connected with the site selection of dry port not to speak of the site selection pointed to a targeted city. Moreover, most of literature concerned about site selection is hard to be persuasive and secure due to the lack of quantitative analysis.

1.3 Research Aim & Significance

So far, the majority of Chinese ports are at the period of transition from Third Generation to Fourth Generation characterized by high-level informationization, customized service and seamless-docking logistics among shipping, port and inland areas.

Although the completion of Yangshan Deep port indicates Shanghai Port joins the ranks of the global largest ports, frankly speaking, Shanghai Port is narrowly at the intermediate stage of Fourth Generation Port. The modern port competition evolves into the rivalry of supply chain including the ports. The establishment of dry port cluster is conductive to the achievement of seamless docking between inland areas and ports.

Throughput is not only a key indicator measuring the scale and development level of

a port but also a motive power of upgrading the port. The central and western regions in china are the direct hinterlands of some ports. However, most of them are shared rivaled by several ports. It is an opportunity for Shanghai to establish dry ports in the inland areas to compete the cargo source with nearby ports.

Site selection of dry port cluster is of paramount importance. On the one hand, all of the areas are not suitable to the needs of Shanghai port. Furthermore, the building of dry ports is capital-intensive and time-consuming. It will be meaningless and wasteful if a region fails to create adequate benefits for Shanghai port. On the other hand, in the one dry port cluster, some areas should be established as the central terminal, others are chosen as secondary and the rest are auxiliary. Therefore, the criteria of site selection are supposed to contain politic, economic, cultural, geographic aspects and so on.

The establishment of dry port cluster makes for the achievement of one-stop customs declaration, inspection, booking, storage, transportation, packaging, distribution. Transportation and logistics will extend into the interior. Port's informationization, network and agility enable the port to make a rapid response to market demands and offer personalized service. Dry port cluster reaches the economic scale through consolidating the source of respective dry ports and helps to come up to all of the criteria of Fourth Generation Port.

2. Connotation & Development of Dry Port Cluster

2.1 Concept of Dry Port Cluster

The dry port industry has been going through a continuous transition and

development process, in other words, its connotation keeps up with the times.

Dry port came into being in United States in 1980s when shippers and forwarders regarded the dry port as an adequate interface with the port and the shipping lines. It was defined by European Commission as an inland depot that connects inland areas with seaports in 1991. America Institute of Shipping Container extended the functions of dry port by providing such services as container loading and unloading, short-term storage and customs inspection. Its main purpose is to stimulate the containerization of landlocked shipping and achieve the profits of inland transportation produced by containerization instead of nothing but a point of junction as described by Europeans.

1998 witnessed dry port industry enters into the second stage. Leveque and Roso, the pioneers in the field of modern dry port, firstly equaled the dry port as a seaport, which is directly connected by rail with inland intermodal terminals where containers can be dealt with in the same way as if they were in a seaport. They contend that the dry port concept goes beyond the conventional use of rail shuttles for connecting a seaport with its hinterland. Being strategically and consciously implemented jointly by several actors, their remarks also go beyond the common practice in the transport industry. Modern dry port should not only function as a logistics center with the features of customs declaration, inspection and issuance of bills of lading, but also set up supervisory organs to provide services for the customer clearance. At the same time, freight forwarding, ship agent and shipping companies also set up branches to make it convenient to take delivery of commodities, return containers, and issue multimodal bill of lading. Inland importers and exporters can complete their booking, customs declaration, inspection and other procedures.

Dry port cluster is a maturity or third stage of dry port industry. Dry port cluster is a hub-and-spoke network of dry ports, in which a hub dry port connected with peripheral subsidiary dry ports links with a seaport. So far, a portion of experts gradually begin to recognize the imperfection of operating dry ports separately and a few worldwide seaports are pondering over and designing the establishment of dry port cluster. It is observed that the dry port cluster will be popular in the foreseeable future.

2.2 Classification of Dry Port Cluster

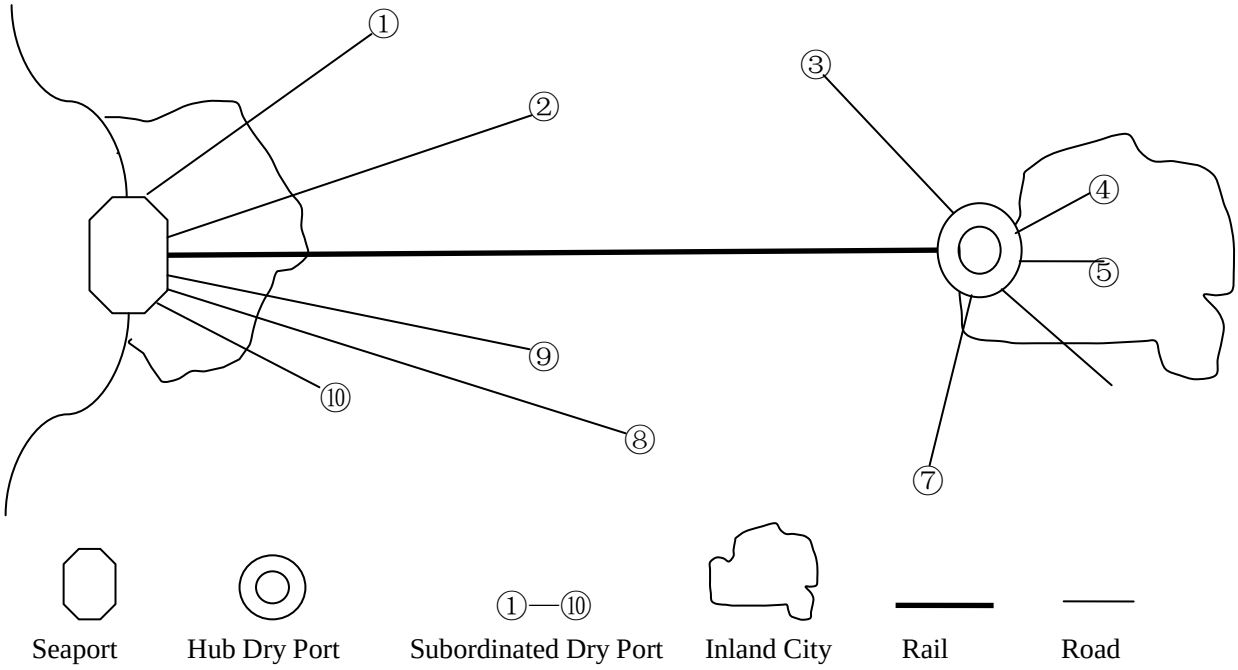
Based upon the functions of dry port clusters and the location of hub dry port, they can be categorized as distant, midrange and close dry port cluster.

2.2.1 Distant Dry Port Cluster

A distant dry port cluster, whose hub is more than 800 kilometers apart from seaport, will be the most prevalent of the three. The major cause for implementing it is that the distance and the size of cargo flow make rail available and practical from a strict cost perspective. Figure 2-1 manifests the operation of a seaport and its hinterlands with the implementation of a distant dry port cluster. In contrast with traditional dry ports to and from the seaport, the difference lies on the functions provided by the hub dry port (whose acronym is HDP) and the movement of the interface with subordinated dry port (whose acronym is SDP). The more structured approach increases the competitiveness of rail against road and SDP 3, 6 and 7 are now served by HDP (shown in Figure 2-1). Parts of the benefits of distant dry port cluster are related to the modal shift from road to rail, thus resulting in reduced congestion at the seaport gates and its surroundings. One train can substitute for 35 lorries in Europe and more than 100 in the US, and reduce external effects along the route (Johan

Woxenius, 2008). The main reason for the seaport to be engaged with a distant dry port cluster is that a wider hinterland can be secured by offering shippers low cost and high quality services.

Figure 2-1 Distant Dry Port Cluster

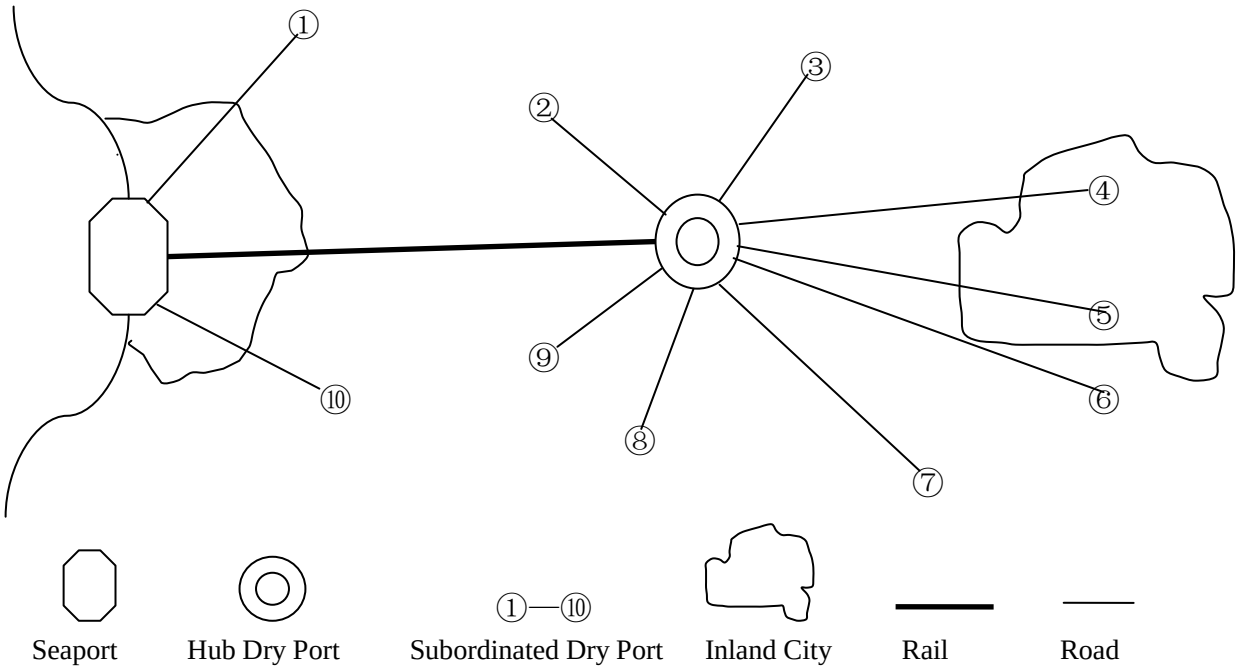


2.2.2 Midrange Dry Port Cluster

Continental services of midrange dry port cluster are generally competitive at distances ranging 500 km from 800km (see, e.g. Van Klink and van den Berg, 1998). A midrange dry port cluster is then situated within a distance from the port generally covered by road transport as shown in Fig. 2-2. Here SDP 2, 3, 7, 8 and 9 are served directly by the HDP while SDP 4, 5 and 6 needed to be transported to HDP for a long time. The midrange HDP here serves as a consolidation point for different rail services. The high frequency achieved by consolidating flows together with the relatively medium distance facilitates loading of containers for one container vessel

in dedicated trains. Obviously, this requires a fairly reliable rail service to avoid the risk of increased dwell times of container vessels and then a dedicated track is probably required initially. In the longer run, direct transshipment between trains and ships can be implemented or whole container terminals can be specialized for rail–sea.

Figure 2-2 Mid-range Dry Port Cluster



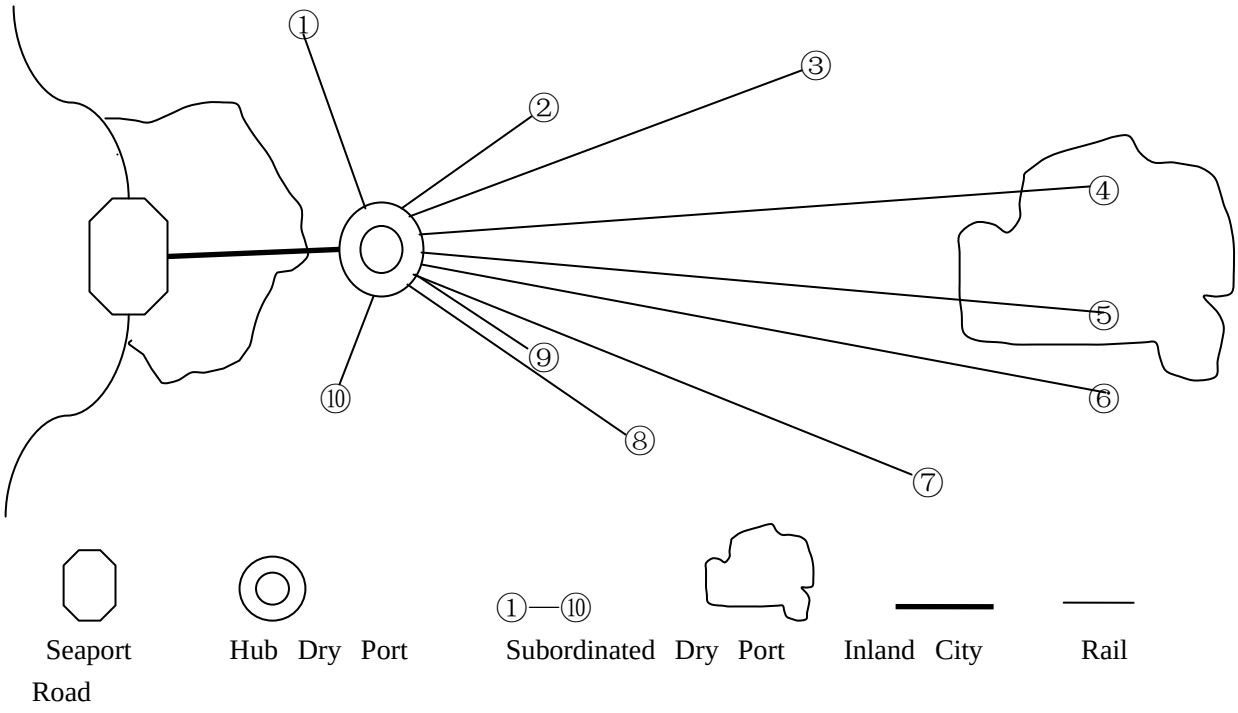
2.2.3 Close Dry Port Cluster

The close HDP consolidates road transport to and from SDP outside the city area offering a rail shuttle service to the seaport (as shown in Fig. 2-3). In this case, SDP 1-10 consolidate to the HDP. Compared to the other two types of dry port cluster, a close dry port offers larger possibilities for buffering containers and even loading them on the rail shuttle in sequence to synchronize with the loading of a ship in the port (Kenth Lumsden, 2008). In case either the ship is behind schedule or the machinery in the quay breaks down, the HDP can serve as a temporary container

yard relieving the seaport's stacking areas and avoiding urban traffic jam or gate congestion.

