Global Port Development Report

(2017)

Shanghai International Shipping Institute（SISI）

May 2018

Preface

In 2017, the world economy was well on track to recovery. Thanks to rebounding international trade, maritime trade saw demand pickup, reversing a declining trend in 2016, and showed a robust growth momentum. The growth in trade in turn gave a boost to global ports' performance. However, with the rise of the Trump-led protectionism and elsewhere as well as the early signs of "deglobalization", international trade will be full of uncertainties in 2018, and the port and shipping industry's development is facing pressure from many factors such as uncertainties in the growth of cargo transport demand. Therefore, we need to keep a close watch on the development of the global port industry, make analysis of related new features and new trends, discover and promote new concepts, technologies, methods and models generated in the process of port development, and provide support for the port industry's healthy and sustainable development.

This report contains nine chapters. Chapter 1 introduces the macro environments of global ports from the perspective of world economy and trade as well as shipping industry development; Chapter 2 analyzes and summarizes production statuses of global ports in 2017 based on the throughput data; Chapter 3 summarizes new trends of port operation and management; Chapter 4 focuses on analyzing the business performance and investment trend of global terminal operators; Chapter 5 summaries the construction of global terminals and their development trends in 2017; Chapter 6 mainly introduces the latest port intelligence technologies and information technologies as well as green technologies employed by ports; Chapter 7 describes the current developments of global green and ecological ports; Chapter 8 assesses the comprehensive services at China's coastal container ports, which aims to appraise the comprehensive service capability of China's coastal container ports; and Chapter 9 forecasts global ports' development focuses and trends in 2018. There are also special topics in various chapters to give thematic analyses and comments on current hotspot issues. Necessary detailed data for the analysis in this report is listed at the end of this report for readers' reference.

The preparation of the *Global Ports Report (2017)* was supported by Shanghai Maritime University and relevant personnel in the port industry. The report has drawn reference from a large number of relevant literatures at home and abroad, and quoted the points of view of some experts and some data from these literatures. The authors would like to express their appreciation.

Please don't hesitate to inform the authors, if there are any deficiencies or errors in this report. The report is prepared in the hope that it can have referential values for promoting communication and exchange in the global port industry, understanding other ports' development status and formulating ports' development strategy.

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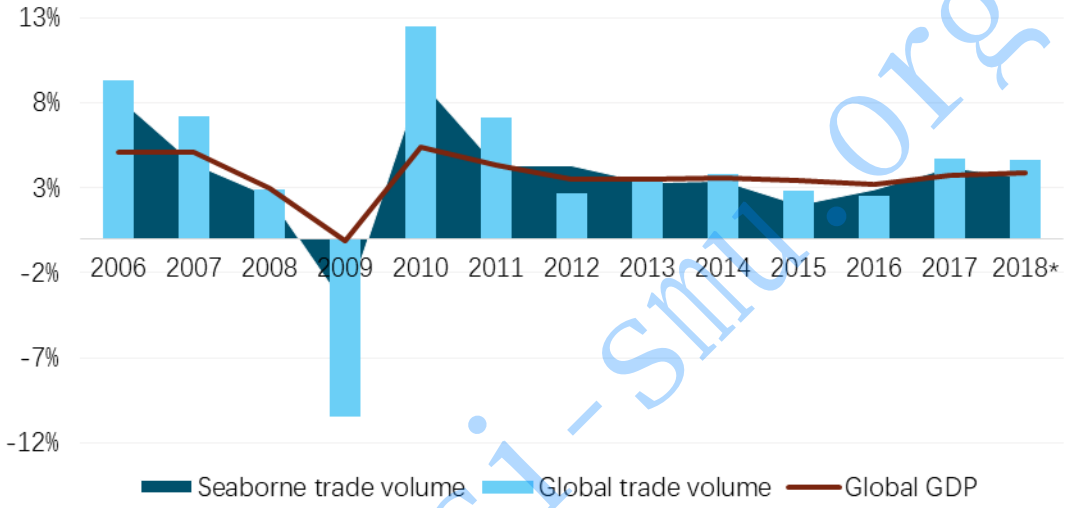
I. Overview of port development environment in 2017

1.1 Overview of global economic development

In 2017, the global economy was on track to strong recovery. It finally emerged out of the shadow of the financial crisis that broke out in 2008 and began to grow at a rate higher than the last three years' average. According to a forecast by the International Monetary Fund (IMF), the global economy grew at 3.6 percent in 2017, setting a new high for the past three years. The fast economic growth was mainly attributable to cyclical factors and enhanced endogenous forces, gradual recovery of market demand and increased global trade activities.



