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INTERNATIONAL SHIPPING HUB COMPETITIVENESS INDEX

NORTHEAST ASIA REPORT

2021

2021

International Shipping Hub Competitiveness Index
Northeast Asia Report


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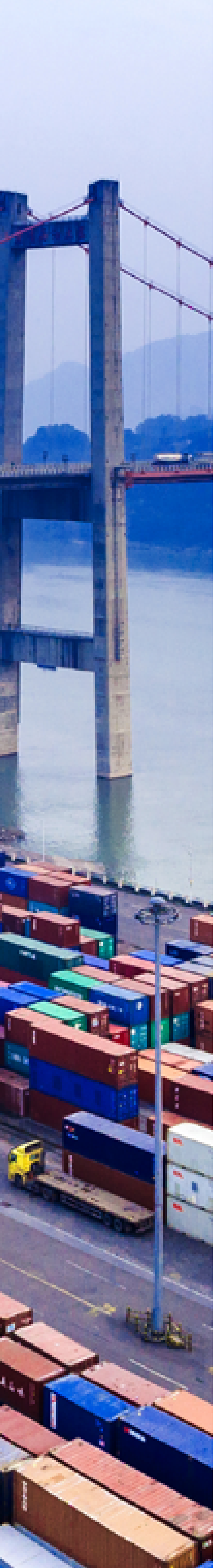

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01 Research Background

With a vast area and abundant resources, Northeast Asia is among the regions of the most energetic economy, and serves as a prime mover of global economic growth. The economies of Northeast Asia include China, Russia, Japan, DPRK, ROK and Mongolia, among which the four economies of China, Japan, ROK and Russia had a total GDP of over 25 trillion U.S. dollars, accounting for 30 percent of the global GDP and a total population of over 1.7 billion people.

The ports within Northeast Asia region mainly include all the ports in Japan and ROK, the far eastern ports in Russia and the coastal ports north of the Yangtze River in China. The construction and development of shipping hubs are of great significance to regional economic development and trade prosperity. Therefore, all economies attach great importance to hub port construction.

Since the early 1990s, ROK began to implement the strategy of developing Northeast Asia logistics centers and vigorously develop international logistics hubs. The third National Port Basic Plan (2011-2020) released by the Ministry of Land, Transport and Maritime Affairs clarified the orientation of Pusan Port as a container transshipment center in Northeast Asia. The ministry also announced the port policy and implementation strategy by 2030 targeting at "realizing smart ports with global competitiveness and high added-value" to expand Korean port and logistics facilities and strengthen global competitiveness. The country will focus on developing Pusan Port to consolidate its position as a logistics hub in Northeast Asia, turn Kwangyang into the strongest integrated logistics port in Asia connected with hinterland industries, and turn the ports along the eastern coast into the frontier base of new energy and logistics.

Japan started the Super Hub Port Incubation Plan since 2004, concentrating on logistics network optimization, port scale expansion and logistics cost reduction so as to attract and collect more cargo sources. To expedite the pace of economic resurrection, Japan further implemented the Container Hub Port International Strategy Program in 2010 that aimed to strengthen infrastructure construction, improve the logistics supply chain supporting facilities and multimodal transport system for container hub ports, and make the Japanese ports bigger and stronger. The medium- and long-term plan of Port 2030 released by the Ministry of Land, Infrastructure, Transport and Tourism also clarifies the targets to further enhance the functions of international strategic container ports, and build world-class ports with better connectivity, intelligence and efficiency.

In recent years, China starts to accelerate the layout and construction of key logistics hubs. In December 2018, the National Development and Reform Commission and the Ministry of Transport jointly published the National Plan on Layout and Construction of Logistics Hubs to speed up the construction of a national logistics hubs network system. By 2025, around 150 national logistics hubs will be built where the port-based national logistics hub cities will focus on connecting with domestic and international shipping routes and port network, and provide their hinterlands and covered regions with logistics services like cargo collecting and distribution, international transshipment, entrepot trade and bonded supervision as well as other value-added services. In February 2021, China issued the Outlines of Planning for a National Comprehensive Three-dimensional Transport Network that clearly required "giving full play to the international hub ports such as Shanghai, Dalian, Tianjin, Qingdao, Lianyungang, Ningbo-Zhoushan, Xiamen, Shenzhen, Guangzhou, Beibu Gulf and Yangpu, consolidating and improving Shanghai's position as an international shipping center, accelerating the construction of shipping hubs with global influence, and advancing the construction of the northern international shipping center in Tianjin, the southeastern international shipping center in Xiamen and the Northeast Asia international shipping center in Dalian."

On November 15, 2020, the treaty of Regional Comprehensive Economic Partnership was officially signed covering the economics of the ten ASEAN countries, China, Japan and ROK in East Asia, and Australia and New Zealand in Oceania. It marked the formation of the largest free trade region in the world that will further eliminate the tariff and investment barriers among the member states, improve the cross-border industries and mutually-complementary trade, and tap the potential of economic and trade vitality within the region, implying significant growth of maritime transportation demand and better development of logistics hubs.

The Northeast Asia region has a cluster of major global shipping hubs i.e. four of the world top ten ports of cargo throughput and three of the world top ten ports of container throughput, thus playing a significant role in the global economic and trade development. For the purpose of evaluating the competitiveness of international shipping hubs in Northeast Asia and boosting their sound and sustainable development, China Economic Information Service (CEIS) started the research on compilation of Northeast Asia International Shipping Hub Competitiveness Index in 2021.

02

Index Connotation

Connotation of international shipping hub

The international shipping hub refers to the port that owns well-established infrastructure capacity and developed shipping routes network, plays a central role in the international shipping networks regionally, and is capable of providing economical, efficient, convenient and integrated transport services for a large amount of goods, thus promoting smooth economic circulation both internally and externally. The international shipping hub is featured with network centrality, i.e. the hub serves as a pivotal node for spatial connection that goods may easily flow from the pivotal node to other nodes of the global network.

Competitiveness of international shipping hub

Based on the aforesaid definition of international shipping hub, its core competitiveness is shown in four major aspects: scale, efficiency, network, green & smart. The scale refers to the hub's capacity and the overall production and operation scale; the efficiency is reflected in the port operation efficiency and the clearance-related service efficiency; the network is demonstrated by the connectivity of the international shipping logistics network and the port collecting and distributing network. Given the new context and regulations on international shipping hubs, the development of green and smart ports is a key measure to improve efficiency and attractiveness as a shipping hub.

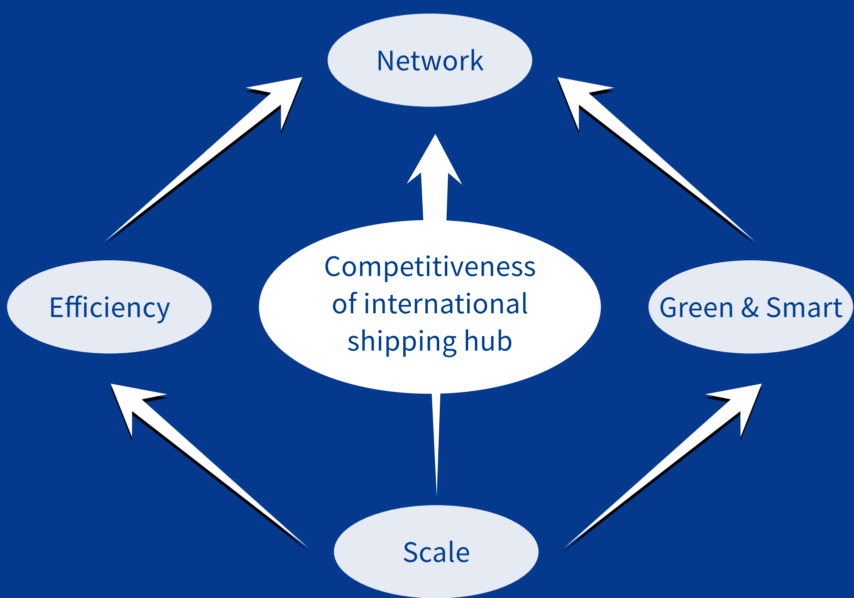

Figure 1 Competitiveness of International Shipping Hub

(1) Large port size

An international shipping hub generally has well-developed hardware facilities with large passage capacity of terminals that can accommodate larger fleets and ensure smooth gathering and distribution of a large number of ships and goods. The port passage capacity of ships and goods is the most straightforward and fundamental competitiveness of an international shipping hub.

(2) Efficient port operation organization ability

Efficient port operation organization ability is the performance of attractiveness and competitiveness of an international shipping hub, guarantees the first-class transport scale, is also one of the core advantages of the port. It is mainly decided by the terminal and berth operation efficiency, and reflected by the waiting time of vessels.

(3) Strong network connectivity

Network connectivity is the essence of international shipping hub competitiveness. A highly competitive international shipping hub generally has densely distributed shipping routes network with extensive connectivity that solicit and attract the flow of a huge number of ships and goods. Meanwhile the well-established and smooth port collecting and distributing network guarantees fast entry and exit of goods, thus achieving scale-up operation.

(4) Active hinterland economy and trade

Hinterland economy and trade demand is a significant pillar for the development of international shipping hubs, and the scales of urban economy and cross-border trade of hinterland cities are of great importance to attracting vessel calls and cargo flow via the shipping hubs. For those hubs with less favorable geographical locations to attract transshipment goods, their survival and growth are highly dependent on the active hinterland economy. Therefore, the vitality of hinterland economy is one of the core competitiveness elements of international shipping hubs.

(5) Favorable business environment at port

The international shipping hub is a provider of trade-related service, and a free and efficient port business environment is decisive to its overall competitiveness. An efficient and convenient port environment is always featured with low cost and short time of port clearance.

(6) High-level intelligence, environmental friendliness and innovation ability

Intelligence and environmental friendliness can effectively enable international shipping hubs to improve service competency, and is an inevitable pathway of sustainability. The intelligent development is realized by the application of new-generation information technology, automation technology, etc. while the green development is realized by the intensified utilization of port resources, application of low-carbon and emission reduction technology, etc. To occupy an advantageous position in intelligence and environmental friendliness brings forth stronger competitiveness and influence for an international shipping hub.

Function and implication of international shipping hub competitiveness index

Based on the connotation and competitiveness performance of international shipping hubs, the International Shipping Hub Competitiveness Index establishes a well-structured evaluation system to evaluate the passage capacity, production scale, hub operation level, network connectivity, business environment, green and smart port development level, urban economic vitality, etc. of the international hub ports (clusters), and quantitatively measures them by index assessment methodology to show the comprehensive port competitiveness of the major shipping hubs in Northeast Asia. The function and implication of the index are:

- Information service: the index shows the development and status of the shipping hub ports in Northeast Asia in an objective and unbiased manner, provides the sequence of their competitiveness, and helps the port enterprises and authorities benchmark their own position, competitiveness and proficiency against other peers.

- Development guidance: the index gives a comprehensive view of pros and cons of the major ports in Northeast Asia as international shipping hubs that may effectively guide the self-diagnosis by local governments and port operators to find the weakness, and pertinently formulate, adjust or update port development strategies. It serves as the basis and insights for these hub ports to cultivate and improve core competitiveness.

03

Index Compilation Methodology

Index design principle

Essence-centered

The index concentrates on the connotation and characteristics of international shipping hubs with definite objects, and accurately shows the intrinsic essence of shipping hubs and their competitiveness, which is "small but beautiful".

Objective and stable

In the design of index, consideration was given to the availability of statistical data and other relevant information. The statistical data regularly released by governmental authorities and authoritative industrial organizations or obtained through big data analysis are objective and stable, which facilitate sustainable and effective tracking evaluation in a long run.

Authoritative and accurate

When determining the indicators of index, the opinions of experts at home and abroad were fully considered, and the descriptions of indicators are accurate, explicit, authoritative and unbiased. Through several rounds of discussion, the data computing and weighing methods are scientific and standardized.

Quantitative and comparative

The comparative common indicators for international shipping hubs were selected rather than some individual characteristic indicators for a certain international shipping hub. The objective quantitative data were collected to avoid any biased comparison due to subjective or objective factors.