A glaring problem exists in the system that road completely substitutes for rail to take the leading role in whole process. Even if the road may be changed into rail in theory, the total rail-building cost for all routes are too high to come into effect.

Figure 2-3 Close Dry Port Cluster



2.3 Functions of Dry Port Cluster

Dry port cluster is profitable and valuable to different operators in the logistics chain. Its functions can be categorized from the microcosmic and macroscopical angle.

2.3.1 Microcosmic Ministrant Functions

There is no doubt that dry port cluster system upgrades the logistics level of seaports improve its competitiveness and collects the cargo flow in the hinterland. Furthermore, seaport city benefits from decreased road traffic saturating the streets which increases the quality of life for the citizens. Less traffic might also liberate valuable areas around the city centre for other purposes than traffic.

Dry port cluster is also obviously beneficial to inland transportation operators in that the brand-new transportation system increases the scale of their business in a comparatively lucrative segment. This is especially vital for rail transport that depends on economies of scale and capable of achieving continental services (Violeta Roso, 2008). At least, the fixed costs of the dry port itself can be distributed between transshipments when adding the dry port cluster flows.

Freight forwarding logistics group can make use of virtual dry port online for goods, contract, reduce labor costs and achieve online customs clearance, commodity inspection, insurance and other business operations online, real-time control operational progress to improve the overall level of service freight forwarding logistics business to enhance its core competitiveness force (ShippingChina, 2009).

From the shippers' perspective, a well implemented dry port cluster offers the rail-road combined transportation with wider range of service area, higher speed and door-to-door service. They are also served in the dry port area with such value-added services as storage, repackaging, assorting and labeling.

2.3.2 Macroscopical Social and Economic Functions

Dry port cluster is conducive to the efficient management and operation of inland container transport, conducive to the supply of distribution for unified management

and scheduling to achieve a reasonable load, improve transport efficiency to ensure the container in inland transport and delivery of effective convergence. At the same time, it also saves energy, reduce pollution and ease pressure on urban transport.

The system is also helpful to the harmonious development between the local economy and regional economic, thus enhancing regional competitiveness, expanding economic exchanges with the outside world, and in the context of globalization seeking division of labor structure in the local place, while promoting the region to attract investment, particularly from foreign and coastal investment, expand financing.

International trade can make use of the dry port to achieve the carriage of goods of door to door service and lower logistics cost, real-time grasp the carriage of goods by the state, and can quickly obtain a bill of lading, improve foreign exchange settlement rate, the rate of increase trading liquidity.

2.4 Development of Dry Port Industry in China

China still stays on the second stage of dry port industry, in other words, the dry ports have not begun to operate with each other. Now the dry ports of representative seaports will be analyzed respectively in the north, east and south of China.

2.4.1 Recent Situation of Domestic Representative Dry Ports

1) Tianjin Dry Ports

Tianjin Port Group regards dry port times as a golden opportunity of upgrading its service level. In 2009, Tianjin port has cooperated with 12 districts including Beijing, Hebei province and Inner Mongolia Autonomous Region to establish dry ports. So

far, the total number has reached 16. In addition, Tianjin Port Group has signed *Letter of Intent Dry Port Project* with Urumqi, Hohhot, Manchuria, Zhengzhou, Shijiazhuang and Taiyuan. Tianjin port's purpose is to take shape international multimodal system by improving the transportation channel from Tianjin port to inland areas, to achieve integration of export clearance by installing Dry Port Electronic Information Platform and form well-planned, comprehensive and complete dry port system.

2) Ningbo Dry Ports

Jinhua, Yiwu, Shaoxing, Yuyao and Yujie, whose mother port is Ningbo seaport, greatly promote the local economic development, at the same time offer efficient cargo source for the Ningbo Port. In 2009, Yiwu City provided Ningbo port with the flow of 230,000 TEU. Under the support of the five dry ports, Ningbo's flow accounted for container ship container ship over a half of that of Zhejiang Province. The outward radiation force of Ningbo port is constantly increasing. According to the latest statistics from Ningbo Customs, import and export value of foreign enterprises in Ningbo occupies over two-thirds of the whole province.

3) Shenzhen Dry Ports

Shenzhen's latest dry port is built up in Anji, an inland city in Jiangxi Province. In the initial, the train shuttle is offered in Tuesday, Thursday and Saturday. In the near future, the service frequency is about to reach once every day with the maturation of dry port service.

2.4.2 The Growth Trend of Domestic Dry Port Industry

Based on the introduction of the representative dry ports above, we can find that the seaports have begun to extend to the inland areas in a large scale though the industry

is still staying on the second stage. The dry port will be empowered with more functions to improve the service level. Some advanced seaports, for example ShenZhen seaport, have considered the project of dry port cluster into consideration.

2.4.3 Problems Existing In the Establishment of Dry Ports

We should note that the establishment of dry port cluster that is a systemic project needs the cooperation among the government, customs, port authority, shipping company and cargo owner. However, for the sake of the short-term profits, some shortsighted local governments and corporations reject cooperation with coastal and other inland cities, thus limiting the development of dry port industry.

The construction of dry port is a capital-intensive investment project, which usually costs no less than 100 million in general. Therefore, it's essential to absorb the capital not only from the government, port authority and shipping corporations, but also from private investors and overseas market (Tan Ka, 2009). However, so far, the growth of dry port industry is limited by the few parties of investors.

China is staying at a stage of rapid development of container transportation. Though the construction of inland container facilities witnesses a rapid development, the development level of these containers facilities varies and the scale of most facilities is rather miniature, not to speak of functioning as pivots.

2.5 Development of Dry Port Industry on the World

The immeasurable benefits and fabulous convenience created by dry port have attracted the attention and interest from every corner of the world. Regarding the era of dry port as a golden opportunity of upgrading their national logistics level,

countries do their utmost to promote the industry both economically and politically. Nevertheless, a part of avoidable dilemma is confronting these countries while they are sharing the profits.

2.5.1 Recent Situation & Dilemma of Developing Countries

1）India

Toward the end of 2008, approximately 200 dry ports have been established at several locations within India, of which 40 of them were proximate to the major gateway seaports, e.g., JNPT, Mundra, Chennai, etc., where 58% and 42% of the container traffic between the dry and gateway ports were handled by roads and rail, respectively (Hariharan, 2001). Until recently, all of the major dry ports were under the public entity of the Indian government, i.e., state-owned corporations (shown in the Figure 2-4). However, the uneven distribution of dry ports within the country, with about 40%, 30% and 20% being located within the southern, western and northern regions, respectively (the central and eastern regions are conspicuous by the almost negligible presence of dry ports) (UNESCAP, 2006) had led to congestion of facilities and breakdown of infrastructure on the one hand, while capacity underutilization on the other hand. Also, according to anecdotal information, given the scarcity in financial resources, technological and management know-how, dry ports in India had never been innovative, where long-term efficiency-enhancing investments, research and development, e.g., RFID, GPS, etc., were never considered, not helped by the Indian government's labor protective policies (Adolf K. Y., 2009). Indeed, the almost complete monopoly of state-owned corporations, notably CONCOR and Central Warehousing Corporation (CWC), had contributed to the problems as mentioned above especially since, as government-approved monopolies, different dry ports often provided generic solutions to non-standardized demands between different regions, raising the question on whether dry port services were really

customer-oriented (UNESCAP, 2005, 2006).

Figure 2-4 Indian dry ports and their operators in 2006.

Operator	No. of dry ports operating
Container Corporation of India Ltd.(CONCOR)	55
All other state-owned firms	53
Total state-owned firms	108
Private Firms	67
Total	177

Source: UNESCAP (2006).

2) Senegal

As the largest port in Senegal, Dakar seaport set up a dry port, 2 km inland from Dakar seaport a cost of CFA16bn (US$35m), to ease congestion at existing port facilities and in downtown (source:*www.cargosystems.net*). The site includes warehousing, container storage and a container repair depot. The warehousing facilities comprise 1×39000sq meters, 3×8700sq meters, 1×1500sq meters and 4×2500sq meters. Additional land adjacent to the dry port has been reserved for to extend the site at a later date. Nevertheless, the problem lies on who is able to operate the dry port in that the port authority is not experiential and affordable enough to run it. The port of Dakar is busy at launching a tender process to find a private operator for its newly built dry port.

2.5.2 Recent Situation & Dilemma of Developed Countries

Although European Union are the pioneer in the dry port industry, there are a number of aspects and trends related to the industry that are worthy of extra attention since they may constitute a substantial potential for the future development of the European transportation system. (Västra Götalandsregionen, 2009)

Firstly, the success of dry ports is solely focused on the container market, but the development related to semi-trailers is far from reaching comparable levels. This is despite the fact that transport of semi-trailers is an important segment from a European perspective since intra-European transport flows to a large extend is based upon the load unit of semi-trailers. As a result the development in this segment should be stimulated by key policy measures. New, innovative and more-efficient handling techniques and rolling stocks are such examples. These possibilities, however, are not only related to technology breakthroughs but are also an issue of system-wide implementations. From our point of view, this is an area that would benefit greatly by policy measures and incentives from the European Commission.

Secondly, a trend that is threatening the efficiency of hinterland transport and dry ports is the development of 'individual' dry port systems by individual ports. The long-term result of this might be local geographical monopolies surrounding dry ports. As a consequence, the entry barriers become immense as the construction of new dry ports creates very unbalanced market situations. The risks also include inefficient infrastructure investments in the transportation system resulting in over-establishments of inland terminals and dry ports that may eliminate the economics of scale on high volume dryport-seaport corridors needed for cost-efficiency and ultimately modal shift. Moreover, the expansion of a seaport's dry port in overlapping hinterlands will also affect competition between seaports in those hinterlands. This calls for effective and coordinative governance and actions not only on the national level but on an EU level in correspondence to the transnational expansion of the ports' hinterland systems (www.dryport.org). A key issue that needs to be considered that dry ports can potentially have the same strategic function as a seaport and thus must be common-user facilities. One possibility for a policy

instrument and incentive would be to offer support for infrastructure investments given that terminal operators offer transparent pricing strategies and third-party access. Preferable, the terminal operator should provide a separate and public income statement.

2.6 Combination Pattern of Dry port Cluster

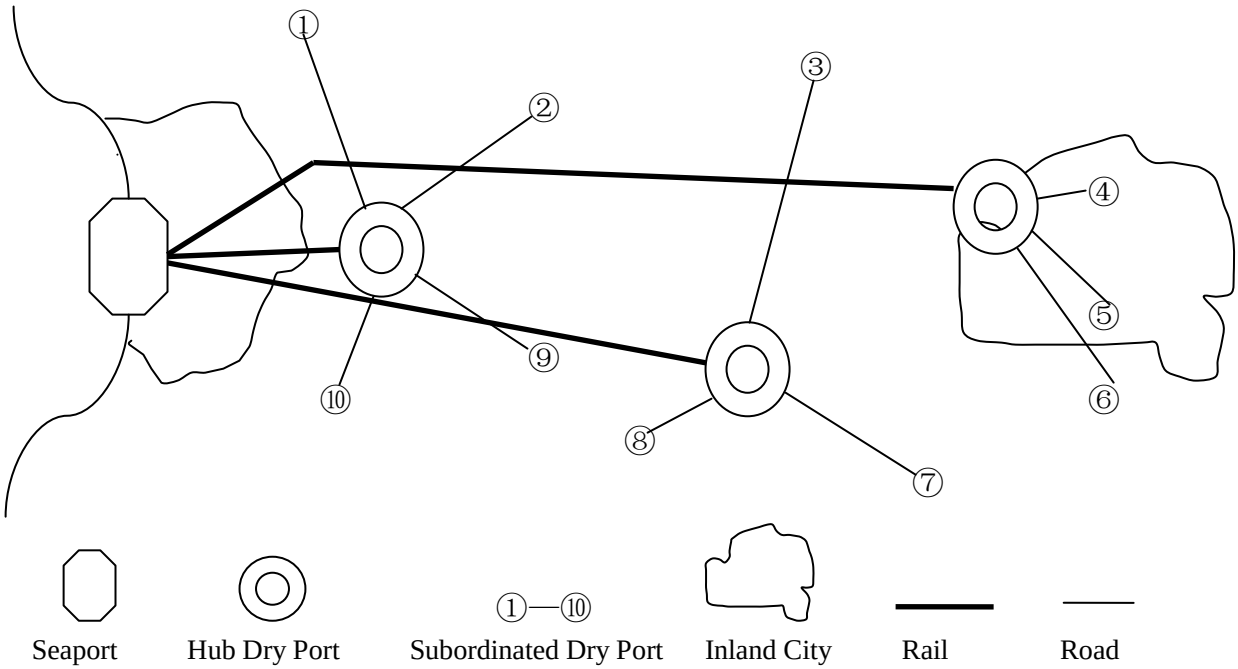
According to the distance from hub dry port to seaport, dry port cluster can be classified into three types—distant, mid-range and close dry port cluster. It doesn't mean that a seaport has no choice but choose one from three, but it is able to choose several from them completely based on the specific needs on all sides and special situation. The situation can be a combination of two types of dry port clusters or that of three types.