Source: IMF data, Clarkson website.

Note: * represents forecast.

Figure 1-1 The Growth of Global GDP , Global Seaborne Trade Volume (2006-2018)

1.2 Overview of global trade development

Global trade was active in 2017. Major economies reversed a declining trend shown in 2016, with both imports and exports achieving high growth rates. According to data from the World Trade Organization (WTO), global goods trade grew 3.6 percent in 2017. In particular, Asia's imports and exports saw the most impressive growth, at 6.4 and 5.8 percent in 2017, up 4.6 and 3.8 percentage points from 2016, respectively. Among Asian countries, South Korea had the most outstanding performance in imports and exports. In 2017, South Korea's exports grew 18.5 percent year-on-year, a new high in history. The EU saw both imports and exports grow more than 7 percent, a significant improvement from 2016, when both imports and exports posted near-zero growth rates. Among the EU countries, Germany, France and Italy experienced the most notable rebound, with impressive growth in imports. North America also saw imports and exports grow significantly, at 4.1 and 4.2 percent, respectively.

Table 1-1 The Growth of Global Trade Volume（2015-2018）

（unit:%）

	2015	2016	2017*	2018*
Global Trade Volume	2.6	1.3	3.6 (3.2-3.9)	3.2 (1.4-4.4)
Export : Developed countries	2.7	1.4	3.0 (2.8-3.2)	2.8 (1.6-3.5)
Developing countries	1.9	1.3	4.7 (4.2-5.2)	4.1 (2.1-5.7)
North America	0.7	0.5	4.2 (2.5-5.3)	3.8 (0.8-6.0)
Asian	1.1	1.8	6.4 (5.9-7.2)	4.8 (1.9-7.5)
Import : Developed countries	4.7	2	3.0 (2.5-3.8)	2.9 (2.6-3.3)
Developing countries	0.5	0.2	5.1 (3.6-6.0)	3.7 (-0.9-7.0)
North America	6.7	0.4	4.1 (3.2-4.8)	3.5 (0.7-6.1)
Asian	2.9	2	5.8 (5.0-6.3)	4.0 (1.3-6.2)

Source: WTO data.

Note: * represents forecast.

1.3 Overview of international shipping market development

In 2017, the volumes of various sea cargoes rose to varying degrees. The international maritime shipping market's overall growth beat expectations in the previous year, giving a boost to confidence in the sector.

1.3.1 The seaborne volume of global container rally

In 2017, maritime container shipping demand improved, as the global maritime container trade volume was projected to hit 191 million TEUs, up 5.2 percent year-on-year, a rate higher than the 3.8 percent in 2016. The growth was mainly attributed to the increase in seaborne shipping volumes on global trunk routes and a robust growth in transport demand in Asia. Container shipping volumes on eastern and western trunk routes were projected to rise 5.1 percent, the fastest growth for the past eight years, while the seaborne shipping volume on the northern and southern trunk routes continued a steady growth, at 3.9 percent year-on-year.

1.3.2 The seaborne volume of dry bulk cargo rebound

In 2017, dry bulk market demand improved, and the global maritime shipping volume of dry bulk goods was estimated to grow 4.2 percent to reach approximately 5.109 billion tonnes. The volume of iron ores transported by sea saw steady growth, thanks to an upturn of the Chinese steel industry, which led to a surge in iron ore demand, prompting Australia to significantly increase iron ore exports to China. The seaborne trade of coal, after two years of decline, recovered in 2017, mainly due to the rapid industrial development in India, Vietnam and other Asian countries, which saw an increasing demand for electricity that resulted in a big gap in their domestic coal supplies. The seaborne shipping volume of minor bulk, boosted by the rapid growth of China's bauxite imports from Guinea, took up an increasing share in the total maritime shipping volume and showed a more obvious effect on driving the growth of sea transport volumes.