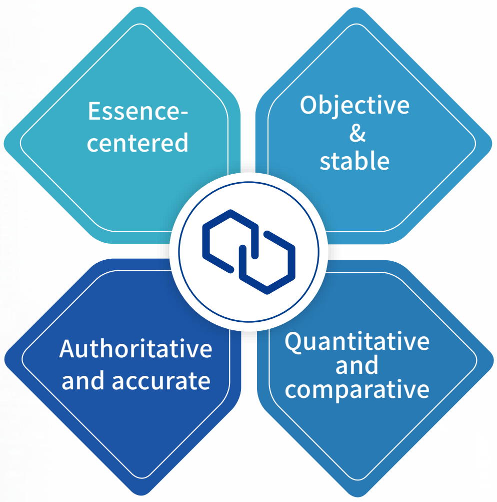

Figure 2 Design Principle of Northeast Asia International Shipping Hub Competitiveness Index

Index system structure

Pursuant to the design principles of international shipping hub competitiveness index and the connotation and competitive performance of international shipping hubs, and through the discussion and confirmation by industrial experts, an index system of objective, quantitative and comparative indicators has been established. All the indicators are sourced from the publicly available data of trusted third-party organizations, the AIS data or those computed by systematic and scientific means, which are all traceable and verifiable.

The indicator system consists of 6 primary indicators and 16 secondary indicators. The primary indicators showing the overall competitiveness of international shipping hubs include hub infrastructure scale, hub operation level, network connectivity, port business environment, smart and green port development, and economic vitality of port city. As detailed extensions of the primary indicators, the secondary indicators with proper representativeness and availability were chosen to illustrate the primary indicators from different perspectives.

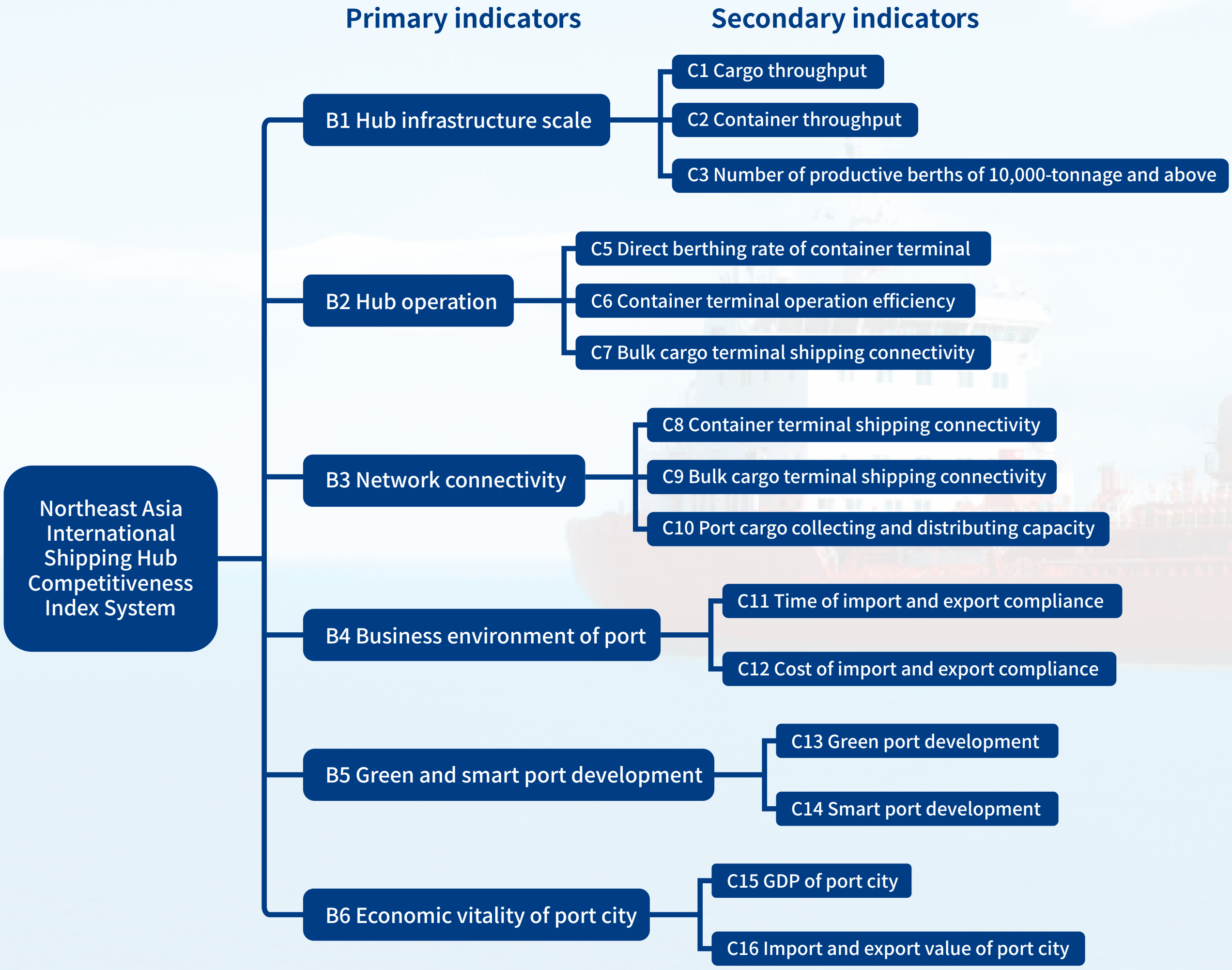

Figure 3 Framework of Indicator System of Northeast Asia International Shipping Hub Competitiveness Index

Descriptions of indicators:

B1 Hub infrastructure scale: it mainly shows the resource endowment of a hub port, and the scale of goods to be handled by the international shipping hub.

C1 Cargo throughput: it refers to the port cargo throughput i.e. the annual port entry and exit cargo volume by water transport and handled by the port.

C2 Container throughput: it refers to the port container throughput i.e. the annual port entry and exit container volume by water transport and handled by the port.

C3 Number of productive berths of 10,000-tonnage and above: it indicates the scale of deepwater berths to accommodate large vessels.

B2 Hub operation level: it mainly indicates the operation efficiency and service level of hub ports.

C4 Direct berthing rate of container terminal: this AIS-data-based indicator refers to the direct berthing rate of container ships arriving at the port, which is the proportion of the number of container ships directly receiving port handling service without waiting against the total number of arriving container ships.

C5 Container terminal operation efficiency: this AIS-data-based indicator reflects the overall service efficiency of hub port for container ships by calculating the annual total time of handling operation for the calling container ships at berths, i.e. the ratio of the annual port container throughput and the total time of ships' handling operation. The unit is TEU per hour.

C6 Bulk cargo terminal operation efficiency: this AIS-data-based indicator reflects the overall service efficiency of hub port for bulk carriers by calculating the annual total time of handling operation for the calling bulk carriers at berths and their total deadweight tonnages, i.e. the ratio of total deadweight tonnages of calling bulk carriers and the total time of handling operation. The unit is tons per hour.

B3 Network connectivity: it comprehensively indicates the service competency of hub port for container and bulk cargo, development level of cargo collecting and distributing network, and market coverage of hub port.

C7 Container terminal shipping connectivity: it mainly measures the number, density, number of connected countries and regions, etc. of container liner services, which is based upon the Liner Shipping Connectivity Index (LSCI) issued by UNCTAD. The Liner Shipping Connectivity Index (LSCI) consists of six objective indicators: number of calling liners, total carrying capacity of calling liners (TEU), number of liner companies, number of liner shipping routes, average size of calling vessel (TEU), maximum size of calling vessel (TEU) and the number of port pairs connected by direct liner shipping service.

C8 Bulk cargo terminal shipping connectivity: it is based on AIS data to indicate the number of port pairs connected by direct bulk shipping service.

C9 Port cargo collecting and distributing capacity: it indicates how reasonable the port's cargo collecting and distributing structure is, and is the sum of all-water cargo transshipment and sea-rail combined transport of containers at the hub port.

B4 Business environment of port: it indicates the port clearance efficiency and service level of hub ports, i.e. the cross-border trade facilitation.

C10 Time of import and export compliance: it is based on the port environment for cross-border trade in the latest Doing Business published by the World Bank, and is the sum of time of import border compliance, time of import documentation compliance, time of export border compliance and time of export documentation compliance.

C11 Cost of import and export compliance: it is based on the port environment for cross-border trade in the latest Doing Business published by the World Bank, and is the sum of cost of import border compliance, cost of import documentation compliance, cost of export border compliance and cost of export documentation compliance.

B5 Green and smart port development: it indicates the competitiveness of hub ports in green and environmental protection and smart innovation.

C12 Green port development level: it comprehensively indicates the green development awareness, the adopted measures and the action results of hub ports. It mainly considers whether the terminals of hub ports win the title of Asia-Pacific Green Ports of the APEC Port Services Network (APSN) and the number of winner terminals. The evaluation system of Asia-Pacific Green Ports measures the green development level of ports in three major aspects: commitment and willingness (green port development awareness and willingness, green port promotion and publicity), action and implementation (clean energy, energy-saving measures, environmental-protecting measures, green management), efficiency and effect (energy-saving performance, environmental-protecting performance).

C13 Smart port development level: it indicates the intelligence degree of hub ports, and measures the innovation and application of smart technologies in ports by calculating the numbers of semi-automated, full-automated and smart berths.

B6 Economic vitality of port city: it reflects the economic and trade vitality of the city where a hub port is located, and the measures how the economic and trade environment supports the development of hub port. The definition of port economic hinterland is a complex comprehensive research topic that in the future the index team will probe into this indicator to optimize the defining method, expand the connotation of economic vitality, and enrich the core factors of flows of people, capital, logistics, information, etc.

C14 GDP of port city: it shows the annual GDP of the city where a hub port is located.

C15 Import and export value of port city: it shows the annual imports and exports of the city where a hub port is located.

Index sampling

The index sampling mechanism follows the regional, representative, objective and typical principle. First, it considers regionalism, concentrates on the Northeast Asian region, and it also considers the representative and objective hub ports that satisfy the data standards of fundamental indicators. In addition, the ports with typical hub characteristics are also included in the sample pool.

Northeast Asia refers to the northeastern part of Asia that generally includes the northeastern region north of the Yangtze River in China, Japan, ROK, DPRK, the Far East region of Russia and Mongolia. Therefore, the sample international hub ports are selected from the above range.

Step 1: the representative ports in Northeast Asia are initially included in the sample pool of ports.

Step 2: the initially selected ports are sequenced in accordance with the cargo throughput scale in 2020, and the top 50 percent of them are selected, then on the basis of which those listed in latest One Hundred Container Ports: Lloyd's List are taken as the selected samples.

Step 3: For those not included in the selected samples, which, despite smaller throughputs, play a pivotal role in their national or regional economic development and offer premium services, after consultation with experts, it has been decided whether to include them in the sample pool.

Through the aforesaid three steps, the sample international shipping hub ports in Northeast Asia are finalized.

Table 1 Ports in Index Sample Pool

No.	Name of port	Country
1	Tangshan	China
2	Qingdao	
3	Tianjin	
4	Rizhao	
5	Yantai	
6	Dalian	
7	Yingkou	
8	Jinzhou	
9	Lianyungang	
10	Nantong	
11	Huanghua	
12	Pusan	ROK
13	Kwangyang	
14	Inchon	
15	Yokohama	Japan
16	Nagoya	
17	Tokyo	
18	Vostochniy	Russia


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04

Evaluation Results

Comprehensive evaluation and analysis

Tiered evaluation

Based on the final evaluation results, the sample ports are divided into four tiers. Tier I includes the ports scoring 70 and above, i.e. Qingdao, Pusan and Tianjin are indisputably the international shipping hubs in Northeast Asia with leading network connectivity, operation performance and infrastructure scale. Tier II includes the ports scoring 50 and above e.g. Tokyo, Dalian and Nagoya, they are not much different from each other. Some of them may have outstanding performance in a certain indicator, but lag behind the Tier I ports as a whole. Tier III includes the ports scoring less than 50, which may have their respective focuses. Tier IV includes the ports scoring less than 40 that implies big development space for them to extend their presence and influence in Northeast Asia.