Within a combination of the three types of dry port cluster (Fig. 2-5), the port and its surrounding city can be relieved of all road connections to locations outside the city area. As is illustrated by the picture, the SDP 1, 2, 9 & 10 closest to the seaport call at the close dry port cluster, two at medium distances SDP 7 & 8 call at the mid-range dry port cluster while SDP 3–6 furthest away from the seaport utilize the distant dry port cluster.

The distant hub dry port is here directly connected to the seaport in that the flows are efficient enough to make a full-train shuttle service possible. Only if either the midrange or close hub dry port is used as a consolidation point coordinated with ship calls by dedicated trains, would the distant dry port cluster be served by a shuttle to the consolidation point. Regardless of whether the containers pass several hub dry ports, they can obviously use the same railway line into the port.

It is not only the number of direct road connection that changes. There are opportunities to transfer activities currently causing congestion at the seaport gates to the hub dry port. These activities include customs clearance, security checks and information handling. Also physical handling such as stuffing and stripping as well as buffering laden and empty containers can be done at the dry port, thus saving precious space in the port. Obviously, the benefits come at a cost and they require that certain conditions are met. The most significant one is that the flows are large enough to facilitate efficient terminal and rail operations, the latter with satisfactory speed and frequency. Midrange and distant dry ports also come with distance requirements.

Figure 2-5 Combination Pattern of Dry Port Cluster



3. Necessity & Feasibility Analysis of Building Dry Port Cluster for Shanghai Port

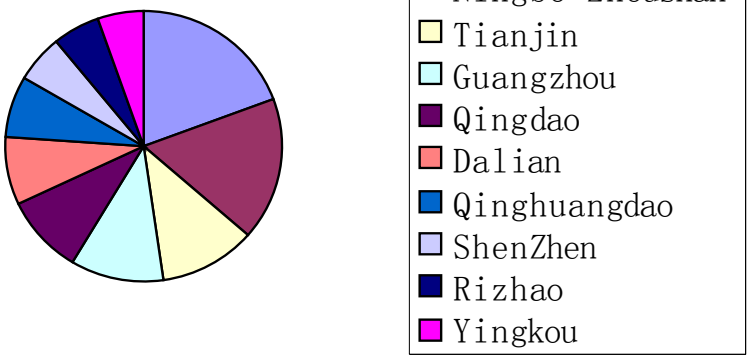
3.1 Status & Logistics Development of Shanghai Port

3.1.1 Leading Role of Shanghai Port in the Domestic and on the Overseas

Located at the front edge of Yangtze River Delta and at the middle of national 18,000 kilometer coastline, Shanghai port is at the connection site between the East-West Yangtze River transport corridor and North-South maritime transport corridor. Shanghai Port, the domestic leading and representative port, functions as not also the largest inland transportation site where quantities of commodities are accumulated in the whole logistics chain but also a pivotal information centre collecting and marshalling substantial information about flow resource, technology and service. The throughput of this port occupies over one-fifth of major national seaports (Shown in the Fig. 3-1). Back on Yangtze River and Faced with East China Sea, Shanghai shares sufficient economic hinterland which concludes 31 provinces and cities in the domestic.

Figure 3-1 Annual Throughput of Top 10 Port in China in 2009

Figure 3-1 Annual Throughput of Top 10 Ports in China in 2009



The traffic infrastructure here are so advanced and the inland transportation tunnel is so convenient that the transportation web of shanghai port extends to Yangtze River Delta, Central China and Southwest China and make it possible to link with the global. Until 2009, Shanghai port whose monthly container transport shuttle service reached 2500 times has established over 200 direct container shuttle with the world including America, Europe, Oceania, Africa, North-east Asia and South-east Asia. Top 20 of global shipping companies have poured into Shanghai while over 100 domestic and overseas shipping corporations set up headquarter subsidiaries and embranchments. All of these contribute to the annual container throughput of 0.59 billion TEU that helps Shanghai port rank 1st and 2nd respectively domestically and globally (Shown in Figure 3-2).

Figure 3-2 Annual TEU of Top 13 in the Global Container Transport Industry

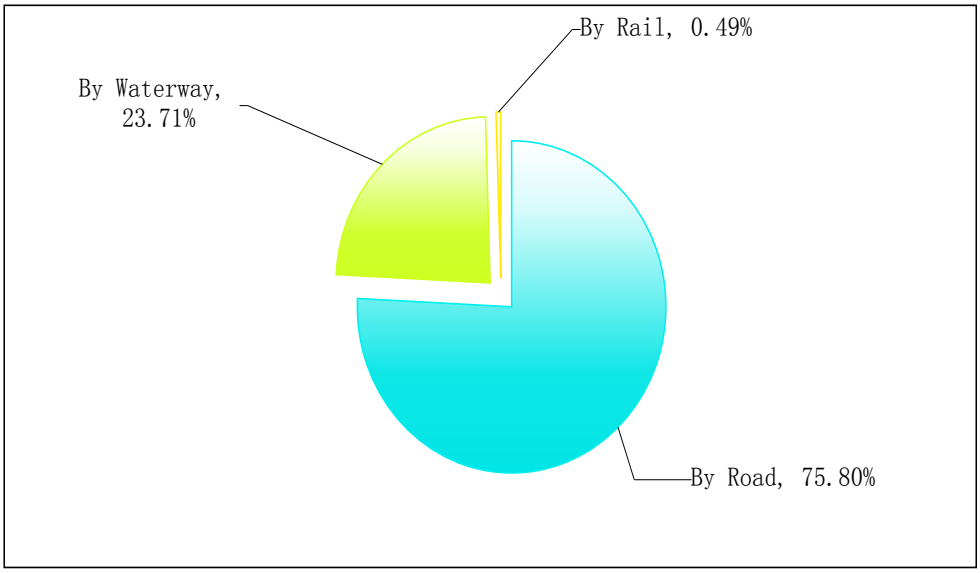
Rank		Port	Country	2008	2007	Surplus	%
2008	2009						
1	1	Singapore	Singapore	29,973,000	27,900,000	2,073,000	7.4
2	2	Shanghai	China	28,006,400	26,152,000	1,854,400	7.1
3	3	Hongkong	China	24,494,000	23,998,000	496,000	2.1

4	4	Shenzhen	China	21,416,400	21,099,000	317,400	1.5
5	5	Busan	Korea	13,420,000	13,261,484	158,516	1.2
6	7	Dubai	UAE	11,800,000	10,650,000	1,150,000	10.8
7	12	Guangzhou	China	11,001,400	9,260,000	1,741,400	18.8
8	11	Ningbo-Zhousan	China	10,933,700	9,430,000	1,503,700	15.9
9	6	Rotterdam	Netherlands	10,800,000	10,790,604	9,396	0.1
10	10	Qingdao	China	10,024,400	9,462,000	562,400	5.9
11	9	Hamburg	Germany	9,700,000	9,890,000	-190,000	-1.9
12	8	Kaosiung	China	9,676,554	10,256,829	-580,275	-5.7
13	14	Antwerp	Belgium	8,663,736	8,176,614	487,122	6.0

3.1.2 Latest Situation of Shanghai Port's Container Inland Transportation

The statistics offered by Shanghai Internaitonal Ports and Shipping Corporation reveal that the containers from Yangtze River Delta account over 85% for the total container throughput of Shanghai port, approximately half of which come from local area and the rest of which from Jiangsu Province and Zejiang Province. As is illustrated by Figure 3-3, the major inland transport way of Shanghai port is by road, which is followed by waterway, the last is by rail.

Figure 3-3 Proportion of Shanghai Inland Transport Ways in 2009



1) Inland container transport by road

Due to relatively high cost, road transport adapts to the range from 300 km to 500 km, therefore the inland container transport by road accumulateds Shanghai City, Jiangsu Province and Jiangsu Province. There are East-West Gangcheng Road & Ganghua Road and South-North Pudong North Road, Puxing Road and Yanggao Road and Highway A20 & A30 around Wai Gao Bridge Harbour District. Yangshan Dry Port Harbour District is surrounded by East-west Nanfeng Driveway, Daye Driveway and Xiexin Driveway and South-north nanlu Driveway, Puxin Driveway and Highway A2, A30. In addition, Donghai Bridge is exclusively utilized for the inland transportation from Yangshan container yard to Shanghai mainland.

2) Inland container transport by waterway

Located at the mouth of Yangtze River Delta, Shanghai enjoys convenient waterborne connections with the cities alongside Yangtze River, therefore the inland container hinterlands of Shanghai port by waterway spreads over Yangtze valley such as Jiangsu Province, Zhejiang Province, Hubei Province, Hunan Province. Shanghai

Inland container transportation by waterway can be classified into two ways: one is to transport the commodities from Shanghai port to inland river, for example, Huangpu River; the other is to transport from Shanghai port to hinterlands alongside Yangtze Valley. So far, accoridng to the container throught of two kinds, the former takes a leading role and the latter one accounts for a rather small share.

3) Inland container transport by rail

Thanks to the characteristics of long distance and large quantity, the transport of Shanghai port by rail is beneficial for the range above 400km and those areas far from Yangtze River golden watercourse, ie.Henan Province, Xiannxi Province, Sichuan Province, Jiangxi Province and Hunan Province. Until now are there mainly Yangpu Station and Luchao Central Station exclusively for the sea-rail combined transportaion operations in Shanghai. The sea-rail route of Waigaoqiao port is from wharf to Yangpu station by road dragage, then to inland cities through Beijing-Shanghai and Shanghai-Kunming railway groundline. With regard to Yangshan port, the containers there are conveyed by lorry through seaport to Luchao station where commodities are fixed on container trunks and then enter into national rail web through Pudong railway.

3.1.3 Problems Existing In Shanghai Port's Container Inland Transportation

The present transportation model of Shanghai port's container inland transportation is focus on road but neglect of rail, thus causing three following problems:

(1) The urban environmental pollution is severe; too much organic hydrocarbon tail gas is emitted into the air.

(2) Shanghai's inland transportation is under higher pressure. Take the roadways

alongside Wusong district, Waigaoqiao district for instance. Their problems lie on individual inland transporation ability, mutual connection ability, rational distribution and transport rationalization. More reliable are on the inland transportation by road, more crowded are urban traffic. These will have a negative effect on the efficiency of Shanghai port's inland container transportation.

(3) The transportation cost becomes relatively high. Currently, the profits of road operators and cargo owners are impacted by overfull toll bars and variety of fees.

3.2 Necessity Analysis of Establishing Shanghai's Dry Port Cluster

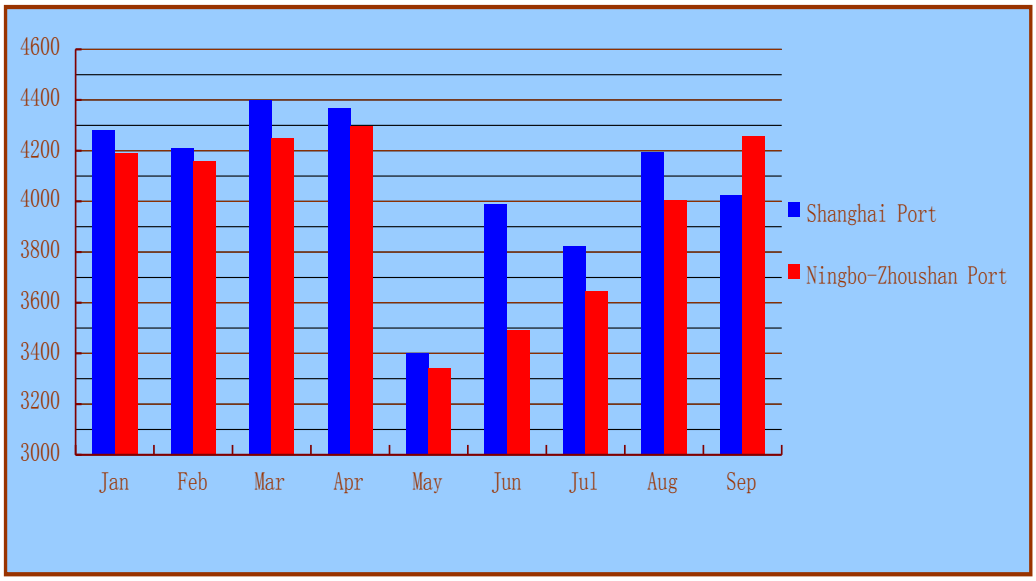
3.2.1 Surving the Severe Port Competition

In all modesty, Shanghai port is confronted with extremely fierece port competition, which come from both global and domestic seaports. Under this circumstance, it is to develop into the first-level seaport that is the only access to avoiding to be obselete.

As competition is heating up, it attacts the most attention from port operators to seize wider economic hinterland and cargo source. The recent five years witness the merged Ningbo-Zhoushan port's thoughput has been expanding dramatically. Global financial crisis puts back the shipping industry, thus causing the decline of Shanghai port's throughput by a small largin while Ningbo-Zhoushan port' annual growth rate incredibly arrives at double digit. In Septermber 2008, Ningbo-Zhoushan port surpusses Shanghai port in annual throughput for the first time, leaping into the largest national seaport (Shown in Figure 3-4). An important reason is that its authority sets store by the construciton of dry port. Until present has Ningbo-zhoushan port fabricated 6 dry ports. Recently, its port group and customs

signed *Memorandum of Construction of Dry Port* with Shangrao City, Ying tan City.

Figure 3-4 The comparision between Shanghai Port and Ningbo-Zhoushan Port In the Thoughput from January to September in 2008



To establish dry port by cooperating with inland areas is an efficient measurement for seaports to capture flow resouce from the landlocked. Seaports need to extent their service scope into the inland in order to attain increasing throughput and improve its competitiveness. Therefore, some thriving cities in the central and western areas are being struggled by seaports repeatedly. So far, some seaports announce the cooperation with certain inland areas, others put forword to the plan of joint work, wairting for further putting into practice. Aprat from Sanming City tha has signed Letter of Intent with Xiamen seaport, Nancang and other areas in Jiangxi Province also show great enthusiasm. Were Shanghai Port to guard against the status of the largest port in China, it should seize the historical opportunity of brodening its hinterlands to improve its core competitiveness.