1.3.3 The seaborne volume of crude oil slow down

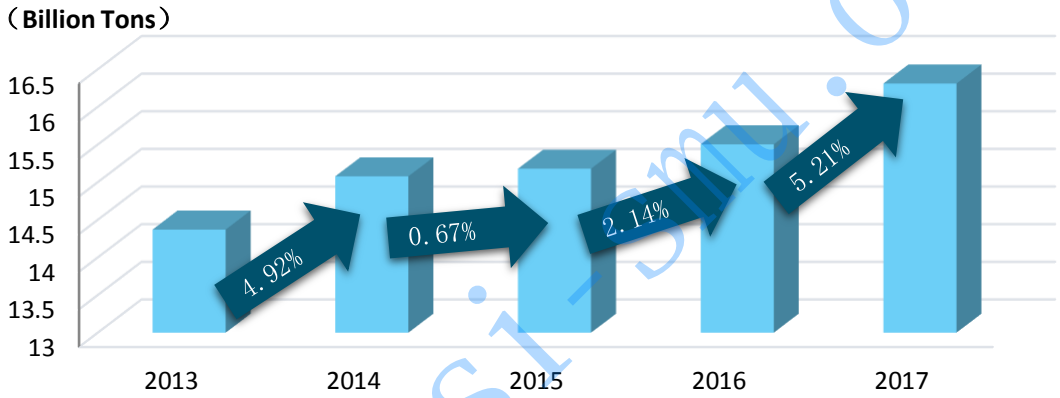
In 2017, the global seaborne volume of crude oil grew 2.8 percent, down 1.3 percentage points from the 4.1 percent in 2016, to 40.2 million barrels. Asia's crude imports, which remained the major driving force for the growth of the global crude trade, were expected to grow 4 percent in 2017 to 22.2 million barrels, accounting for more than half of the total volume of the global crude trade. However, due to Japan's declining crude imports as a result of its inadequate refining capacity, Asia's crude import volume is expected to see slower growth. On the other hand, the growth of global crude exports was impeded by the OPEC-led oil output reduction plan in 2017, as the Middle East, the major crude-exporting region, posted a decrease of 2 percent in its crude export volume. With climbing shale oil production, the total volume of US crude exports in 2017 was projected to double that of the previous year but still fall short of fully filling the gap in supply caused by the OPEC-led output cut.

II. Comments on port production situation in 2017

2.1 Overview of global port throughput

2.1.1 Growth rate of cargo throughput runs high

Thanks to the improving global economic and trade situation, the world's major ports, on the whole, saw their throughput grow fast in 2017. The ports reversed the sluggishness suffered in the previous two years, with throughput totaling about 16.3 billion tonnes, up 5.22 percent year-on-year, an increase of 3 percentage points from a year earlier.

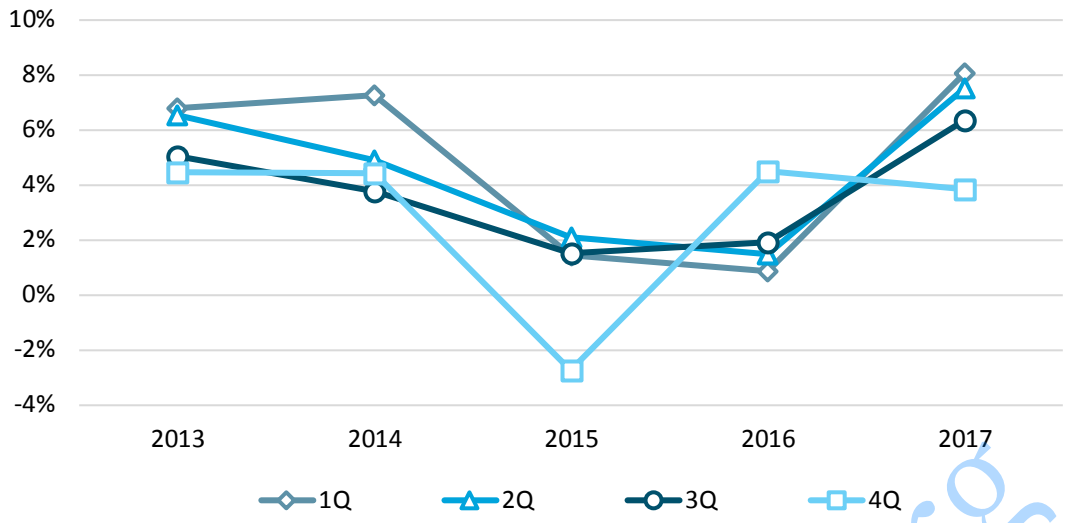


Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-1 Cargo Throughput of Major Global Ports (2013-2017)