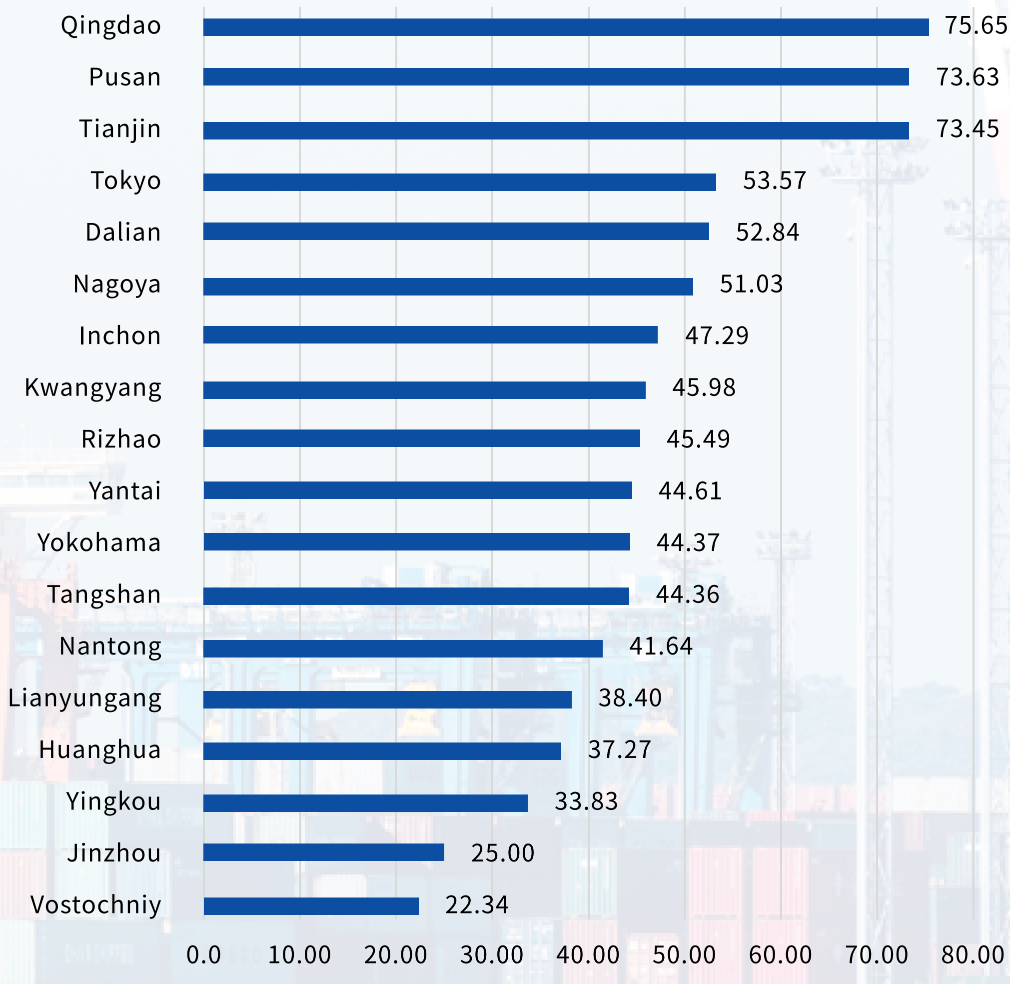


Figure 4 Tiered Evaluation Results of Northeast Asia International Shipping Hub Competitive Index

Evaluation of individual indicators

With respect to the infrastructure scale, Qingdao Port enjoys the most prominent advantage of infrastructure supporting capacity. The sample ports have greatly variant performance that more than 50 percent of them are lower than the average score. Qingdao ranks No.1 with the highest score of 93.90. Among the sample ports, Tangshan registered the largest cargo throughput in 2020 (700 million tons), followed by Qingdao (600 million tons). The top three ports of container throughput are Qingdao (22.01 million TEU), Pusan (21.81 million TEU) and Tianjin (18.35 million TEU). On the whole China's hub port infrastructure is larger than that in Japan and ROK. All the sample ports in Japan, ROK and Russia except Pusan are scored less than the average level.

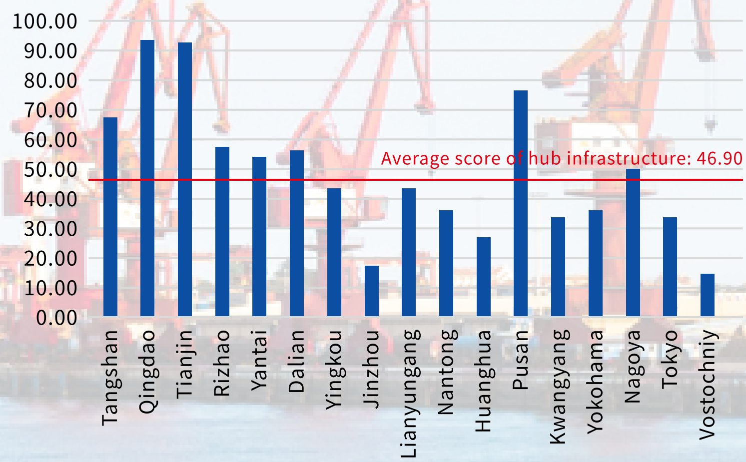


Figure 5 Infrastructure Scores of International Shipping Hubs in Northeast Asia

Table 2 Production Scale of Northeast Asia International Shipping Hubs in 2020

Name of port	Cargo throughput (mil tons)	Container throughput (mil TEU)
Tangshan	702.60	3.12
Qingdao	604.59	22.01
Tianjin	502.90	18.35
Rizhao	496.15	4.86
Yantai	399.35	3.30
Dalian	334.01	3.12
Yingkou	238.21	5.65
Jinzhou	106.41	1.64
Lianyungang	241.82	4.80
Nantong	310.14	1.91
Huanghua	301.25	0.73
Pusan	410.52	21.81
Kwangyang	273.27	2.15
Inchon	151.78	3.26
Yokohama	93.62	2.66
Nagoya	168.52	2.47
Tokyo	82.88	4.75
Vostochniy	77.40	0.45

With respect to hub operation level, Qingdao Port has the highest comprehensive operation level, followed by Pusan, Tianjin, Rizhao and Kwangyang. With respect to operation efficiency, driven by the maturing automation technology, the berth handling efficiency repeatedly hit new peaks. Nevertheless, due to the global pandemic in 2020, a number of hub ports like Pusan, Qingdao and Tianjin incurred port congestion and the average vessel waiting time was extended.

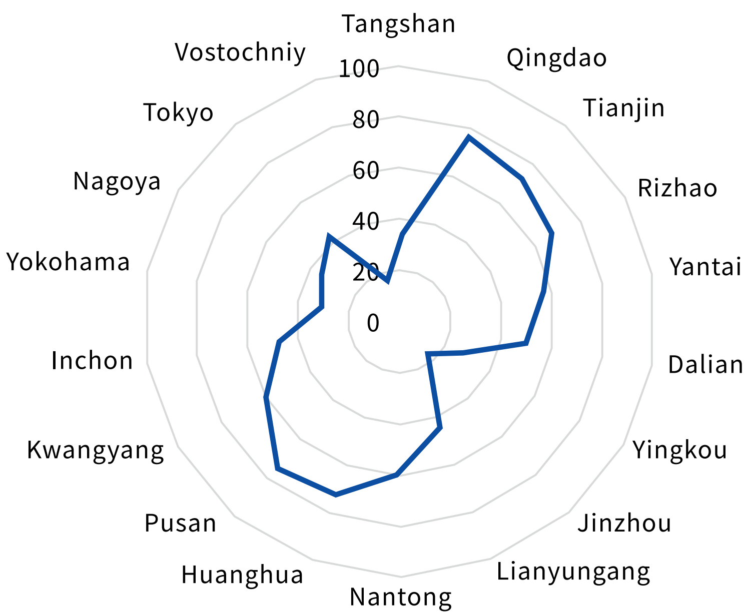


Figure 6 Scores of Hub Operation Service Capabilities of Northeast Asia International Shipping Hubs

For the network connectivity, the top five ports are Pusan > Qingdao > Tianjin > Dalian > Nagoya. Among the top ten ports, there are four Chinese ports, three Korean ports and three Japanese ports. For specific indicators, Pusan Port holds the leading position in terms of container shipping connectivity, bulk cargo shipping connectivity and port collecting and distributing capacity. In the LSCI released by UNCTAD, Pusan and Qingdao ranked fourth and sixth by 119.15 and 97.03 scores, showing strong competitiveness in the global container transport network.

Table 3 Top Ten Northeast Asia International Shipping Hubs of Network Connectivity

Ranking	Name of port	Score	Country
TOP 1	Pusan	98.30	ROK
TOP 2	Qingdao	85.27	China
TOP 3	Tianjin	81.34	China
TOP 4	Dalian	77.29	China
TOP 5	Nagoya	53.27	Japan
TOP 6	Tokyo	52.36	Japan
TOP 7	Kwangyang	48.52	ROK
TOP 8	Yokohama	46.62	Japan
TOP 9	Tangshan	40.97	China
TOP 10	Inchon	36.34	ROK

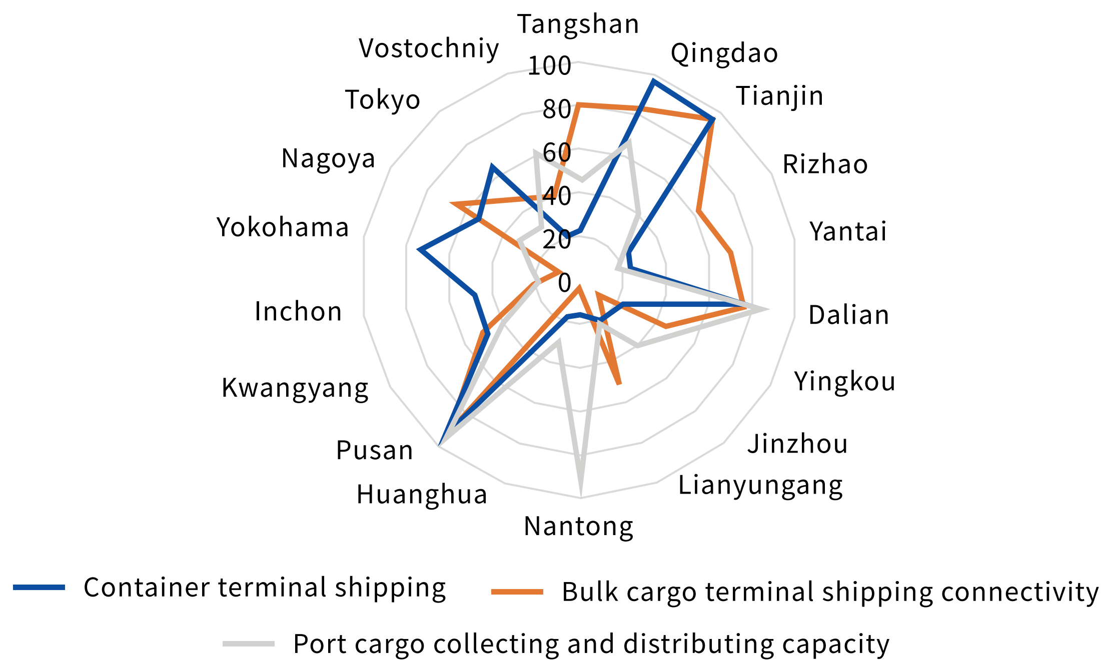


Figure 7 Scores of Detailed Indicators of Network Connectivity of Northeast Asia International Shipping Hubs

Under the indicator of smart and green port development, the top five hub ports are Qingdao (83.18), Pusan (80.27), Tianjin (66.24), Lianyungang (50.52), Tangshan (48.86) and Inchon (48.86). Driven by the emerging automation and intelligence technologies, the shipping hubs start smart-oriented transformation to improve port operation efficiency and service level. The hub ports in ROK and Japan like Pusan, Nagoya and Tokyo started early in automated terminals. For instance Nagoya Port has built up a fully-automated TCB container terminal in 2005. Although starting late, China sustains the boom of smart port development that several domestic ports like Qingdao and Tianjin are all equipped with automated container terminals with world-class automation levels. With regard to the green port competitiveness, in 2020 the terminals in Qingdao and Tianjin won the title of Asian Pacific Green Port. Highlighted by the launch of a zero-carbon terminal in Tianjin and the progression of a zero-carbon emission demonstration zone in Rizhao, the ports in China have strengthened the decarbonization efforts and become greener.