3.2.2 Upgrading Shanghai Port's Logistics Service Level

Modern ports have entered into the 4th generation, whose port competiton is characterized by evolving into the competition of supply chain in which the ports participate. Zhenhong, a researcher of Shanghai International Shipping Institute, defines the 4th-generation port as a port that functions as a node of supply chain, puts emphasis on the interation of logistics among ports, satisfies the individualized needs and provides elobarate operations and just-in-time service in order to promote the seamless connection among the concerned sectors of supply chain.

It is to build up dry port cluster that fulfills the development needs of the 4G port. The dry port functions as a logistic center providing such services as clearance, inspection and issue of B/L and a supervisory organ offering customs, quarantine of animals and plants and sanitary inspection. Meanwhile, the subsidiaries freight forworder, shipping agent and shipping company set up in dry port is convenient for delivery and redelivery of commodities and issue of multimodal B/L in which the interior is port of destinaiton or shippment. Inland importers and exporters may accomplish booking, clearance and other formalities and then provide the commodities with freight forworder and shipping company, which can be deemed as 'Declearance in hinterland, loading in seaports'.

In a word, dry port makes it possible to achieve 'seamless docking' between inland areas and seaports by offering these services in a node including customs, inspection, booking, inland transport, storage, packing and distribution. Practically, the kind of transportation model extends transport, loading & unloading and logistics service into the hinterlands.

3.2.3 Lowering the Cost of Transportation

The establishment of dry port cluster contributes to expansion of cargo flow of seaport. More importantly, the benefits for customers are embodies in the savings of time and vigor and the decline of financial costs by a large margin.

Statics from Union Daily reveal that total cost per container inluding transport, clearance and Terminal handling charge throught dry port is $50 lower than traditionally. In other words, the total cost can be savedy by $ 5 thousand per 100 containers. As a rule, the cargo owners' cost is declined by approximately one-fifth by sea-rail combined transport. Furthermore, thanks to uniform container size, the modal saves the cost of containers and time of loading & unloading. It is observed that sea-rail is the most economical way in the different transport modals of dry port.

3.2.4 Stimulating the Foundation of 'Two Centers'

A central governmental announcement was made public by the State Council of PRC in April 29th, 2009 in relation to promoting the development of modern service and manufacturing industry and the establishment of Internaitonal economic and shipping cernter.

The Two Centers refer to international economic and shipping center. First and foremost, let's ponder over the foundation of inernational shipping center. It is universally acknowledged that London, New York and Tokyo are the three largest international shipping centers. Shangahi, in contrast, still has some gaps in its service capabilities, with the lack of creating value-added ability just being the most glaring. As an international shipping center, its status is more dependent on its funcitons on giving an impetus to regional and universal development in all aspects rather than solely on its own scale and annual throughput (Hou jin, 2008). Viewing the subject from this angle, Shanghai is poor in conjunct development with nearby cities and

inland areas. It is eager to cooperate dry port cluster to help each other forword.

To some extent, a adavanced shipping and logistics indusry is a fundamental prerequisite of setting up an international economic center. Take the ongoing World Expo for example. Successful bid for EXPO 2010 not only bolsters the comprehensive image of Shanghai, an international metropolis and gives an impetus to economic and trade growth, but also results in a resurge of logistics pressure. Fabulous amount of builing materials and exhibits on the halls and a mass of tourists and journalists all over the world generates the quantities of baggages and materials logistics. On a daily basis, the number of tourists reaches 400 thousand, no less than 1600 tons of daily necessity are consumed and and over 200 tons of wastes need to clear up in time, during the first two months of the world expo(Chen boyun, 2010). By dry port cluster, these daily necessity and builing materials can be transported to Shanghai from inland areas in a timely and orderly fashion.

3.3 Feasibility Analysis of Establishing Shanghai's Dry Port Cluster

3.3.1 Feasibility Analysis of Logistics

The infrastructure of Shanghai port is well-constructed and advanced, especially in the container transportat industry. Until 2008, Shanghai port was equiped by 3150 pieces of loading & unloading machinery of different types, including 170 container bride cranes, 338 operating ships and 7 transport vessels. There are 59 container freight stations and container yards covering 1.69 million square meter that are content to inland transport, loading & unloading and other value-added services about containers. Furnished with 1202 wharfs and berths, 171 of which has the handling ability of above 10 thousand TEU, Shanghai port deals in 91.6-kilometer

pier line and processes the handling ability of 25.352 million TEU. More detailedly, Shanghai port's container throughput came up to 2.8 million TEU in 2008 with 46 specialized container berths.

Thanks to superior collection and distribution ability and developed shipping market, Shanghai port, as one of the largest transportation networks, has basically formed a multimodal transport network integraded with railway, highway, water, air and other modes of transport. It is characterized by the highest speed and lowest cost and in the Yangtze River Delta and Yangtze River cargo transit. The network also includes Beijing-Shanghai and Shanghai-Hangzhou rail route connecting every corner of the country, Shanghai-Nanjing Road and Shanghai-Hangzhou expressway, and four national highways(204,312,318,320) and Hu-Jia, Sui Song Highway and urban outer belt highways linking nationwide highway network. Its waterway refers to Yangtze-River and the Grand Canal.

With regard to science and technology, Automobile Acqusition & Data Collection, Information and internet technology (GPS, RFID, EDI) and advanced administrative system(VMI, ERP) are applied into Shanghai logistics. Guite a few subjects specialized in logistics have been added to colleges and unversities over the length of the local government so as to cultivate professional logistics personnel and enrich the public knowledge about logistics by various channels.

The integration among business flow, cargo flow and intelligence flow gradually take shape the modern logistics distribution system characterized by acquisition of information and technology and management theory of supply chain (Chen bo Yun, the challenges and opportunities confronting Shanghai in Expo 2010).

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3.3.2 Feasibility Analysis of Economics

Shanghai port backs on to the fertile and promoting Yangtze valley holding over 200 open ports whose commodities goes through Shanghai port. 35% of the transshipment commodities and 90% of international cargoes of Shanghai port in 2007 source from Yangtze river basins. That's why Yangtze-River Delta functions as the direct hinterland of Shanghai port.

Yangtze-River Delta, the most developed region in China, occupies a pivotal position in nationwide economic and social development. The region consisting of Shanghai City, Zhejiang Province and Jiangsu Province takes up less than 1% of the total national land creates 24.5% of GDP and 28.5% of annual fiscal revenues in 2006. The regional GDP in 2006 approached RMB 4 trillion, increased by RMB 556.3 billion compared with 2005. The figure in 2007 amounted to RMB 4667 billion unprecedentedly. The economic power and trade potential here provide Shanghai port with plenitudinous source of goods.

Apart from Yangtze-River Delta, the indirect hinterland of Shanghai port refers to upstream and midstream of Yangtze valley including Si-chuan Province, Hu-bei Province, Hu-nan Province, Jiang-xi Province, An-hui Province and Chongqing City, whose containers mostly go through Shanghai port and whose total population surpasses 400 million. This excetional advantage is hard to be compareby by any other port in the universe.

Besides the strong point of hinterland, Shanghai port benefits from the local developed market economy. After all, the contruction of dry port cluster is fund-consuming and labor-consuming. The economic growth upgrades overall industrial structure obviously, make it possible to form and solidify its own core

competitiveness. The urban public finance-revenue arrived at 254 billion in 2009, up 7.7% over last year; At the same period, the value-added in tertiary industry seized approximately six-tenths and Non-Public Sectors Of the Economy did 47 %. The proportion of Shanghai's tertiary industry outweighs 60% of the city's GDP. It's observed that its total GDP has exceeded Hongkong.

3.3.3 Feasibility Analysis of Socity

There's no doubt that the costal cities may prosper form the construction of dry port cluster. With regard to the inland cities, they are also beneficial from the magnificant project. Dry port shrinks the distance and time from inland cities to international market dramatically, further promotes them to open up to the outside world.

Take the western regions for instance. Western regions have been striving to structure sea-land combined transport web for years. Although Southwest Channel opened in 2005 improves Southwestern regions' access to the ports in Beibu Bay, the channel is still unsatisfactory and far from adapting the needs of regional economic growth. Its main problem manifests the lack of integrated logistics and ralatively high time and fund cost. Deeper reason is that western seaports and landlocked are poor in essential knowledge, rich experience and abandant funds. For this reason, western regions are eager to cooperate with Shanghai port in order to make full use of the advantages of Shanghai's talents, funds, technology and experience, bind cargo resource and land of western regions, thus improving the logistics web access to sea of western regions.

Based on the discusson above, we have every reason to believe that the project will be backed up by both coastal cities and inland areas.

3.3.4 Feasibility Analysis of Law

The dry port built up in the collaboration between inland areas and coastal cities functions as a seaport. That means an inland city may sign a trade contract with clearance in the interior by the existing transport mechanism and a seaport solely responsible for transportation assembles a bridge linking the interior and the world.

For instance, Wuhu (inland city) cooperates a dry port with Shanghai (coastal city) and exports cargoes to Tokyo, Japan. In the column of Price Term in trade contract filled FOB Wuhu JPY 160.00/PC; Loading port: Wuhu; Unloading port: Tokyo. The cargos are handed over in Wuhu.

In like manner, the commodities are exported into Wuhu. In the column of Price Term in trade contract filled CIF Wuhu JPY 160.00/PC; Loading port: Tokyo; Unloading port: Wuhu. The cargos are handed over in Wuhu.

According to the terms of FOB, the risk of both parites concerned is bounded by the ship's rail. The risk is still under the seller's obligation even if the commodities are shipped out dry port, but have not been loaded on the vessel (Xiping, 2005). Only when the cargos are loaded does the risk shift to the receiver.

3.4 Redimentary Site Selection of Dry Port Cluster For Shanghai Port By Exclusive Method

China is a country of vast dimensions, covering 9.6 million kilometers. It consists of eight sectors-East China, South China, North China, Central China, Northwest China, Southwest China, Northeast China and Taiwan Region (Shown in Figure 3-5). Despite the fact that China has ample source of hinterland, it doesn't mean that all of the eight sectors are profitable and meaningful to Shanghai port. Therefore, it is a key

issue on how to choose the appropriate hinterlands for Shanghai port, after all, the project of dry port cluster is fund-consuming and time-consuming. In case the site selection is irrational and illogical, Shanghai and inland areas will be confronted with massive waste of fund, time energy and building materials. The Exclusive Method will be utilized to get rid of these sectors worthless to Shanghai Port.

Figure 3-5 Administrative Map of China (Sourced from Expedia)

Taiwan Region is the first not to be taken into account mainly owing to geographic and political factors. First and foremost, it is an island, seperated by sea. Furthermore, although the relax atmosphere appears in the recent years after the confrontation between two sides of Taiwan straits for more than half a century, 'Three Exchanges' have not actually achieved not to speak of the economic mutual dependent relationship.

Except for Shannxi Province, Sichuan Province, Guizhou Province and Chongqing

City, northwest and southwest region of China are not worth considerating on account of geographic and economic factor. The complex and varied terrains and landforms as well as the elevation ranging from 2-4 kilometers creates a natural obstacle to the outside world, thus directly holding up the local economic and trade growth. The high cost of infrastructure construction here and limited cargo flow are difficult of attract the interests from investors.

It is also rarely possible for Northeast China, North China and South China to become Shanghai port's hinterland. The main problem lies on rivalry, embodying that Shenzhen port & Guangzhou port in South China, Tianjin port & Qinghuangdao port Dalian port and Yingkou port in Northeast China are among TOP 10 of the largest ports in China. After all, these ports are much closer to the local area than Shanghai port, therefore a amount of transportation cost can be saved. Shanghai port still has to face the disadvantage of distance when comparing Shan Dong province, the norhern region of East China with Qingdao port and Lian yungang port.

The remaining areas-most area of East China and a part area of southwest, Central China, Shannxi Province-are regraded as ideal hinterlands for Shanghai port with regard to geographic, economic and social factor. In spite of the competition from Ningbo port and Shenzhen port, Shanghai port has not palpable demerits compared with competitors. Under these circumstances can Shanghai port make full use of its economic, administrative, talented advantages. Whatever difficulties Shanghai port will be confronted with, it needs to seize these prolific hinterlands as fast as possible in that Ningbo port and Shenzhen port have been engaged with striving for the limited hinterland. However, before that, Shanghai port should ponder over how to put its plan into effect.

3.5 Pattern of Dry Port Cluster Suitable to Shanghai Port

Based on the discussion above, Shanghai port is likely to establish the dry port in eleven provinces and cities, namely Sichuan Province, Chongqing City, Guizhou Province and Shanngxi Province, Henan Province, Hubei Province, Hunan Province, Jiangxi Province, Anhui Province, Shejiang Province and Jiangsu Province. It is essential to establish one or several dry ports for each province owing to the massive land and regional disparity in terms of policies & regulations and economic development level. According to the distance form Shanghai and geographic sectors, these dry ports can be classified into three dry port clusters.

West Dry Port Cluster, also called the far dry port cluster, consists of the dry ports from Sichuan Province, Guizhou Province, Shannxi Province and Chongqing City;

Central Dry Port Cluster, also deemed to the mid-range dry port cluster, is made up of the dry ports sourcing from Henan Province, Hubei Province, Hunan Province, Jiangxi Province, Anhui Province.