2016	2017	2018	2019	2020
Bangkok Port, (Thailand)	Bintulu Port (Malaysia)	Port of Bangkok (Thailand)	Port of Laem Chabang (Thailand)	Kai Tak Cruise Terminal (Hong Kong, China)
Jurong Port (Singapore)	Chiwan Container Terminal (China)	Jurong Port (Singapore)	Lianyungang Xinsu Terminal (China)	Port Kelang (Malaysia)
Ningbo Zhoushan Port Beicang No.2 Container Terminal (China)	Johor Port Authority (Malaysia)	Kai Tak Cruise Terminal (Hong Kong)	Port of Taichung (Taipei, China)	Port of Hualian (Taipei, China)
Port Klang (Malaysia)	Batangas (the Philippines)	Port of Singapore (Singapore)	Qingdao Qianwan United Container Terminal (China)	Port of Singapore (Singapore)
Singapore Port (Singapore)	PSA Singapore Terminals (Singapore)	Port of Cagayan de Oro (the Philippines)	SBCP (Malaysia)	Qingdao Port Dongjiakou Ore Terminal (China)
Tanjung Palapas (Malaysia)	Shekou Container Terminal (China)	Xiamen Hairun Container Terminal (China)	Port of Matarani (Peru)	Cai Mep International Terminal (Vietnam)
Qinhuangdao Port No.6 Port Company (China)	Cat Lai Port (Vietnam)	Taipei Port (Taipei, China)	Peru LNG Melchorita Terminal (Peru)	Tianjin Port Alliance International Container Terminal (China)
		SIPG Shandong Container Terminal (China)		Zhangjiagang Port Group Gangsheng Bulk Cargo Terminal (China)
		Xiamen Ocean Gate Container Terminal (China)		

Figure 8 List of APSN Asian Pacific Green Ports in 2016-2020

With respect to the port business environment, the Korean ports have higher level of cross-border trade facilitation, followed by the Chinese, Japanese and Russian ports. Pusan Port of ROK conducts integrated supervision of port handling area, free trade area and industrial economic processing area so that the transshipment goods can be exported without filing, and thus the cargo flow is fast, convenient and efficient. With respect to the economic vitality of port city, the sample ports of Tokyo, Yokohama and Nagoya in Japan are all within the international metropolitan circles that the huge economic scale brings abundant cargo sources for the ports, thus well maintaining their competitiveness.

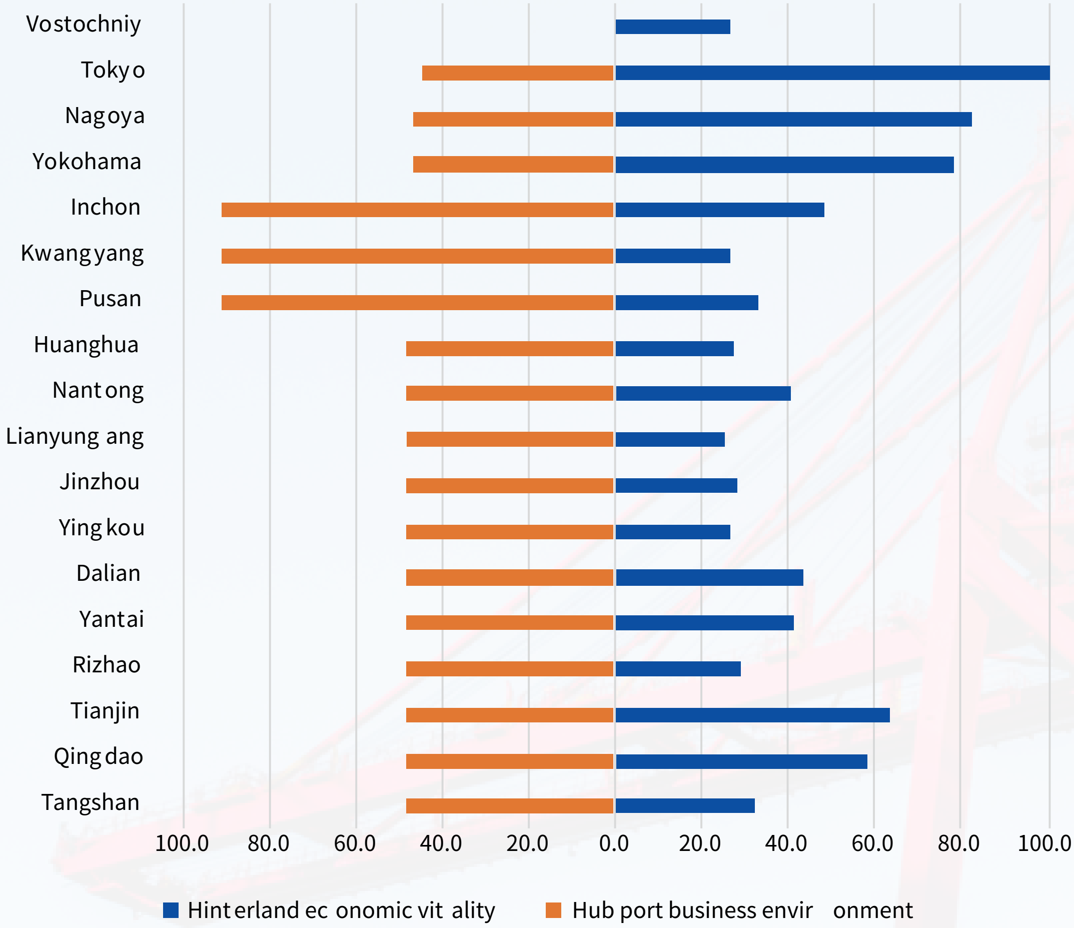


Figure 9 Scores of Port Business Environment and Urban Economic Vitality of International Shipping Hubs

Competitiveness analysis of major international shipping hubs

Qingdao Port: absolute strength of infrastructure scale and strong comprehensive competitiveness

Located at the intersection of the Belt and Road, Qingdao Port owns world-class infrastructure and outstanding port conditions among the peers in Northeast Asia. This natural deepwater port has planned and built up the first-class terminal facilities for larger fleets that its giant deepwater terminals can accommodate the largest container ship, ULCC (450,000DWT) and VLOC (400,000DWT).

Its container service scale is bigger than that of Pusan and ranks first in Northeast Asia. In the context of integrated port development, Qingdao makes good use of the platform of Shandong Port Group to increase shipping routes, expand transshipment scale and enlarge cargo capacity that bucks the trend and maintains upward momentum. In 2020, Qingdao's cargo throughput registered 605 million tons with a year-on-year increase of 4.7 percent, ranking fifth in the world by overtaking Singapore Port. Its container throughput reported 22.01 million TEU with a year-on-year increase of 4.7 percent that for the first time surpassed Pusan Port, ranking sixth in the world and first in Northeast Asia.

Qingdao Port is accelerating the pace of turning from a gateway port to a hub port, and ranks first in northern China in terms of both quantity and density of shipping routes that connect 700+ ports in 180+ countries and regions. With 20 newly-added container shipping routes in 2020, Qingdao's ranking is only next to Hong Kong in the LSCI list, the sixth in the world and No.1 in northern China. Qingdao boasts a well-established cargo collecting and distributing system. Its sea-rail combined transport network covers the whole country and extends to Central Asia and Europe. In 2020, the share of sea-rail clean transport of commodities like iron ore in Qingdao Port reached 78 percent, and the sea-rail combined transport volume registered 1.708 million TEUs, ranking first among all coastal ports in China.

Qingdao Port boasts strong competitiveness of intelligent development and a leading position in green development level in Northeast Asia. It owns the full-automated container terminal - Qianwan container terminal capable of realizing whole-process automated operation. Its berth operation efficiency keeps making new records, 50 percentage points higher than the average efficiency of worldwide terminals of the same type. Qingdao is always committed to building a green port that its new Qianwan container terminal and Dongjiakou ore terminal won the title of Asia Pacific Green Port. So far the berths at Qingdao Port are 100-percent connected with shore power that supplies over 2,300 vessels per annum. Meanwhile all the berthing tugboats in the harbor district are connected with shore power that the annual power consumption by calling vessels and tugboats exceeds 2,000MWh.

In the National Plan on Layout and Construction of Logistics Hubs, Qingdao is positioned as "four types" of national logistics hub city of seaport, airport, productive service, commerce and trade service, the most diversity among the logistics hub cities in China. Qingdao Port will take advantage of the big platform of Shandong Port Group to increase shipping routes, expand capacity, enlarge transshipment, build land ports and broaden cargo sources, and target at an international shipping center in Northeast Asia with extensive international influence and competitiveness.

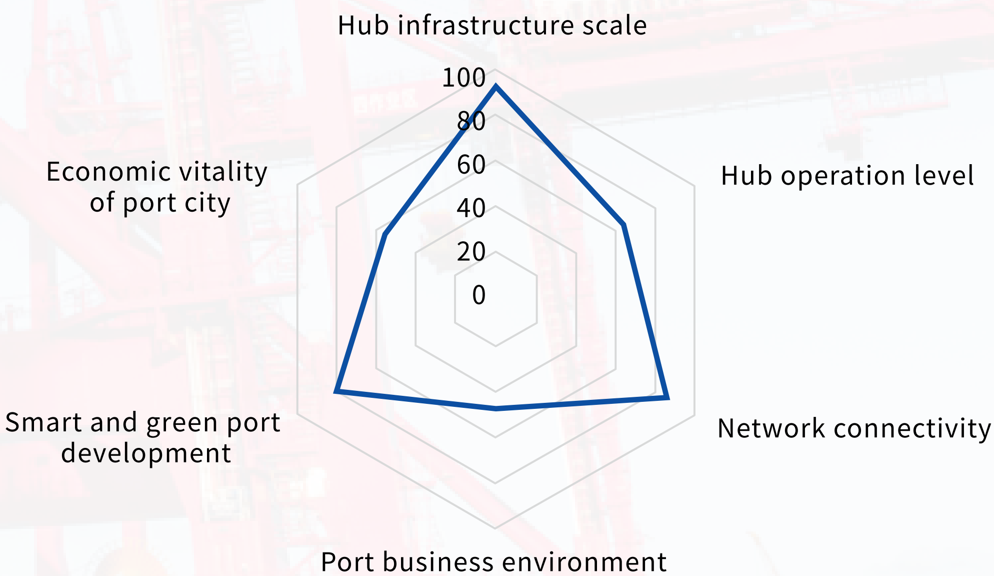


Figure 10 Competitiveness of Qingdao Port by Indicator

Pusan Port: top connectivity of hub network and unparallel international liner transshipment service

Pusan, ROK's largest port, has excellent geographical location and infrastructure conditions, and concentrates on container transport. It has broad deep waters with a coastline of 202 km long, and the depth of main fairways reaches 15 to 17m. As the seventh busiest container port in the world, Pusan has two major container logistics centers, i.e. North Port and New Port, and totally 40 container berths, handling 75 percent of the country's container volume. The daily handling volume exceeds 59,000 boxes. In 2020, Pusan accomplished a total container throughput of 21.81 million TEU, slightly down by 0.8 percent due to the impact of COVID-19.

Through years of development, Pusan has turned out to be the international shipping hub with the best connectivity in Northeast Asia. In the latest LSCI issued by UNCTAD, Pusan ranks fourth in the world and holds an overwhelmingly advantageous position in Northeast Asia. As a free trade port with high facilitation of cross-border trade, Pusan owns a dense network of shipping routes connecting 500+ ports in 100+ countries and regions. It runs totally 269 liner service routes with a sailing schedule of 2,000+ voyages/month, and each year handles about 12 million TEU of on-carriage containers, a proportion of over 55 percent. Pusan Port attaches great importance to the marketing promotion of container transshipment service and the strategic partnership with other ports that a dedicated port marketing association has been founded to promote its international container logistics service, thus maintaining steady growth of international container transshipment throughput.

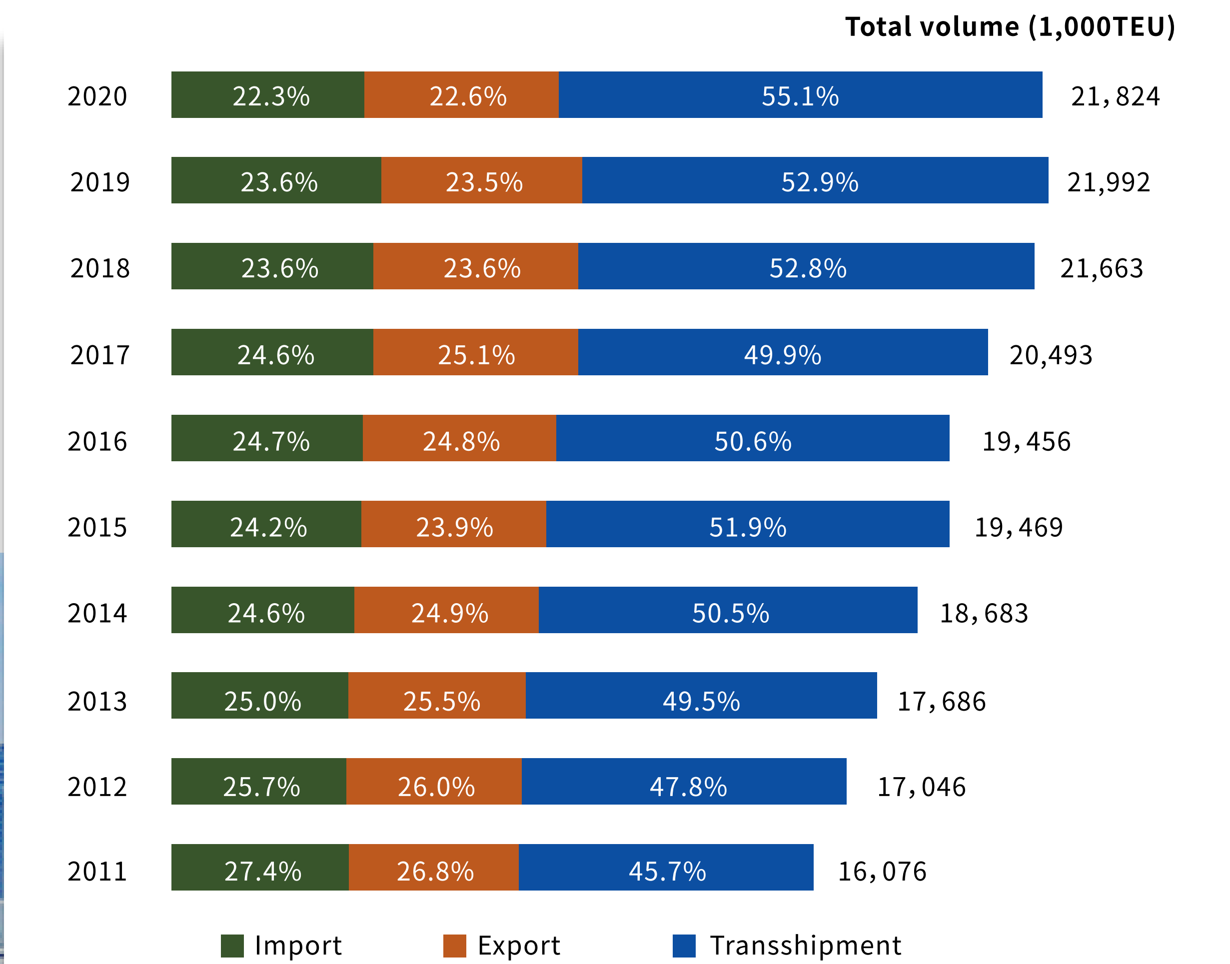


Figure 11 Proportions of Cargo Transshipment at Pusan Port in 2011-2020

Pusan had an early start of building automated terminals and has built up over 20 automated berths. Since 2008, Pusan has built up a number of semi-automated terminals e.g. Hanjin terminal, HMM terminal, New Port PNC terminal and BNCT terminal, of which the PNC terminal is the largest one in Pusan Port and the semi-automated "ARMG + trailer" is applied in horizontal transport. The New Port BNCT terminal is the first automated container terminal deployed vertically to the coastline in Asia, and "ARMG + SHC" is applied in horizontal transport.

The city of Pusan has a relatively small economy scale so that the port development is heavily dependent on transshipment. To improve and consolidate the competitiveness as a transshipment center, Pusan Port expedites resource integration and port infrastructure construction. According to its development strategy by 2030, the container service function of North Port will be relocated to the New Port for centralized international container logistics operation. The New Port will have 45 container berths, and plan to increase the share of transshipment goods from 50 percent to 60 percent, becoming the world second largest transshipment port with dense logistics network.

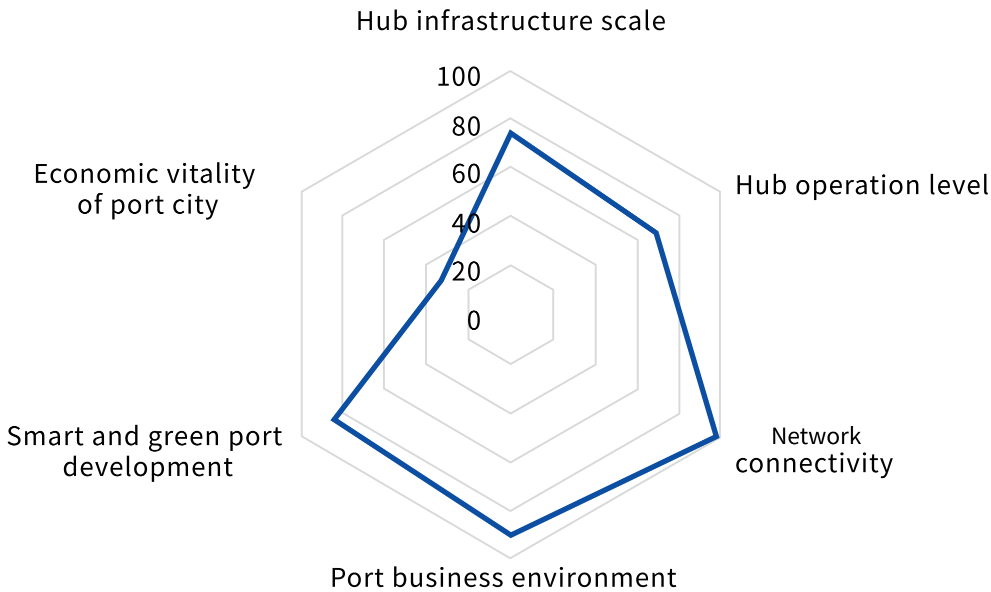


Figure 11 Proportions of Cargo Transshipment at Pusan Port in 2011-2020

Tianjin Port: favorable infrastructure conditions and improving hub connectivity

Tianjin Port is highly competitive for its good infrastructure conditions and rapid growth of container service. As a world-class artificial deepwater port and a modern integrated port, Tianjin Port has favorable infrastructure conditions with 22m depth of fairways that can accommodate 300,000DWT vessels. It owns 173 berths including 128 berths of 10,000 tonnages and above. Though its container throughput is lower than that of Qingdao and Pusan, Tianjin Port remains among the top ten ports in the world with an ascending trend. In 2020, Tianjin's container throughput was 18.35 million TEU, up 6.1 percent year on year, which hit a new high and ranked eighth in the world by surpassing the port of Hong Kong.

Tianjin Port has fairly good network connectivity and its perfecting logistics network covers the northeast, north and northwest China. The port operates 130 container shipping routes with over 550 voyages each month, and maintains trade relations with 800+ ports in 200+ countries and regions. Tianjin Port further deepens the pivot-feeder interaction with the ports in Hebei Province, and the Tianjin-centered network of Bohai Rim feeder service has taken shape that the 19 feederline routes cover all major ports in the Bohai Rim area. The port also consolidates the logistics collecting and distributing network system by deploying more than 20 inland dry ports, opening new channels of sea-rail combined transport and expanding the hub coverage. In 2020, its sea-rail container throughput exceeded 800,000 TEU with a remarkable year-on-year increase of over 40 percent, a new historical record.

Tianjin speeds up the building of a smart and green hub port. In 2020, it achieved the scale-up operation of unattended electric truck fleets, the largest fleet scale in the world, and the physical operation of unattended whole-process operation

of the transformed traditional container terminal, which lowers the per unit energy consumption by 20 percent and uplifts the overall efficiency by 20 percent. In addition, Tianjin Port Alliance International Container Terminal was listed in Asia Pacific Green Port that keeps improving the green development level by energy mix optimization, "highway to railway" plus "dry bulk to containerization", targeted pollutant control, etc. In October 2021, the intelligent container terminal at C section of Beijiang Port District, Tianjin was officially launched into operation that the first "smart zero carbon" terminal in the world plays an exemplary role in the intelligent upgrading and low-carbon development for global ports.

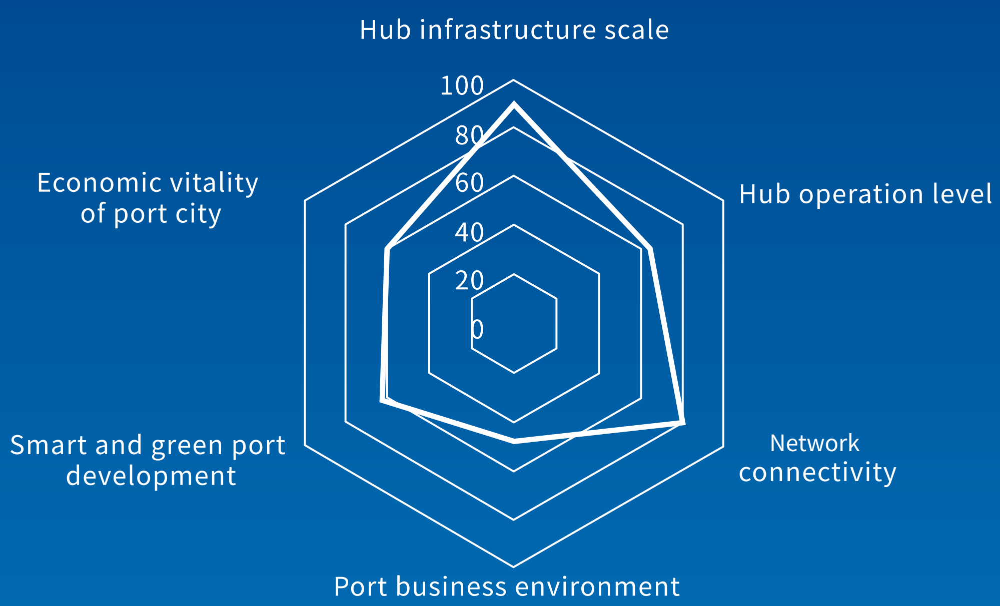


Figure 13 Competitiveness of Tianjin Port by Indicator

Tokyo Port: prosperous hinterland economy and trade, and prominent regional strategic advantage

The city where Tokyo Port is located has the best economic vitality in Northeast Asia. Tokyo is the capital and a center of economy, culture, politics and transportation of Japan, and thus Tokyo Port has unparallel strategic advantages of politics, economy and geographical location. Tokyo Keihin Industrial Zone has the most concentrated factories and plants, mainly electrical and mechanical manufacturers, which together with the developed secondary industry serve as a prime mover of sustainable port development. In 2020, Tokyo Port accomplished a total cargo throughput of 80.88 million tons and a container throughput of 4.75 million TEU, maintaining the top position among the container ports in Japan for consecutive years.