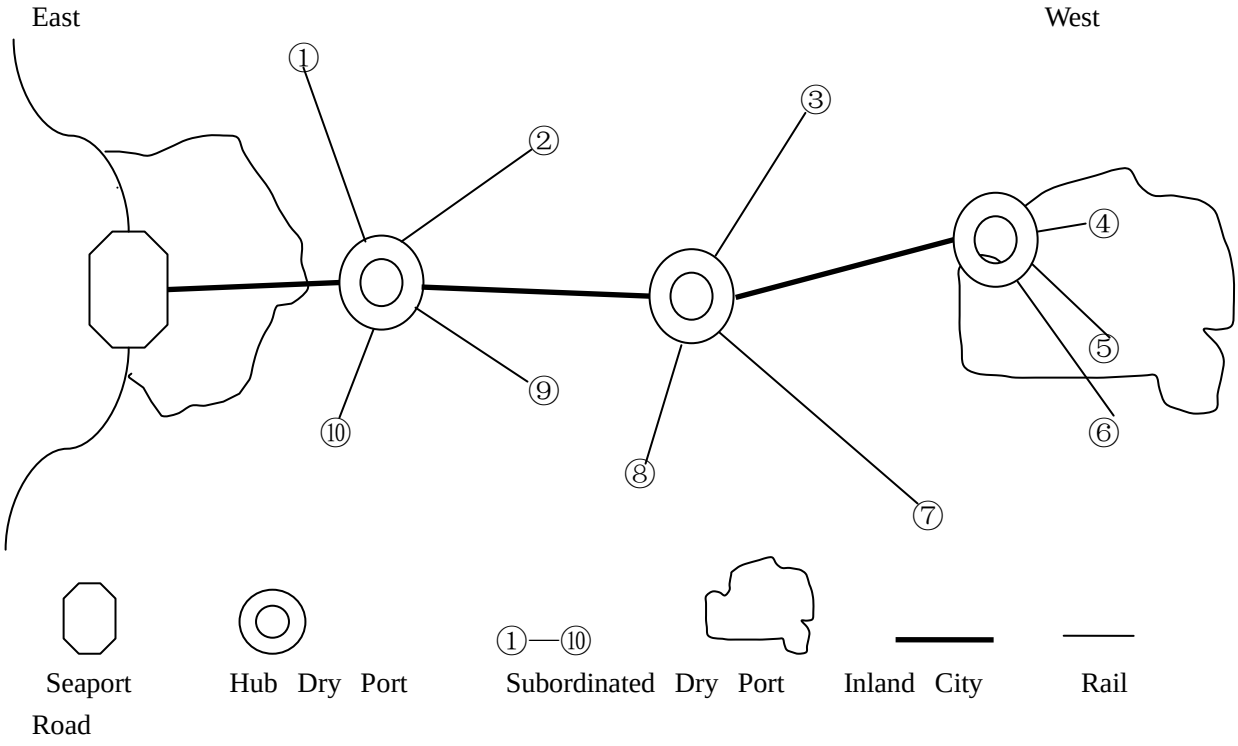
East Dry Port Cluster, also regared as the close dry port cluster, is composed of the dry ports coming form Zhejiang Province and Jiangsu Province.

One thing to be mentioned is which dry port cluster Anhui Province belongs to depends on its elected dry port's specific location.

In every dry port cluster, a hub will be chosen and the rest will be subordinated. The railways will link Shanghai port with the three hubs collecting its subordinated dry

port by road.

Figure 3-6 Model of dry port cluster of a seaport



4. Site Selection of Shanghai Dry Port Cluster By Analytic Hierarchy Process

4.1 Introduction of Analytic Hierarchy Process

As mentioned, Analytic Hierarchy Method will be utilized in choosing the appropriate position of dry port cluster. The Analytic Hierarchy Process (AHP) is a structured technique for dealing with complex decisions. Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. The AHP provides a comprehensive and

rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions .

An AHP hierarchy is a structured means of modeling the problem at hand. It consists of an overall goal, a group of options or alternatives for reaching the goal, and a group of factors or criteria that relate the alternatives to the goal. The criteria can be further broken down into subcriteria, sub-subcriteria, and so on, in as many levels as the problem requires (Source: Wikipedia). The hierarchy can be visualized as a diagram like the one below, with the goal at the top, the alternatives at the bottom, and the criteria in the middle. There are useful terms for describing the parts of such diagrams: Each box is called a node. The boxes descending from any node are called its children. The node from which a child node descends is called its parent. Groups of related children are called comparison groups. The parents of an Alternative, which are often from different comparison groups, are called its covering criteria. Applying these definitions to the diagram, the four Criteria are children of the Goal, and the Goal is the parent of each of the four Criteria. Each Alternative is a child of its four covering criteria. There are two comparison groups: a group of four Criteria and a group of three Alternatives. The design of any AHP hierarchy will depend not only on the nature of the problem at hand, but also on the knowledge, judgments, values, opinions, needs, wants, etc. of the participants in the process. Published descriptions of AHP applications often include diagrams and descriptions of their

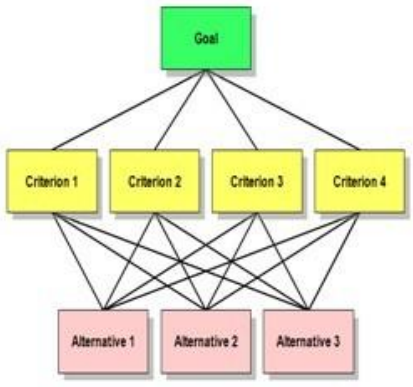
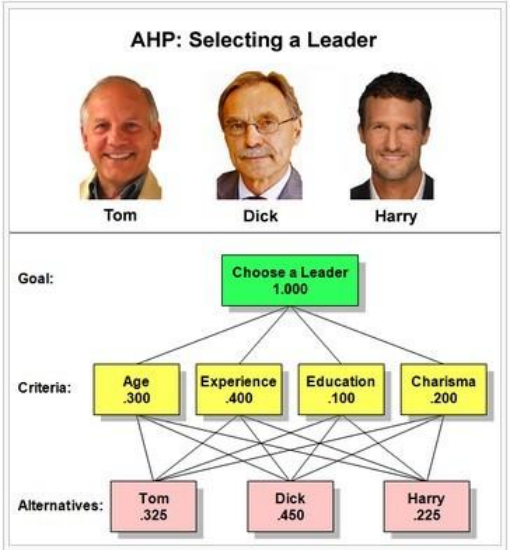


Figure 4-1 AHP Model

hierarchies. These have been collected and reprinted in at least one book. You can see a series of complex hierarchy here. As the AHP proceeds through its other steps, the hierarchy can be changed to accommodate newly-thought-of criteria or criteria not originally considered to be important; alternatives can also be added, deleted, or changed (Saaty, Thomas L., 1995).



AHP has been popular around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education. Take the selection of leader as an example. The decision goal is to select the most suitable leader from a field of three candidates. Factors to be considered are age, experience, education, and charisma. According to the judgments of the decision makers, Dick is the most suitable candidate, followed by Tom and Harry. (As is shown in Figure 4-2)

Figure 4-3 Criteria and Implication of Scale Value in AHP

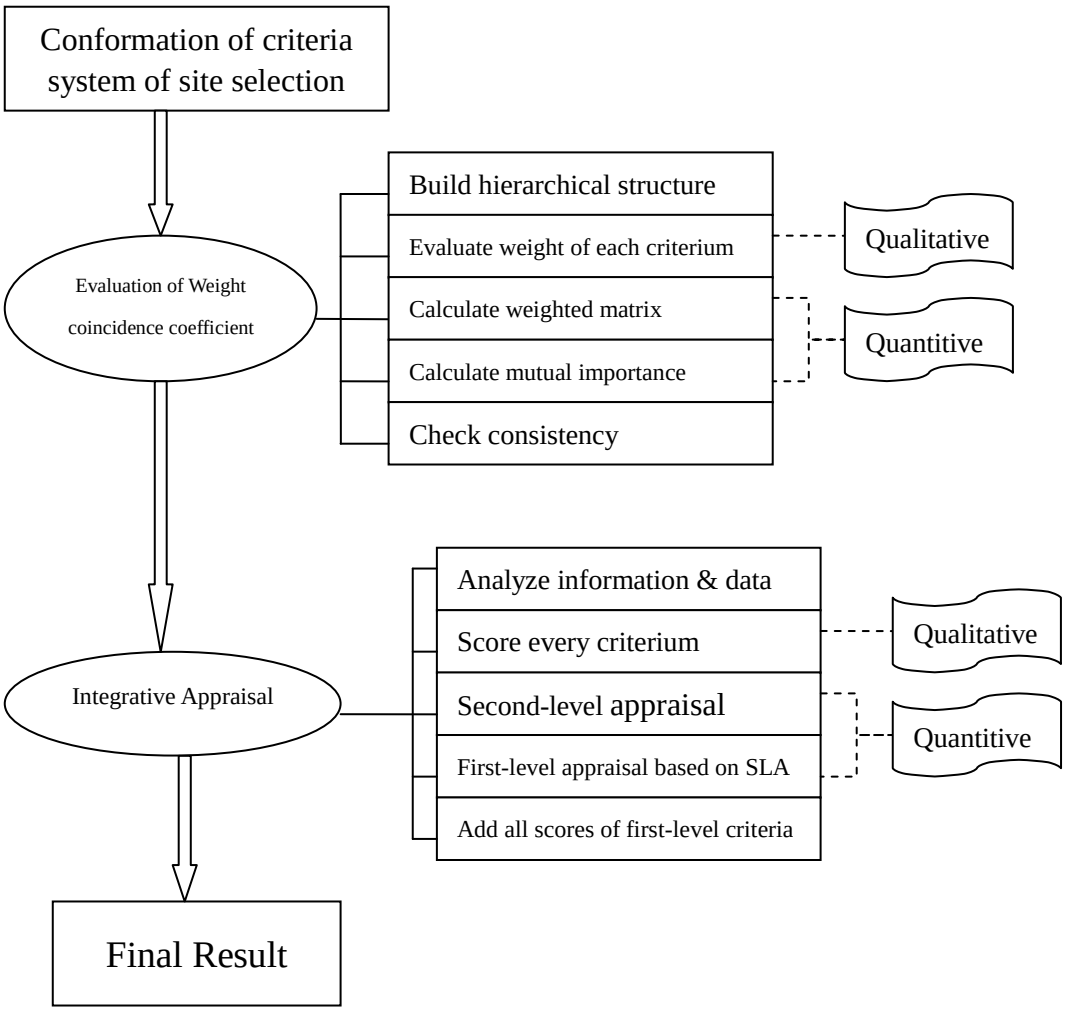
Scale Value	Implication
1	Element A is as vital as Element B
3	Element A is a bit more vital than Element B
5	Element A is even more vital than Element B
7	Element A is a lot more vital than Element B
9	Element A is by far more vital than Element B

2，4，6，8	The intermediate value is selected if its importance is between two value
Reciprocal	If importance comparison between i and j scores a_{ij}, importance comparison between i and j scores $\frac{1}{a_{ij}}$

4.2 Mentality of Implementing Quantative Model

The key of AHP is to select appropriate criteria and value mutual relationship. On the one hand, the mutual importance of two critieria is checked for consistency; on the other hand, such a criterium as economy has a wide range, therefore it is furthermore divided into several small facotors. In the integrative paper, the quantitative model is designed based on the following mentality (shown in Figure 4-4).

Figure 4-4 Frame of Building Quantitative Model



4.3 Election of Criteria

The site selection of dry port cluster should be taken into consideration as a whole over a long hual. It embodies that the locail regions obeys the central government, present interests is surbodianted to long-term interests and both the current needs and the future development are taken into account. In view of serving for international container multi-modal transportation, the overall layout of dry port cluster depends

mainly on the development level of the hinterland, including the economic growth and container flow. Furthermore, the selected region is able to enhance the connections of container transportation hub in the construction of various transportaion modes, make full use of the merits of multi-modal transportation so as to improve the holistic effectiveness and efficiency while maximizing the concerned parties involved in contaienr multi-modal transportation.

Main influernce factors are selected from plenty of factors and are summarized as that of economy, geography, policy and infratructure.

4.3.1 Factor of Economy

The entire economic level of a region generates the scale of its container flow and dominates the volume of container freight for local production & livelihood comsumption. Prosperous regional economy gears up the web networks of container multi-mdoal transporation and in turn the formation of the transport model gives an impluse to its economic growth. For this reason, the dry port, as the core of container multi-modal transport webworks, is ordinarily selected at the developed area to ensure plentiful resource of cargo.

Dry port cluster is a product of modern economic development to a certain stage. Hereby, the local national economic growh level is a vital macro-environment for the site selection of dry port cluster. The factor of economy is the entire economic level entiring the final profits of all the permanent corporations in a certain period, which can be measured by GDP.

4.3.2 Factor of Geography

As a rule, the center of logistics is established at the junction point of traffic and the

hub of railways or roads, where internal and external trade is relatively active and economy is flourishing.

Furthermore, pointed to its specific features, the traffic convenience between Shanghai port and dry ports are taken into account. Here, it is measured by the distance from the candidate cities to the highways in Shanghai.

4.3.3Factor of Policy

The construction of the regional economy and traffic must conform to the development program of nationwide macro-economy and traffic & transportation. Government's policy guidance and support for regional economic and transport development will profoundly affect the level of regional economic growth and improvement of traffic & transport networks as well as the ministries in connection with container multi-transportation. Obviously, the site should be chosen in the region whose external trade and transportation are taken seriously by the central or/and local government.

To some extend, developed transport by an inland river is a counterpower to the establishment of dry port as a result of land transport and waterway being replaceable.

4.3.4Factor of Infrastructure

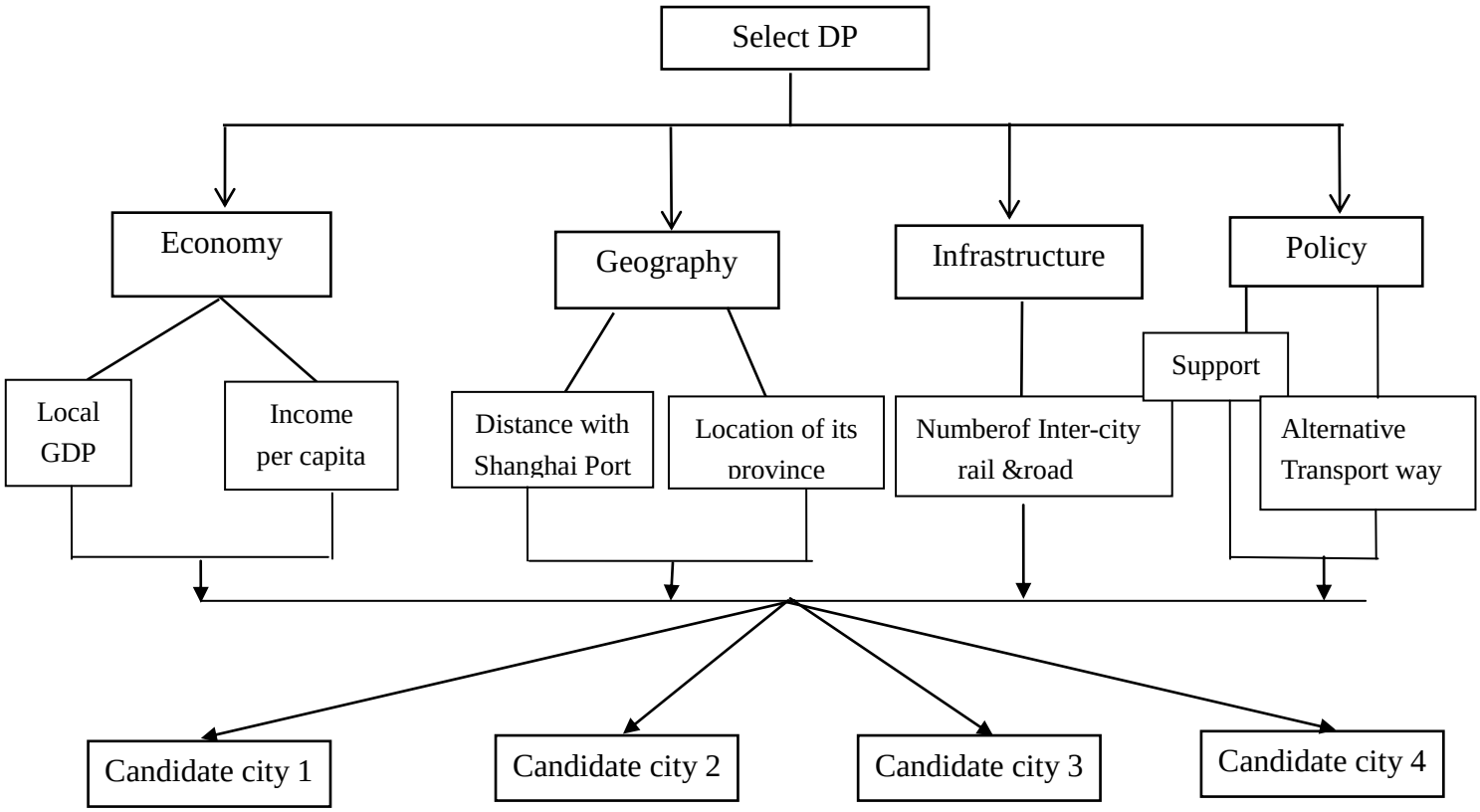
Transport facilities and devices place a vital position on the site selection of dry port cluster. The acreage of urban roads is regarded as the representative index for factor of infrastructure.

4.4 Building AHP Model

Step 1: Set up the AHP framework

Based on the discussion above, Economy, Geography, Policy and Infrastructure are selected as criteria in this case.

Figure 4-5 AHP Model



Step 2: Determine each criterion's weight

1) Build Pair-wise comparison matrices

The ratio is valued in the light of the importance each criterion exerts to the site selection of dry port cluster.

Figure 4-6 Judgment Matrix of the First Level Evaluation Indexes

	Economy	Geography	Infrastructure	Policy

Economy	1	1/2	2	3
Geography	2	1	3	4
Infrastructure	1/2	1/3	1	2
Policy	1/3	1/4	1/2	1

$$A = \begin{bmatrix} 1 & 1/2 & 2 & 3 \\ 2 & 1 & 3 & 4 \\ 1/2 & 1/3 & 1 & 2 \\ 1/3 & 1/4 & 1/2 & 1 \end{bmatrix}$$

2) Add all of the scores in every column to M_i

$$M_1 = 1+2+1/2+1/3 = 23/6$$

$$M_2 = 1/2+1+1/3+1/4 = 25/12$$

$$M_3 = 2+3+1+1/2 = 13/2$$

$$M_4 = 3+4+2+1 = 10$$

3) Normalize Pair-wise comparison matrices A to get A_{nom}

$$A_{nom} = \begin{bmatrix} 6/23 & 6/25 & 4/13 & 3/10 \\ 12/23 & 12/25 & 6/13 & 2/5 \\ 3/23 & 4/25 & 2/13 & 1/5 \\ 2/23 & 3/25 & 1/13 & 1/10 \end{bmatrix}$$

4) Estimate the weight for criterion i

$$W_i = \frac{\sum_{j=1}^{n} a_{ij} *}{n} \qquad W = [0.2771 \quad 0.4658 \quad 0.1611 \quad 0.0960]$$

Step 3: Checking for consistency

1) Compute Aw

$$AW = \begin{bmatrix} 1 & 1/2 & 2 & 3 \\ 2 & 1 & 3 & 4 \\ 1/2 & 1/3 & 1 & 2 \\ 1/3 & 1/4 & 1/2 & 1 \end{bmatrix} \begin{bmatrix} 0.2771 \\ 0.4658 \\ 0.1611 \\ 0.0960 \end{bmatrix} = \begin{bmatrix} 1.1202 \\ 1.8873 \\ 0.6469 \\ 0.3854 \end{bmatrix}$$

2) Calculate $\lambda_{\max}$

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} = \frac{1.1202}{4*0.2771} + \frac{1.8873}{4*0.4658} + \frac{0.6469}{4*0.4658} + \frac{0.3854}{4*0.0960} = 4.0311$$

3) Compute the constancy index

$C_I = (\lambda_{max} - N)/(N-1) = (4.0311-4)/(4-1) = 0.0104;$

The average consistency of the matrix with same number of factor as known in Figure 4-6 $R_4=0.89$;

Figure 4-7 Average Random Identical Indexes

n	1	2	3	4	5	6	7	8	9	10	11	12
R_I	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54

4) Compute the constancy ratio

$C_R = C_I/R_I = 0.0104/0.89 = 0.0116 < 0.1$, the weight of the four factors (geography, economy, infrastructure and policy) are respectively 0.2771, 0.4658, 0.1611 and 0.0960.

In the same way above, the weight of second-level factors are confirmed as shown in Figure 4-7. Figure 4-8 reveals the relationship between second-level criteria.

Figure 4-8 Confirmation on the Relationship between Second-level Criteria

Second-Level Criteria

Economy	Income PC	Local GDP		Economy	Income PC	Local GDP			CR	Number
Income PC	1	1/5		Income PC	0.1667	0.1667		0.1667	0.3333	2
Local GDP	5	1		Local GDP	0.8333	0.8333		0.8333	1.6667	2
	6	6			0.1667	0.8333				0

Geography	Distance	Location		Geography	Distance	Location			CR	Number
Distance	1	3		Distance	0.75	0.75		0.75	1.5	2
Location	1/3	1		Location	0.25	0.25		0.25	0.5	2
	1.3333	4			0.75	0.25				0

Policy	Support	Alternative		Policy	Support	Alternative			CR	Number
Support	1	1/4		Support	0.2	0.2		0.2	0.4	2
Alternativ	4	1		Alternativ	0.8	0.8		0.8	1.6	2
	5	1.25			0.2	0.8				0

Figure 4-9 Weight of Second-Level Factor

First-Level Factor	Weight	Second-Level Factor	Weight
Geography	0.2771	Location of its province	0.8333
		Distance with Shanghai Port	0.1667
Economy	0.4658	Local GDP	0.7500
		Income Per Capita	0.2500
Infrastructure	0.1611	Number of inter-city road & rail	1
Policy	0.0960	Support Policy or not	0.1667
		Develop alternative transport way or not	0.8333

4.5 Standards of grading

There are totally seven criteria will be scored. Full score of each factor amounts to 10. In every dry port cluster, the highest score of GDP and income per capita are scored by 10 and their span of score ranges from 0 to 10. Factor of ‘Location in its province’ witnesses five situations: Center, Inner Ring, Middle Ring, Outer Ring and Borderline. Their score are respectively 10, 8, 6, 4 and 2. Whichever city gets support from the government is qualify for 10 scores in the aspect of policy. The number of main intra-province directly refers to its score in the aspect. Two factors- distance with Shanghai Port and developing alternative transport method or not-are negative in that they play an adverse effect on land carriage. No alternative transportation methods there help the city avoid to be penalized. If it exists, 10 scores have to be deduced. As for the factor of distance, the score equals to the distance divided by -200.

4.6 Establishing Distant Dry Port Cluster for Shanghai Port by AHP

Distant dry port cluster, also called western dry port cluster from the geographical perspective, consists of the dry ports from Sichuan Province, Guizhou Province, Shannxi Province and Chongqing Municipality. From the geographic perspective, Chongqing Municipality will be constructed as HDP, the rest dry ports function as SDP. However, a considerate proportion of areas in southwest are suitable to develop into dry port for a variety of reasons- abrupt topography, backward economy, religious belief and so on. These candidate cities below are suitable and fit to function as dry port.

Figure 4-10 Original Data of Cities in Guizhou Province and Sichuan Province

Province	City	Economy		Geograhpy		Infrastructure	Policy	
		GDP(Billion $)	Income PC(Billion $)	Distance from Shanghai Port (Km)	Location of its province	Number of main inter-province rail & highway	Support(0or1)	Alternative
Gui Zhou	Gui Yang	13.3	2212	1530	Center	5	0	NO
	Zun Yi	10.6	1663	1461	Mid-Ring	6	0	NO
	An Shun	2.64	356	1610	Inner Ring	3	0	NO
Si Chuan	Mian Yang	12.6	2214	1591	Inner Ring	3	0	NO
	Cheng Du	66.2	2744	1673	Center	6	1	NO
	Nan Chong	10.1	134	1473	Borderline	4	0	Water
	Le Shan	9.1	259	1723	Inner Ring	4	1	Water

Figure 4-11 Calculated Data Based on Original Information

Province	City	Economy		Geograhpy		Infrastructure	Policy	
		GDP	Income PC	Distance	Location	Number	Support	Alternative
Gui Zhou	Gui Yang	2	8.1	-7.65	10	5	0	0
	Zun Yi	1.6	6.1	-7.31	6	6	0	0
	An Shun	0.4	1.3	-8.05	8	3	0	0
Si Chuan	Mian Yang	1.9	8.1	-7.96	8	3	0	0
	Cheng Du	10	10	-8.37	10	6	10	0
	Nan	1.5	0.5	-7.37	2	4	0	-10
	Le Shan	1.4	0.9	-8.615	4	4	10	-10

Figure 4-12 Final Result

Gui Zhou			Si Chuan			
Gui Yang	Zun Yi	An Shun	Mian Yang	Cheng Du	Nan Chong	Le Shan
0.13347	-0.23722	-0.24495	-0.55304	2.138073	-2.12792	-2.17454

Consequently, Guiyang is scored the highest mark among all of the candidate regions in Guizhou province, followed by Zunyi and An Shun. Located at the center of Guizhou Province, Guiyang is not far from Chongqing, the distant HDP. It is the largest industrial and economic and the capital of the province. The total distance of its urban road counts up to 3437 kilometers, including 902-kilometer highway. The local government does its utmost to make its inter-province transportation more perfect.

Chengdu is undoubtedly chosen as the dry port in Sichuan Province. Chengdu, which is the capital city of Sichuan Province, functions as the political, economic and cultural center at the provincial level. It is a land area of uniform elevation with relatively hot climate. In 2009, its foreign trade volume equals a total of $29.52 billion, increased annually by 36.9%. Shanghai-Tibet Highway goes through the city whose total urban road distance amounts to 20100 kilometers, including 437-kilometer highway. The local government constitutes a magnificent goal of western logistics and transportation center.

In 2005, Shanghai government, together with Xi-an government, signed the memorandum of co-establishing dry port. By far, $1 billion has been invested on the construction of container yard, highway, railway, service stations and other infrastructure and value-added GDP the project created has run into $54 billion. The huge amount of funds source from three main tunnels: 62% from Shanghai government and corporations, 17% from Xi-an government and corporations and 12% from Singapore Communication Group (China Ports Net, 2009). Xi-an Harbor Authority's target is to develop into TOP 1 among all the national dry ports, relying on rail container freight station, newly-built rail bulk storage yard and peripheral convenient rail & road networks to make it possible to link with coastal ports.

4.6 Establishing Mid-range Dry Port Cluster for Shanghai Port by AHP

The mid-range dry port cluster forms up in Central Plains, including Henan Province, Hubei Province, Hunan Province and Jiangxi Province. The map of China indicates Hubei stands at the front and central part of Mid-range dry port cluster, therefore is

the most suitable to function as HDP.