Tokyo Port has an extensive network of shipping routes that its 96 container trade lanes of the four major container terminals i.e. Oi terminal, Aomi terminal, Shinagawa terminal and the terminal outside central breakwater extend shipping routes to China, ROK, South Asia, North America and Europe, connecting Tokyo with the world. According to the eighth port planning amendment, Tokyo Port is actively exploring the international trunk routes to Europe, America and Asia, and intends to further improve the overall logistics efficiency and enhance the global competitiveness by developing new facilities and restructuring and upgrading of the existing terminals.

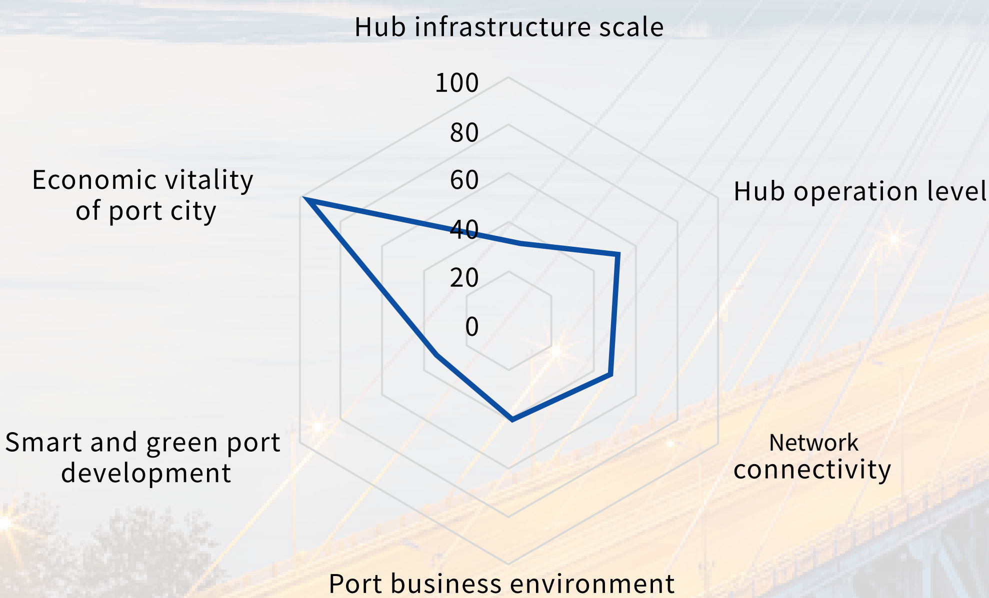


Figure 14 Competitiveness of Tokyo Port by Indicator

Dalian Port: frustrated production scale and challenged port development

As a major hub of national integrated transport system and a major coastal port, Dalian Port enjoys complete infrastructures and the advantageous location at the heart of the Northeast Asia economic circle. It has 12 port districts including "one island and three gulfs" and over 200 production berths, more than half of which are above 10,000 tonnages. The port runs over 100 container trade lanes covering 300+ ports in 160+ countries and regions, which is the most important container hub port, ore distribution center, grain transshipment center, petroleum and liquid chemical storage and distribution base in Northeast China.

However, Dalian's throughput gets frustrated for years due to the inadequate economy and trade vitality of the northeast hinterlands and the streamlined business under strategic adjustment. In 2020, Dalian's cargo throughput reported 334.01 million tons, down 8.8 percent year on year; its container throughput was 5.11 million TEU, a plunge of 41.7 percent. Dalian started late in construction of an intelligent port. Its conversion project of automated container yards was put into operation in 2020, and its smart transformation needs to speed up.

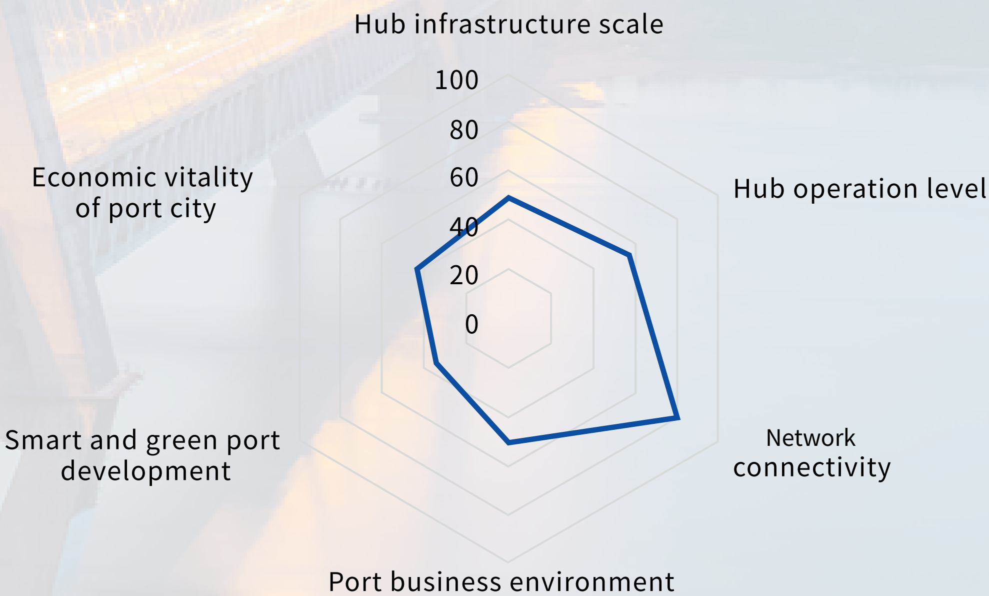


Figure 15 Competitiveness of Dalian Port by Indicator

Nagoya Port: developed hinterland industries but network connectivity below average level

Located Port in the central part of Japan, Nagoya is the biggest integrated port in this country capable of handling all types of goods. The city of Nagoya has well-established industries and world-renowned enterprises of automobile, industrial machinery, aviation and aerospace, electrical machinery, etc. The industrial output value of Aichi-ken, the place where the port is located, ranked first in Japan since 1977. As the cradle of Japan's auto industry, Nagoya Port is the biggest export place of automobiles in Japan that shipped about 1.4 million vehicles a year. In 2020, Nagoya's cargo throughput was 168.52 million tons and the container throughput was 2.47 million TEU.

Nagoya Port has trade relations with over 170 countries and regions, and established friendly partnership with the port operators like SIPG, Port Authority of Thailand and Port Authority of Zeebrugge, but its competitiveness indicator of network connectivity is below the average level. The port started early to build smart berths. Its TCB terminal is the first full-automated container terminal in Japan, and one of the most advanced container terminals widely recognized by the world.

To improve hub service level and maintain international competitiveness, the local government keeps advancing infrastructure construction and updating port equipment. In the future, Nagoya Port will focus on its competitiveness in five major aspects: logistics, industry, communication, environment and safety, and target at an international hub port of high connectivity, attractiveness, added value, safety and environmental friendliness for the port-related manufacturing industries.

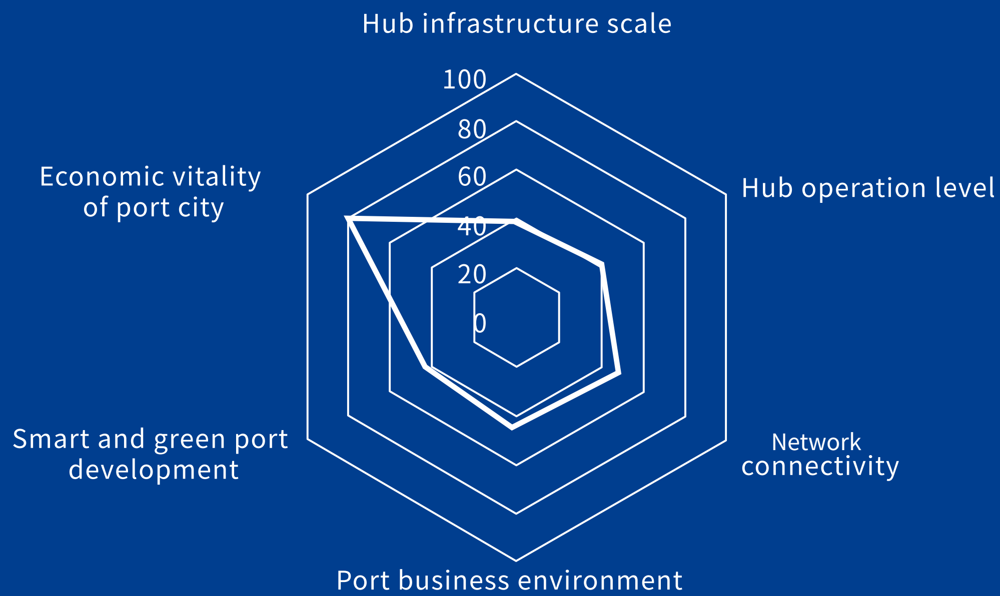


Figure 16 Competitiveness of Nagoya Port by Indicator

Rizhao Port: a major hub of bulk commodities with good port operation performance in the Bohai Rim port cluster

Situated at the southern coast of Shandong Province, Rizhao Port has favorable natural conditions and an annual passage capacity of over 400 million tons. The port mainly handles bulk commodities like metal ore, coal and grain that the import volume of iron ore ranks first among China's coastal ports, and holds the leading position in China in terms of the throughputs of coke, wood chip, bean, dried cassava, etc. In 2020, Rizhao's cargo throughput totaled 430 million tons, an increase of 7.6 percent year on year while the container throughput was 4.86 million TEU, up 8 percent. It had eight types of cargo with annual throughput over 10 million tons, five of them ranking No.1 in China.

Rizhao Port is highly competitive for its unparallel efficiency of dry bulk handling in China that the handling efficiency for a single ore carrier reaches 9,786 tons/hour and that of a coal carrier reaches 9,486 tons/hour. The port is experiencing rapid smart and green development. In October 2021, the first open and parallel-type fully-automated container terminal was launched at Rizhao port. The successful practice of independent science and technology innovation by the Chinese ports provides a "Chinese model" for worldwide ports to convert traditional terminals into fully-automated container terminals, and is of exemplary significance for the automated container terminals to usher in a new era of low cost, short construction period and quick investment return. The construction of smart and green dry bulk terminals at Rizhao Port is also underway. In addition, the port keeps improving its cargo collecting and distributing system that in 2020 it newly developed 6 domestic and foreign trade lanes, and the sea-rail combined transport volume soared up by 41.5 percent over the previous year. It targets at a comprehensive logistics hub for boosting the Belt and Road Initiative, a key hub of energy and raw materials in northern China and a coastal hub of domestic container transport.

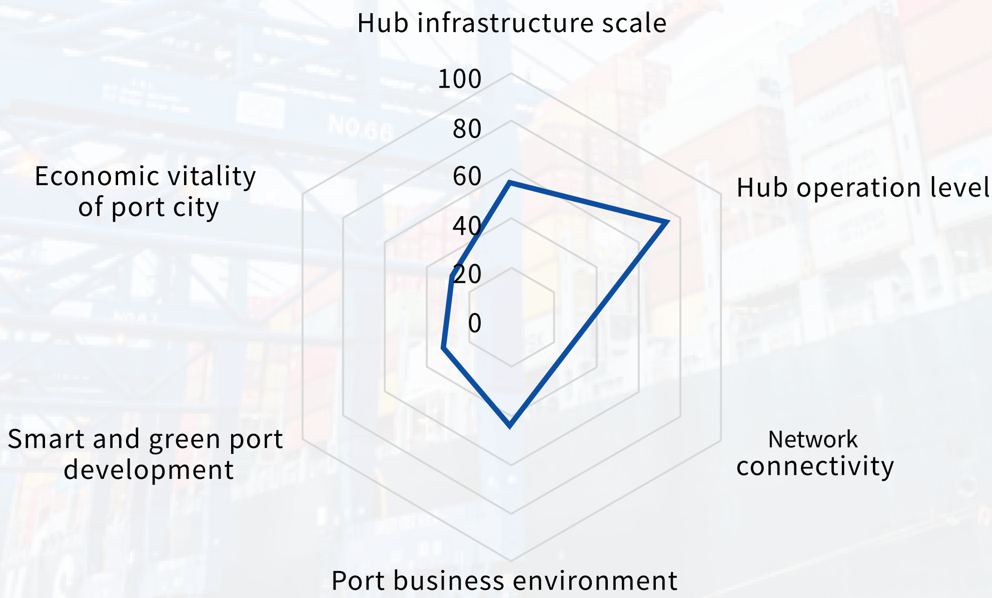


Figure 17 Competitiveness of Rizhao Port by Indicator

Yantai Port: prominent advantage of characteristic bulk cargo service and reinforced role as a hub

Yantai has been a major coastal trade port in northern China since ancient times, and a critical pivotal node of the Chinese 21st-century Maritime Silk Road. It has well-established port infrastructure such as the 400,000DWT ore terminal, 300,000DWT crude oil terminal and 2.71 million cb.m tanks, and the berths of 10,000DWT and above accounted for about 66 percent. Yantai maintains stable growth of port production with considerable potentials. In 2020 Yantai Port completed a total cargo throughput of 399.35 million tons with a year-on-year increase of 3.4 percent while its container throughput was 3.3 million TEU, a y-o-y increase of 6.4 percent.

Yantai Port concentrates on the bulk cargo handling like bauxite, liquefied oil products, metal ore, coal and chemical fertilizer, among them, bauxite and chemical fertilizer have traditional advantages, and remains the No.1 port of bauxite and chemical fertilizer imports and exports in China for a long time. So far, Yantai Port maintains shipping and trade relations with 150+ ports in 100+ countries and regions, and gradually forms a modern logistics system for imported energy, total logistics of bauxite, container transshipment, fertilizers, commercial vehicles, etc. The intensified network of shipping routes to Japan and ROK highlights the role of hub port at the southern coast of the Bohai Gulf.

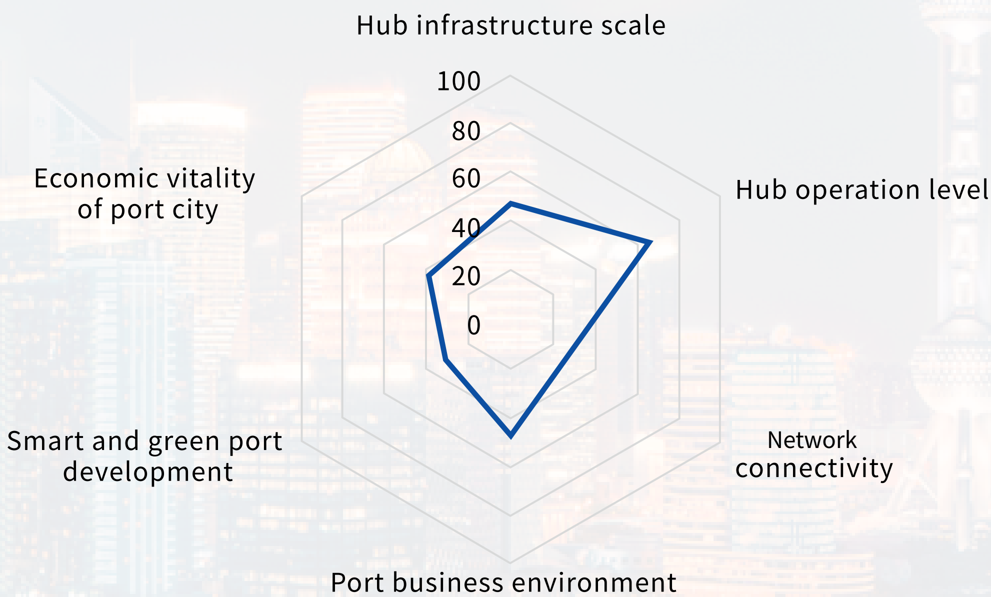


Figure 18 Competitiveness of Yantai Port by Indicator

Kwangyang Port: good business environment and prioritized industrial needs in hub construction

As the port with the largest import and export throughput and the second largest cargo throughput in ROK, Kwangyang Port is located south of Pusan and in the coastal Yeosu region, the southernmost part of ROK. Connected with 122 ports globally, it has superior natural conditions and its fairways with a water depth of over 20m can accommodate the largest container ships in the world. In 2020, Kwangyang Port completed a cargo throughput of 270 million tons, down 11.8 percent year on year and its container throughput was 2.15 million TEU, down 9.4 percent.

Backed by the developed industrial parks and the biggest steel manufacturer POSCO, Kwangyang Port takes a leading position in steelmaking and chemical sectors. In the medium- and long-term plans, the port will take advantage of its adjacency to hinterlands to improve infrastructure, accelerate the construction of automated container terminals, expand production and service capacity, and aim to build a "Port of Rotterdam" in Northeast Asia and a multi-purpose logistics hub to drive the national economic growth.

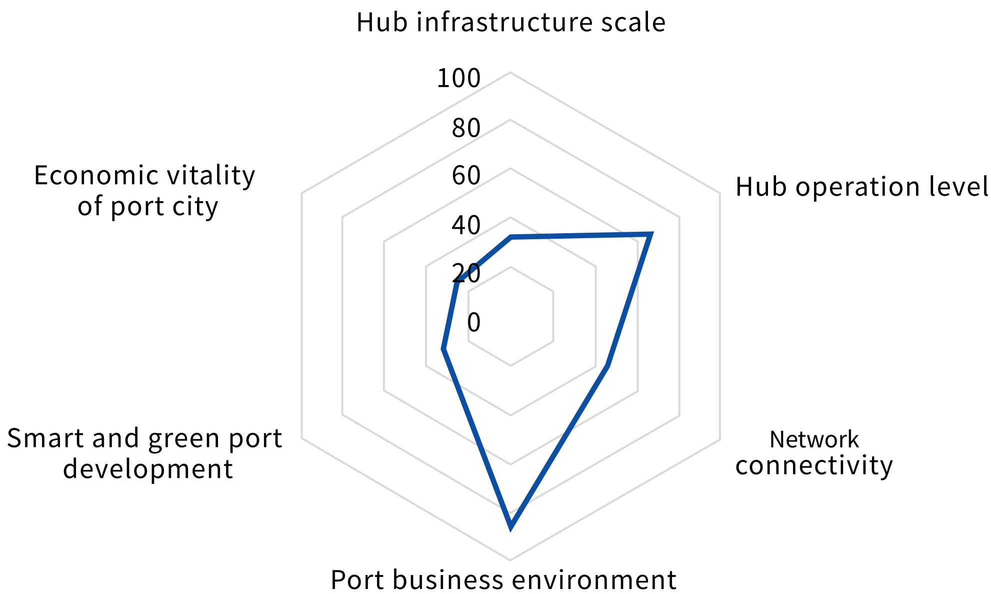
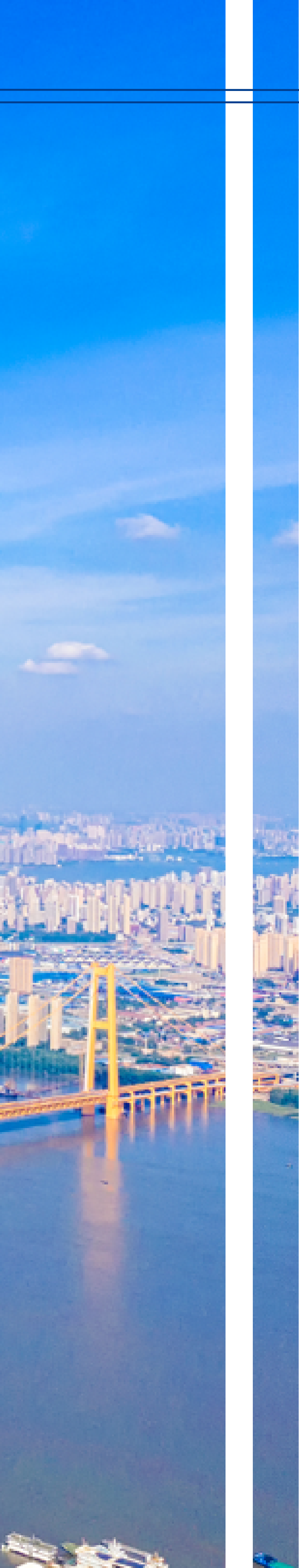


Figure 19 Competitiveness of Kwangyang Port by Indicator



Tangshan Port: No.1 cargo throughput and expanding port influence

As the largest import ore handling port, the largest steel export gateway, the largest coal and energy export port, a major oil and gas import base and storage center in China, Tangshan has excellent conditions of hardware facilities, and its cargo throughput ranks first in Northeast Asia. By the end of 2020, Tangshan Port owned 129 berths of 10,000DWT and above and a designed annual passage capacity of 654 million tons. In 2020, Tangshan's cargo throughput totaled 702 million tons, up 7 percent year on year, ranking second among the worldwide coastal ports, and its container throughput was 3.12 million TEU, up 5.8 percent.

The port keeps expanding its presence and influence globally, and connects with 190+ ports in 70+ countries and regions by 228 shipping routes. In 2020, with 6 incremental inland ports, Tangshan totally had 38 inland ports. The China-Japan-ROK-Mongolia international trains are in regular operation that 50 freight trains departed from Tangshan in 2020, an increase of 25 percent over the previous year.

Though the intelligent operation is at a low level, Tangshan now actively advances digital transformation. Through the remote operation system, the cargo handling services like unattended driving of container trailers and automatic unloading at yards are available. In the future, Tangshan Port will spare more efforts on 21 smart port programs e.g. "5G + unmanned container truck" to further improve the port operation efficiency and service level.

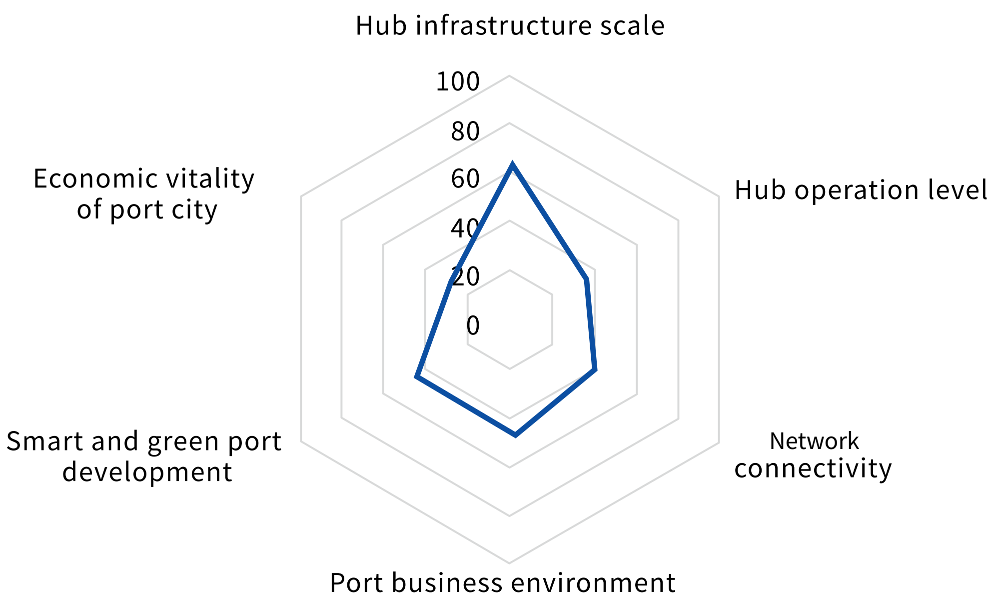


Figure 20 Competitiveness of Tangshan Port by Indicator

Vostochniy Port: Russia's major gateway in the Far East but with weaker competitiveness

As the destination of the Siberian continental bridge, Vostochniy Port lies in the northwest coast of the Sea of Japan and is Russia's largest and deepest port in the Far East region. However, it is not quite competitive in Northeast Asia and in particular gets the lowest scores in the indicators of hub infrastructure scale, operation level and business environment.