Figure 4-13 Original Data and Digits of Cities in Henan Province, Hubei Province, Hunan Province and Jiangxi Province

Province	City	Economy		Geograhpy		Infrastructure	Policy	
		GDP(Billion $)	Income PC(Billion $)	Distance from Shanghai Port (Km)	Location of its province	Number of main inter-province rail & highway	Support(0or1)	Alternative
He Nan	Kai Feng	10.9	1765	864	Inner ring	4	1	NO
	Luo Yang	29.9	2158	932	Outer ring	5	0	NO
	Zheng Zhou	48.5	2314	841	Mid-ring	7	1	NO
Hu Bei	Xian Ning	5.97	1558	703	Outer ring	4	1	NO
	Yi Chang	18.3	1725	972	Mid-ring	6	1	NO
	Xiang Fan	17.7	1808	886	Borderline	4	0	NO
Hu Nan	Jin Zhou	10.4	1793.4	893	Mid-ring	3	0	Water
	Yue Yang	17.8	2050	823	Borderline	4	0	NO
	Chang Sha	48.5	2689	893	Mid-ring	7	1	NO
	Xiang Tan	10.8	2114	911	Inner ring	3	1	NO
Jiang Xi	Yi Yang	8.9	1592	928	Center	3	0	NO
	Jiu Jiang	12.2	1800	558	Borderline	7	1	NO
	Fu Zhou	5.4	1785	617	Inner ring	4	1	NO
	Jin De Zhen	4	2153	462	Borderline	5	0	NO

Figure 4-14 Calculated Data Based on Original Information

Province	City	Economy		Geograhpy		Infrastructure	Policy	
		GDP	Income PC	Distance	Location	Number	Support	Alternative
He Nan	Kai Feng	1.6	6.6	-4.32	8	4	10	0
	Luo Yang	4.5	8	-4.66	4	5	0	0
	Zheng Zhou	7.2	8.6	-4.21	6	7	10	0
Hu Bei	Xian Ning	0.9	5.8	-3.52	4	4	10	0
	Yi Chang	2.7	6.4	-4.86	6	6	10	0
	Xiang Fan	2.6	6.7	-4.43	2	4	0	0
	Jin Zhou	1.5	6.7	-4.47	6	3	0	-10
Hu Nan	Yue Yang	2.7	7.6	-4.12	2	4	0	0
	Chang Sha	7.2	10	-4.47	6	7	10	0
	Xiang Tan	1.6	7.9	-4.56	8	3	10	0
	Yi Yang	1.3	5.9	-4.64	10	3	0	0
Jiang Xi	Jiu Jiang	1.8	6.7	-2.79	2	7	10	0
	Fu Zhou	0.8	6.6	-3.09	8	4	10	0
	Jin De Zhen	0.6	8	-2.31	2	5	0	0

Figure 4-15 Final Result

He Nan			Hu Bei				Hu Nan				Jiang Xi		
Kai Feng	Luo Yang	Zheng Zhou	Xian Ning	Yi Chang	Xiang Fan	Jin Zhou	Yue Yang	Chang Sha	Xiang Tan	Yi Yang	Jiu Jiang	Fu Zhou	Jin De Zhen
0.901163	0.682412	3.965497	0.650132	0.750941	1.786609	0.276257	0.061428	2.087371	0.351348	1.689349	0.961579	0.841266	0.369946

Zhengzhou, which is called 'heart of Chinese railway', links with other areas by railway and road. There are two major stations in the city, one of which is the biggest marshalling station in Asia and the other is the largest bulk freight station. The city is also among the seven largest road network cities. So far, the flow can be sealed here. The area is rich affluent coal and ore that is convenient for the construction of rail and road. Thanks to the geographic and traffic advantage, Zhengzhou witnesses a quick economic growth-increased by 12% compared with last year. The local government invests RMB 10million in improving the traffic infrastructure.

Lying on the center of Central China and middle part of Yangtze River, Xiangfan is one of the stations or stops of Jiang-Guang rai line, JingZhu highway and National Highway #106、#107 and #316. Its GDP in 2009 added up to $6 billion, grown by 8.5% compared with last year. Remarkably, several cities in Hubei Province are stronger both in the economic power and at the aspect of infrastructure. Take Wuhan as an example. As the capital of Hubei Province, it is the most developed city in the province beyond doubt. However, its local government pays more attention on waterway and even puts forward 'Strategy of Yangtze River'. To some extent, waterway and land carriage are substitutable, furthermore, the fund of construction is limited.

The Changsha witnesses its GDP amounts to RMB 375 billion, ranking seventh in all of the province capitals alongside the country. Manufacturing industry plays a predominant part in the local economic growth. The result of selection owes to its relatively close distance from HDP and the ability of radiation toward all sides by convenient traffic-totally 193-kilometer highways and six trans-province rail lines.

Compared with other selected dry port, Jiu jiang gets the lowest score in that some

perfect sites have been grabbed by Ningbo port ahead. Jiu Jiang, a northern city of Jiangxi Province, shares an ideal situation but still is confronted with some problems in the traffic infrastructure. The situation warns Shanghai port and government of striving for hinterland as fast as possible, otherwise the golden chance will be wrested in the near future.

4.7 Establishing Close Dry Port Cluster for Shanghai Port by AHP

Close dry port cluster consists of Anhui Province, Jiangsu Province and Zhejiang Province, which lies on the downstream of Yangtze River and possesses the natural advantage of waterway. Therefore, quite a few regions aren't the ideal sites for dry ports. Furthermore, some hinterland has been grabbed by two rivals- Ningbo port and Lianyungang Port. Considering the cargo flow is huge, it is essential to establish several dry ports.

Figure 4-16 Original Data and Digits of Cities in Zhejiang Province and Anhui Province

Province	City	Economy		Geograhpy		Infrastructure	Policy	
		GDP(Billion $)	Income PC(Billion $)	Distance from Shanghai Port (Km)	Location of its province	Number of main inter-province rail & highway	Support(0or1)	Alternative
Zhe Jiang	Jia Xing	28.2	6665	87	Borderline	4	1	NO
	Li Shui	8	3466	345	Mid-ring	4	0	Water
	Hu Zhou	16.4	5796	139	Outer ring	3	0	NO
An Hui	Tong Ling	5.1	2466	350	Borderline	4	0	Water
	Xuan Cheng	6.4	1956	261	Outer ring	4	1	NO
	Chao Hu	7.8	2123	343	Outer ring	5	1	NO
	He Fei	29.4	2523	403	Center	8	1	NO
	Ma An Shan	9.8	2998	287	Borderline	4	0	Water

Figure 4-17 Calculated Data Based on Original Information

Province	City	Economy		Geograhpy		Infrastructure	Policy	
		GDP	Income PC	Distance	Location	Number	Support	Alternative
Zhe Jiang	Jia Xing	9.6	10.0	-0.44	2	4	10	0
	Li Shui	2.7	5.2	-1.73	6	4	0	-10
	Hu Zhou	5.6	8.7	-0.70	4	3	0	0
An Hui	Tong Ling	1.7	3.7	-1.75	2	4	0	-10
	Xuan Cheng	2.2	2.9	-1.31	4	4	10	0
	Chao Hu	2.7	3.2	-1.72	4	5	10	0
	He Fei	10.0	3.8	-2.02	10	8	10	0
	Ma An Shan	3.3	4.5	-1.44	2	4	0	-10

Figure 4-18 Final Result

Zhe Jiang			An Hui				
Jia Xing	Li Shui	Hu Zhou	Tong Ling	Xuan Cheng	Chao Hu	He Fei	Ma An Shan
3.562255	0.562207	3.805714	-0.14149	1.521477	1.4539	5.269699	0.544129

In June 12, 2009, the forum of Quyang ocean-train transportation takes place in Quyang. In the forum, Shanghai port and Quyang have decided to build up the dry port hand in hand. Apart from Quyang, Anhui province has another 16 cities. Based on the criteria of concerned aspects, the scores are given as following (Figure 4-9):

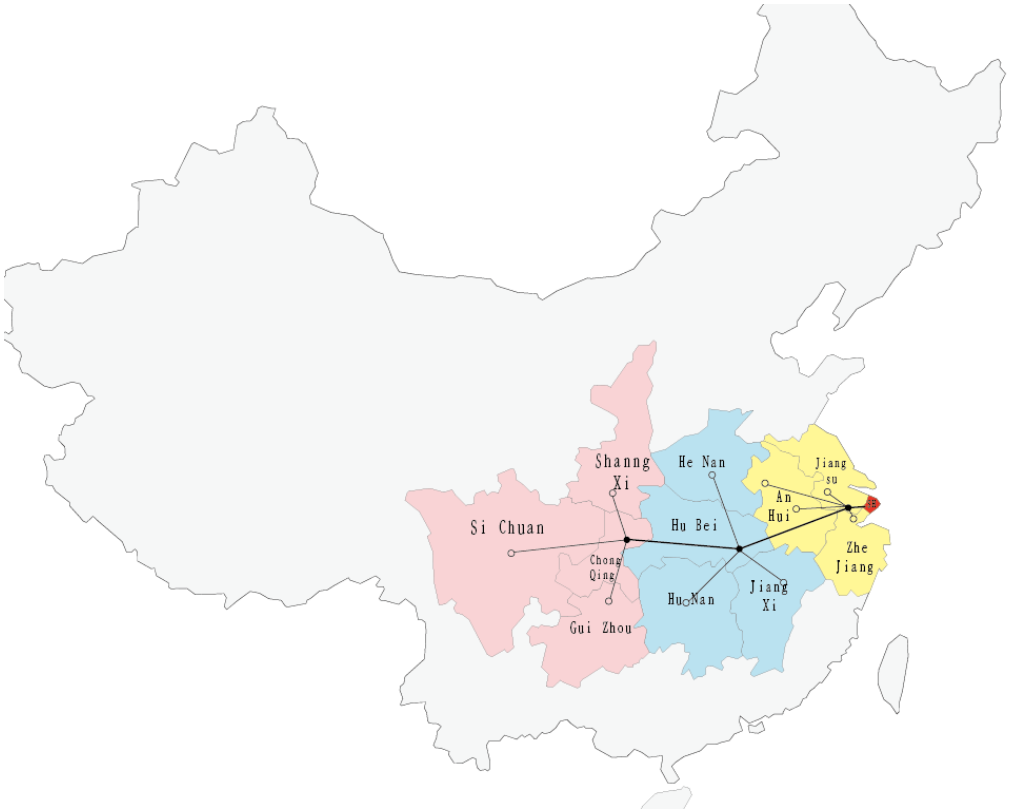
He Fei's GDP accounts for over one-fifth of the whole province. As the capital of province, its traffic links with every corner of its province by national highways, inter-province highways and rail lines. Some other cities overlooking Yangtze-River in Anhui Province equals waterway as land way even attach more weight to the former.

So far, Suzhou and Taicang have become dry port of Shanghai Port. The dry port is built up at the Wuzhong area of Suzhou. Su Zhou is powerful in its economic development with the GDP of $120 billion, ranking the fifth over the country and second in East China. Its transportation is so convenient that it is easily accessible to other areas by highway. Taicang is also an ideal site as a result of its advanced

container yard and enthusiasm in direct export and import.

Huzhou is a front line of reform and opening-up. The local government is engaged in stimulating its overall development of economy, transportation, tourism and trade. Silk cloth is its symbol of city and globally renowned. That is why the orders for silk commodities worth millions of dollars come from all over the world. The huge demand drives the need for high-effective logistics. The final consequence is shown in the chart below:

Figure 4-19 Map of Dry Port Cluster of Shanghai Port



5. Measures to Make Function Shanghai Dry Port Cluster Better

5.1 The Research on the Layout of Dry Port Container Yard

Although dry ports differ from their layouts and features, each must be equipped with the following infrastructure: temporary storage yard for dismounting containers, container yard for storage of empty and loaded containers, look out post for the check-up of import and export containers, staff offices and circulation tunnels for facilities and vehicle.

As is mentioned in Chapter Two, dry port in this case falls into hub dry port and subordinated dry port. The two kinds of dry ports are different in layout mainly because SDP makes function by lorry-in-and-rail-out or rail-in-and-lorry-out but HDP does rail-in-and-rail-out. Furthermore, HDP that functions as the distribution center of SDPs needs much larger operation & storage area. Through the analysis and reference of Corwith Dry Port in Chicago and Qingdao Dry Port, the layout of HDP and SDP are respectively designed in Figure 5-1 and Figure 5-2.