Vostochniy Port is operated by eight independent terminal handling companies. Vostochniy Port Holdings Company runs the largest high-tech coal transshipment terminal (JSC terminal) in Russia. In 2020, the terminal's coal transshipment volume reached 26.85 million tons that accounted for 15 percent of Russia's total coal exports. Vostochniy container terminal is mainly operated by VSC with annual handling capacity of about 650,000 TEU. As the largest container terminal in the Far East region of Russia, it owns three rail transit areas and provides all-round handling, transshipment and warehousing services. For green development, Vostochniy Port Holdings Company implements a comprehensive environment plan to minimize the exposure of coal to exterior environment and curb its pollution. With respect to smart development, the port now owns two automated terminals (JSC terminal and VNT terminal) with satisfactory cargo handling efficiency.

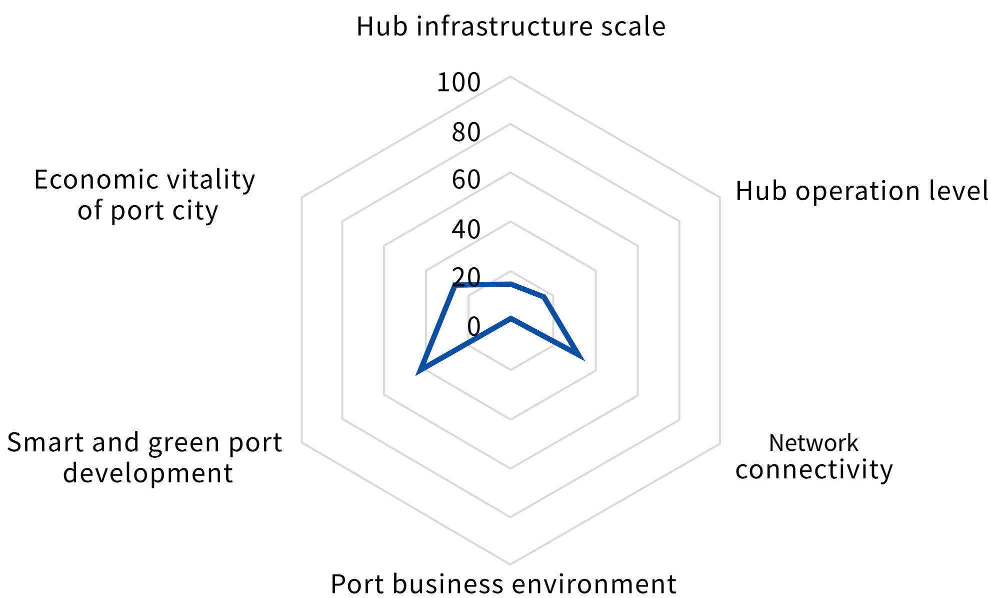


Figure 21 Competitiveness of Vostochniy Port by Indicator


87.2%
33%

05

Index Computation Methodology

Index data processing

Owing to the differences of indicator attribute, unit of measurement, numerical magnitude and form of relative number, comprehensive assessment and analysis cannot be performed directly, and thus each indicator needs to be non-dimensionalized to remove the dimensional influence.

Also known as data standardization and normalization, the non-dimensionalization is a mathematical transformation method to remove the dimensional influence of original variables. Based on regularity of data distribution, the index performs non-dimensionalization processing of the underlying statistical data through standard deviation normalization, which is to calculate the standard value of each indicator of each city by the mean value and variance. The formula of the standardized value of the mth indicator (positive indicator) of the pth port city is as below:

$$x_{i,j,p} = \phi\left(\frac{z_{i,j,p} - mean_{i,j}}{sd_{i,j}}\right)$$

$$mean_{i,j} = \sum_{p} z_{i,j,p}$$

$$sd_{i,j} = \frac{1}{a-1}\sum_{p=1}^{a}(z_{i,j,p} - mean_{i,j})^2$$

Where i and j stand for the primary and secondary indicators respectively, $x_{i,j,p}$ is the standardized value of the p^{th} port under the j^{th}secondary indicator, $z_{i,j,p}$ is the actual value of the p^{th} port under the j^{th} secondary indicator, $mean_{i,j}$ is the mean value of all sample ports under the j^{th} secondary indicator, $sd_{i,j}$ shows the standard deviation of all sample ports under the j^{th} secondary indicator, and $\phi(\ )$ is the distribution function of the standardized normal distribution. Hence for the negative indicator, its formula is as below:

$$x_{i,j,p} = \phi\left(\frac{mean_{i,j} - z_{i,j,p}}{sd_{i,j}}\right)$$

Method of weight settings of index system

The system of Ningbo-Zhoushan Sea-rail Combined Transport Development Index applies the combined subjective + objective weight method.

1 Subjective weight

The Delphi method, a subjective weighting method, was applied in the weights of primary indicators of index system. Through rounds of consultation with experts for their comments and feedback, the weights of primary indicators were sorted out, summarized and calculated.

2 Objective weight

The entropy value method, an objective weighting method, was applied in the weights of secondary indicators of index system.

The concept of entropy is derived from thermodynamics that measures the system status uncertainty. More information means less uncertainty and smaller entropy, while less information means more uncertainty and bigger entropy. Given the characteristics of entropy, the calculated value of entropy can be used to judge how random and disorder an event is, and measure the dispersion of an indicator. Bigger measures of dispersion means its greater influence on the overall evaluation results, and leads to bigger weight. As an objective weighting method, the entropy value decides weights on the basis of measures of dispersion of actual indicator values that avoids the deviation caused by manmade factors. However, it ignores the importance of the indicator itself, and thus the weights need to be properly adjusted in line with experts' comments.

The basic steps of entropy value method are:

1. Calculating the entropy value of system

$$E_j = -k \sum_{i=1}^{m} P_{ij} \ln (P_{ij})$$

Where $\kappa = 1/\ln(m)$ shows the contribution of the ith solution under the jth attribute, and the constant value is $\kappa = 1/\ln(m)$.

2. Calculating the difference coefficient

$$D_j = 1 - E_j$$

Where D_j is the difference coefficient.

3. Calculating the weight of entropy value

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

Where j=1,2,⋯,n.

Calculation method of composite index

By linear weighted summation, the scores of international shipping hubs in Northeast Asia are calculated. After standardized data processing and determination of indicator weights, the values of primary indicators are calculated by weighted summation:

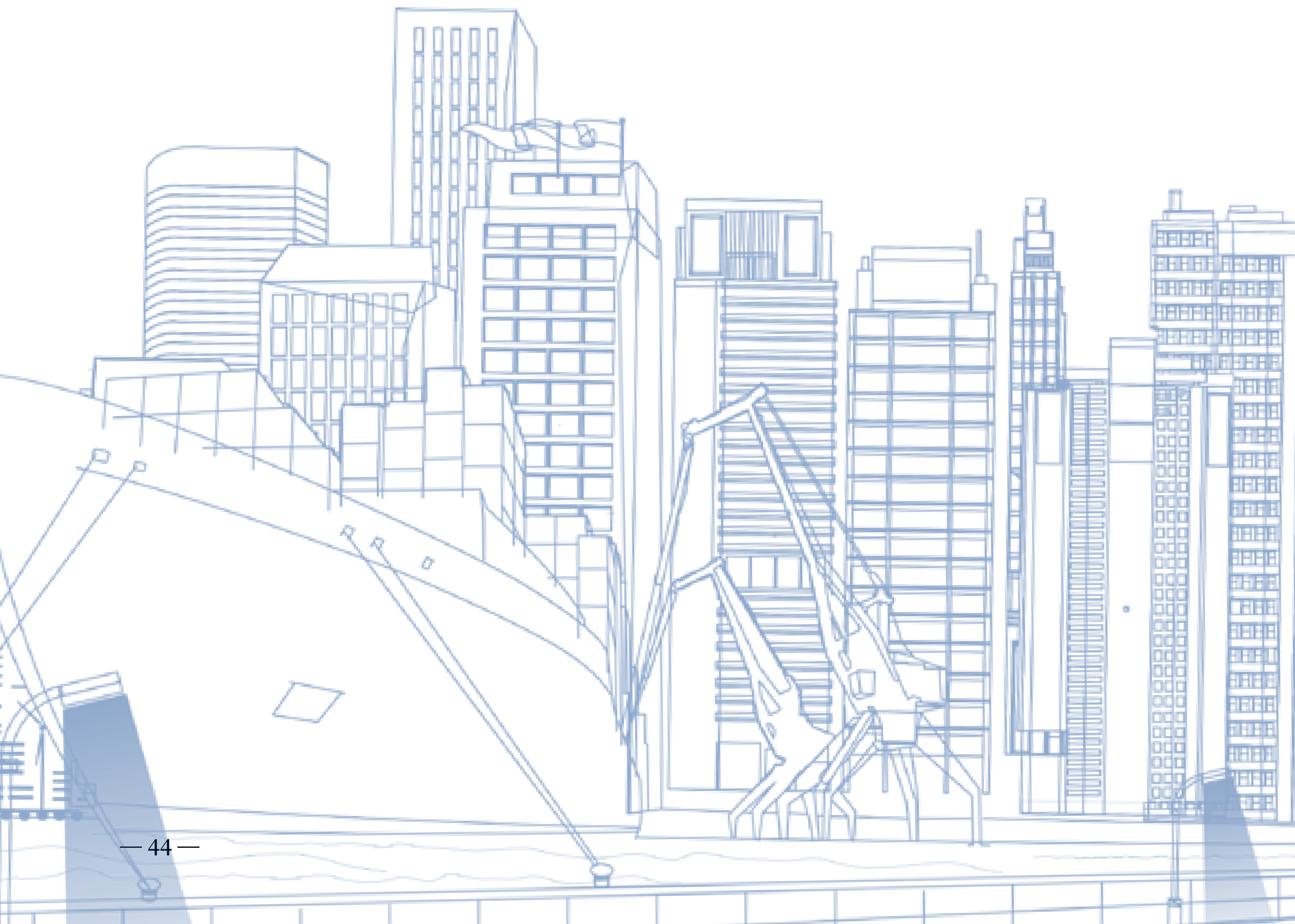
$$y_{i,p} = \sum_{j} x_{i,j,p} \times u_{j}$$

Where u_j is the weight of the j^{th} secondary indicator, and $y_{i,p}$ is the score of the p^{th} port of the i^{th} primary indicator.

So, the formula of final scores of hub ports is:

$$D_{p} = \sum_{i} y_{j,p} \times w_{i}$$

Where w_i is the weight of the i^{th} primary indicator and D_p is the final scores of the p^{th} hub port.



Indicator weights

Table 5 Indicator Weights of Northeast Asia International Shipping Hub Competitiveness Index

Primary indicators		Secondary indicators	
Name of hub port	Weight	Name of hub port	Weight
B1 Hub infrastructure scale	0.2	C1 Cargo throughput	0.28
		C2 Container throughput	0.46
		C3 Number of productive berths of 10,000-tonnage and above	0.26
B2 Hub operation level	0.2	C4 Direct berthing rate of container terminal	0.30
		C5 Container terminal operation efficiency	0.50
		C6 Bulk cargo terminal operation efficiency	0.20
B3 Network connectivity	0.2	C7 Container terminal shipping connectivity	0.53
		C8 Bulk cargo terminal shipping connectivity	0.26
		C9 Port cargo collecting and distributing capacity	0.21
B4 Business environment of port	0.1	C10 Time of import and export compliance	0.67
		C11 Cost of import and export compliance	0.33
B5 Green and smart port development	0.1	C12 Green port development	0.30
		C13 Smart port development	0.70
B6 Economic vitality of port city	0.2	C14 GDP of port city	0.25
		C15 Import and export value of port city	0.75

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