Figure 5-1 SDP Container Yard

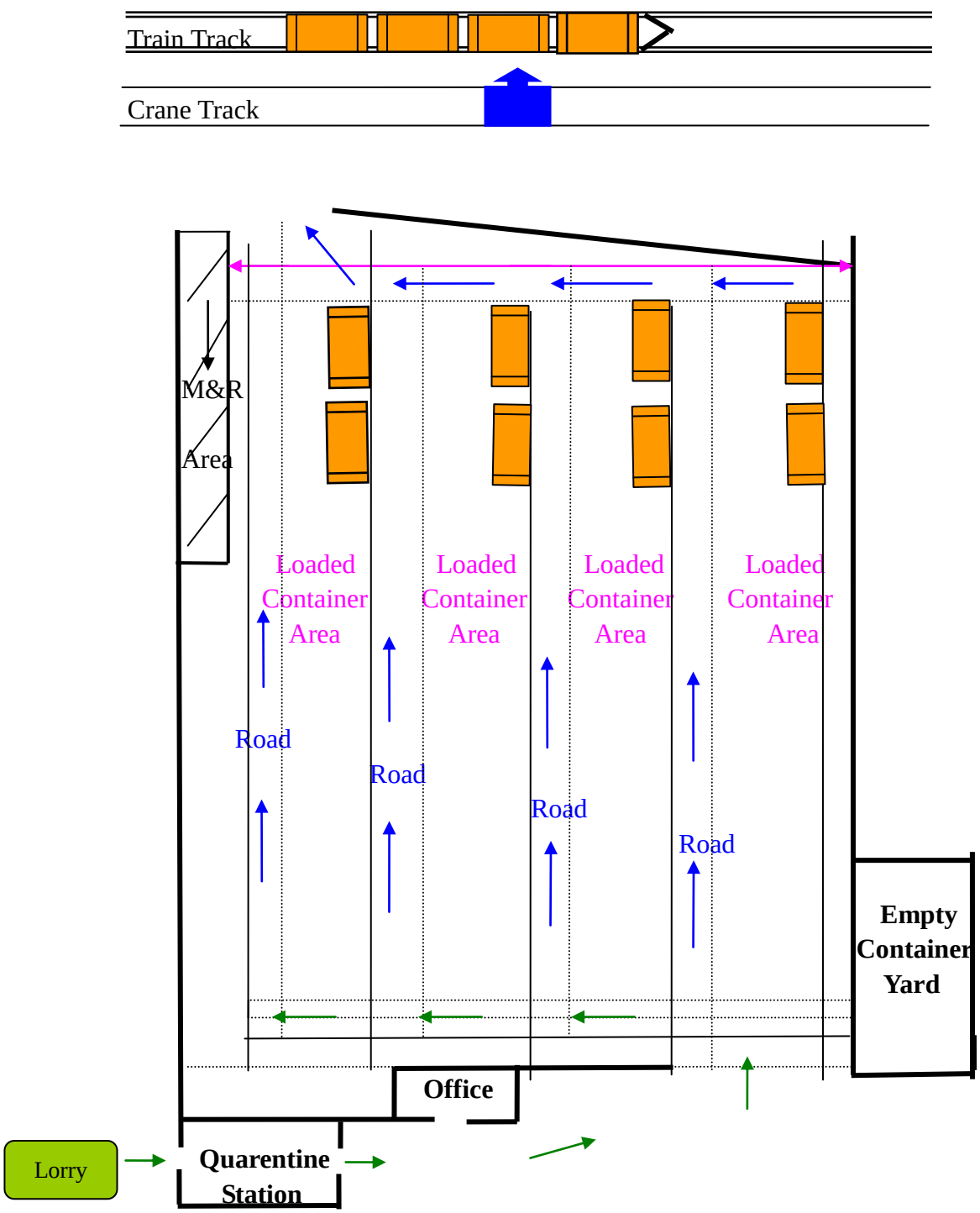
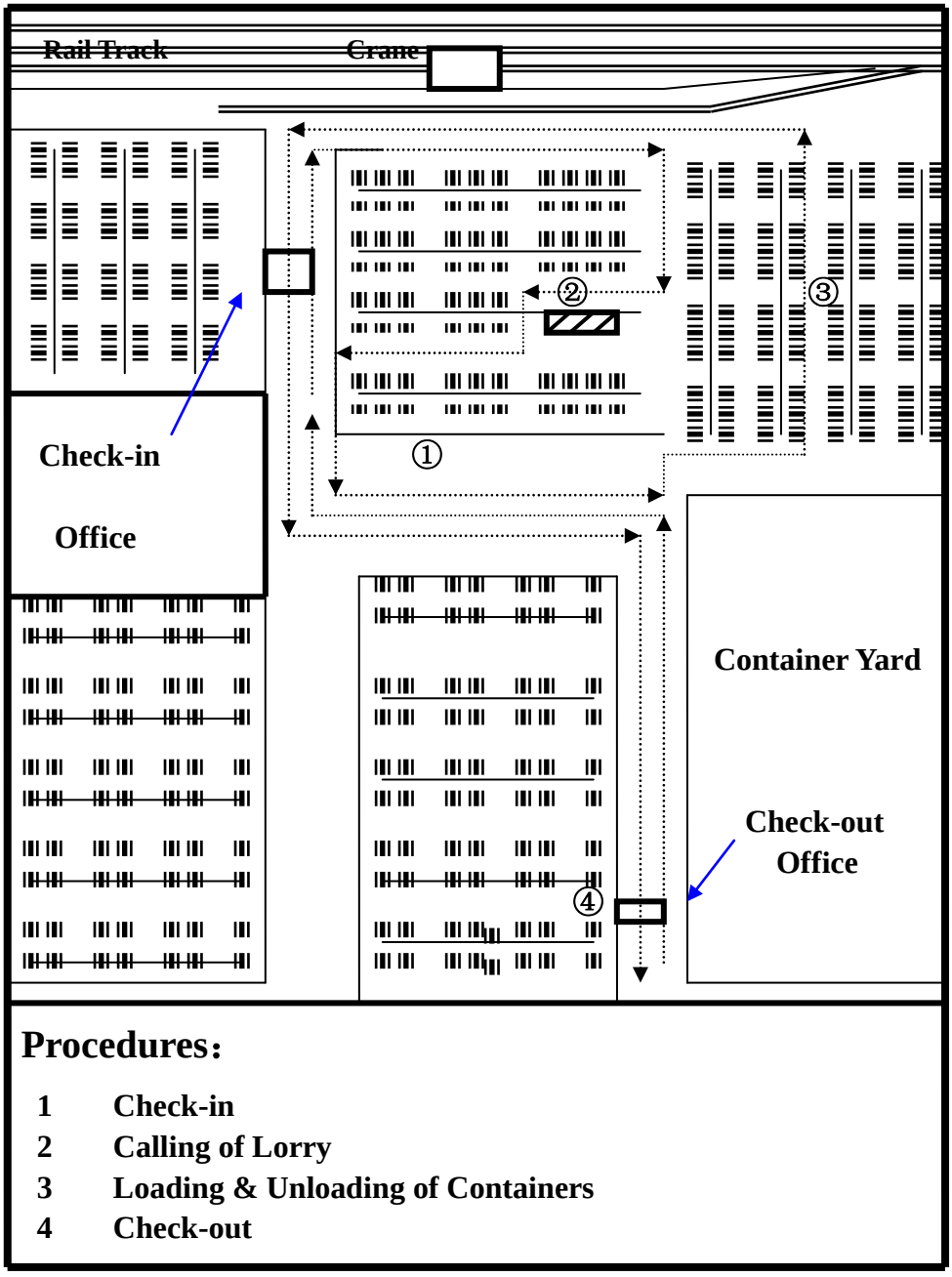


Figure 5-2 HDP Container Yard



5.2 The Installation of EDI System

In the international trade, a large number of documents and contracts about trade and transportation need to be signed, examined, transmitted, receipted and coped with. This mode is inefficient, fund-consuming and error prone. With the popularity and innovation of computer techniques, it becomes a development trend to commence the high-efficient processing and transmission of business & trade intelligence by hi-tech. As a result, the establishment of EDI system is a key link. The followings are the orders for the different parties concerned.

5.2.1 Latest Ship Situation

It is laid down that the ship agent is under the responsibility of informing the port authority of the possible arrival time of ship 72 hours, 48 hours and 24 hours respectively in advance. The contents to be forecasted include name of vessel, nationality of vessel, arrival time, draft forward & after draft, inward & outward cargo description and loading & unloading situation of specials. This information helps the port authority to make a reasonable arrangement shorten turnaround of a ship and cut down its cost. Meanwhile, the ship owners should also master the latest operational situation at berth, berth-waiting time and departure time.

5.2.2 Information about inland container transportation

The landlocked collection and distribution plays a predominant role in international container multi-model transportation. The latest situation of cargos include the position, number and destination port of cargos, which help dry port agent to arrange storage yard and vans in time and consignees to take delivery of commodities.

5.2.3 Information about Supervisory and Release of Containers

The seaport's and dry port's authority are supposed to be informed of customs declaration or cargo report, licenses, receipts and inspection certifications. The transport operators wish port agents to return release information concerned so as to decrease dwell time and increase transport efficiency.

5.2.4 Information about Security and Insurance of Containers

If desired, tally company supply his insurer with the information about overloading and short loading used to audit amount insured. Transport operators communicate with banks by transferring the information on payment and exchange settlement.

5.3 Suggestions for Decision Makers

5.3.1 Suggestions for Shanghai Port Authority

1) building up dry ports according to the criteria of 4G Port

In the new situation must the port make full use of its own merits to make itself larger and stronger, thus make it better to participate in cooperation and division of labor in supply chain and satisfy the needs of its own harmonious and sustainable growth. As a brand-new concept of port, dry port is also no exception. Combining with the functions of 3G port, dry ports should put emphasis on the interaction with its seaport and other dry ports and coordination with other logistics activities in supply chain so as to satisfy the needs of differential service and supply intimate operations and agile service, thus achieving integrated and flexible inland ports and seamless docking among the parties concerned in supply chain.

2) Diversified financing tunnels

The cost of setting up dry port cluster is so enormous to utilize flexible and multiple cooperation methods. For instance, the local government who offers inland and the

seaport authority who invests may cooperate with rail operators who manage with container logistics centers, may do with logistics or manufacturing corporations possessing logistics place and may establish a joint venture with dry ports.

5.3.2 Suggestions for Shanghai Government

1) Accelerating the establishment of transportation infrastructure

Advanced transport infrastructure and rational logistics network of dry port are able to extend the radiating capacity of Shanghai port, make a complete revolution of storage of cargo resource in the interior, expand the scale of Shanghai port and further attract container companies, international freight forwarding agents and international liner service and other transport corporations. The formation of effective and efficient logistic networks requires Shanghai to cooperate not only with other cities and provinces but also with transport ministries, thus making seamless docking among several transport modes.

2) Strengthening the cooperation with inland government

The establishment of dry ports is difficult to succeed without all-out support from inland government including propagation and coordination. In addition, its success also depends on the close cooperation among local customs, quarantine office, railway operators, roadway operators, banks and other departments concerned and ship company and cargo owners' willing to work hand in glove, in which customs' intervention and support is the most vital guarantee. Without the support from the customs would the dry ports lose its vigor and advantages and fail to give full play to its efficiency. For this reason, the support from local government and enterprises, in particular the customs' intervention is the premise of the successful operation of dry ports. A way helpful to promote the cooperation among these concerned departments is to reinforce all parties' comprehensive understanding to dry ports. Meanwhile, it is

the responsibility of Shanghai government to master an overall design.

Conclusion

Combined with actual operational situations of Shanghai Port, this research makes an analysis of site selection of dry ports by AHP. Through the discussion above, the conclusions are as follows:

Pointed to the present problem existing in Shanghai port and the future trend, the establishment of dry ports becomes the priority of the seaport. Shanghai government has the responsibility of making an in-depth research on this project and concerned works so as to stimulate its harmonious and rapid development.

The site selection of dry port that functions as the core of inland container transport network is so vital that it is related with the profits of the government, cargo owner and operators. Furthermore, owing to the variety of the functions of dry port, its site selection relates to a range of domains. The purpose of this research is to carry out a tentative and basic inquiry on the site selection of dry port cluster for Shanghai port.

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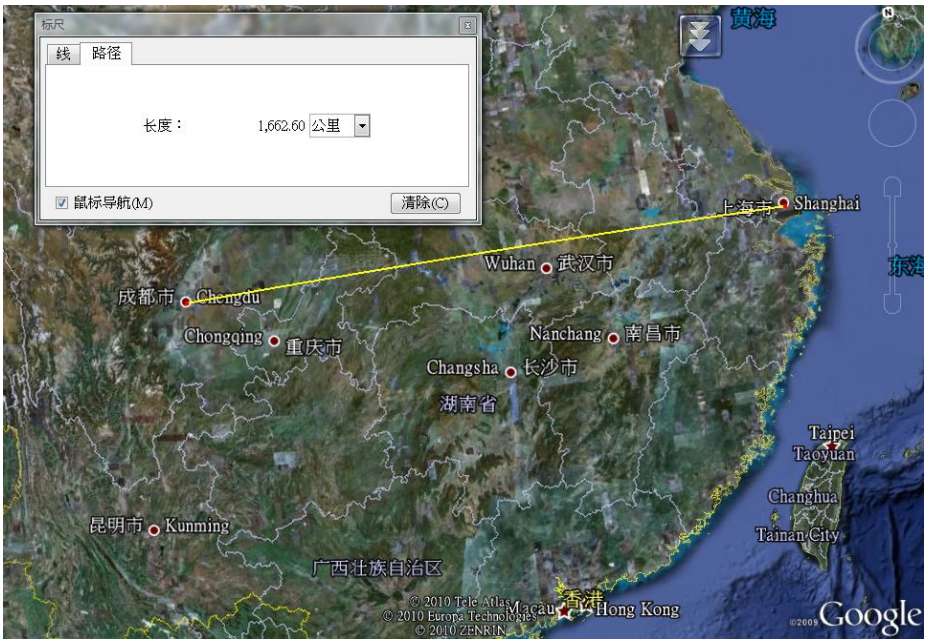
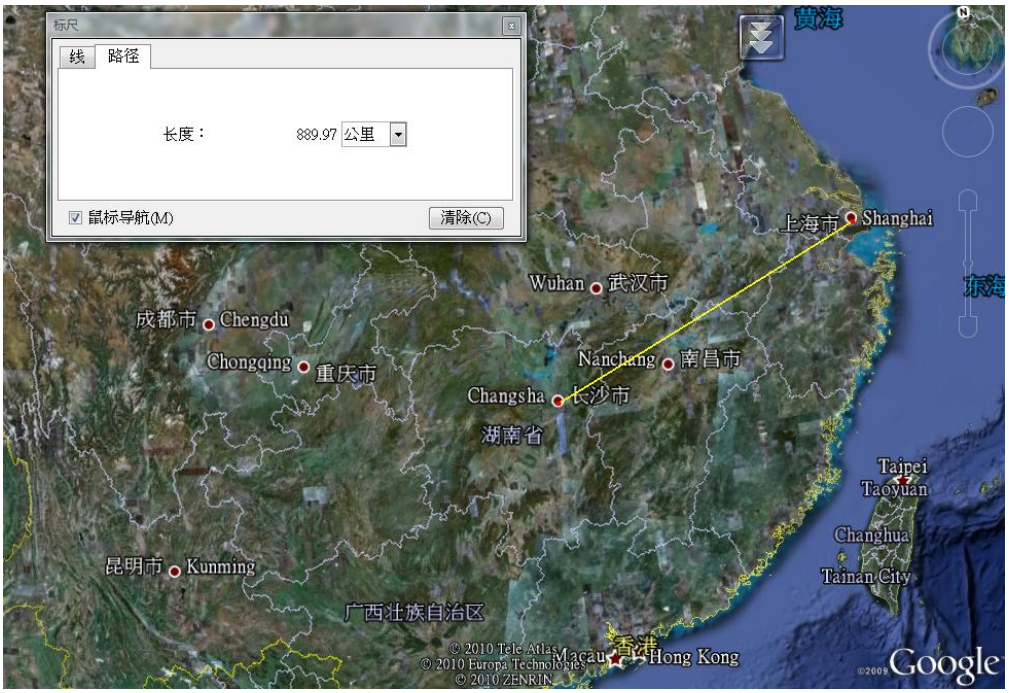
Appendix

Google Earth Software for Measuring the distance between two cities

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Wuhan 武汉市
成都市 Chengdu
Chongqing 重庆市
Nanchang 南昌市
Changsha 长沙市
湖南省
Taipei
Taoyuan
Changhua
Tainan City
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