2.1.2 Cargo throughput keep growth momentum for full year

The total cargo throughput of the world's major ports peaked in the first quarter before falling quarter by quarter, but overall it sustained a high growth. In the first quarter, global ports had a good beginning, with cargo throughput at major ports growing 8.07 percent year-on-year. In the second quarter, the ports' cargo throughput continued to climb because of the improving global economy, rebounding international trade and rising commodity prices, and achieved a growth rate of 7.51 percent. In the third quarter, the ports' throughput continued the good momentum in the first half of the year and grew by 6.34 percent. The fourth quarter posted a year-on-year growth rate of just 3.83 percent, slightly lower compared to the first three quarters, due to a high base figure for the same period of 2016.



Source：Websites of Various Port Authorities，sorted by SISI

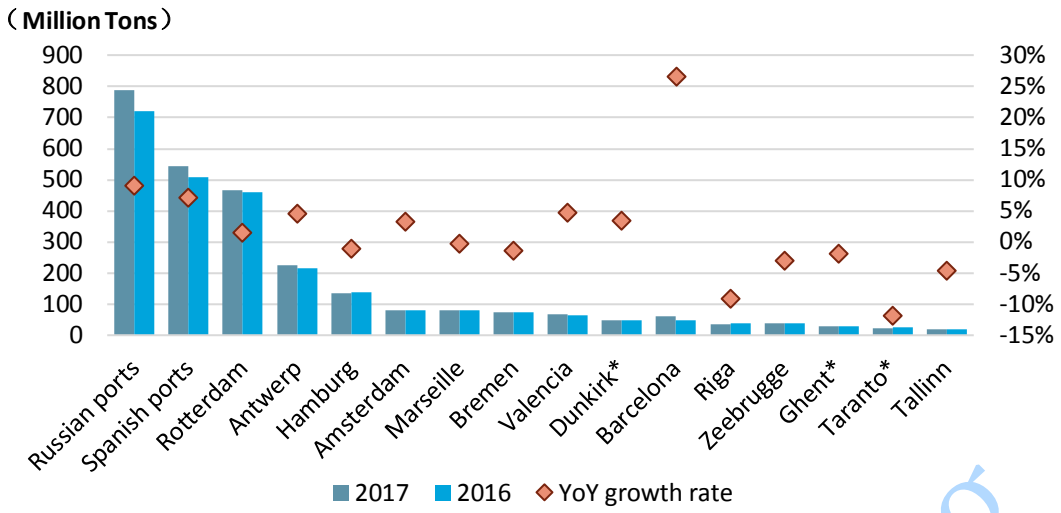
Figure 2-2 Growth Rate of Global Major Ports Throughput by Quarter (2013-2017)

2.1.3 Growth rates of cargo throughput of various regional ports rise in pace

1. Cargo throughput of European ports rises gradually

In 2017, cargo throughput of major European ports hit 2.7 billion tonnes, up 4.89 percent year-on-year.

Among the major ports, Russia benefited from an upturn in the coal market and its annual cargo throughput reached 790 million tonnes, up 9.01 percent year-on-year. Spanish ports' cargo throughput jumped 7.08 percent year-on-year to 540 million tonnes, thanks to China COSCO Shipping Corp's investment in relevant terminals and the opening of trade corridors under the Belt and Road initiative. At Rotterdam, the robust growth in container throughput became the major driving force for growth, but the growth in dry bulk fell slightly, resulting in a slower overall growth, and the total cargo throughput of the port increased by 1.3 percent to 470 million tonnes. Antwerp maintained a high growth in cargo throughput, with most of the cargoes showing good performance, especially break bulk, which jumped by 10.5 percent.



Source: Websites of Various Port Authorities, sorted by SISI.

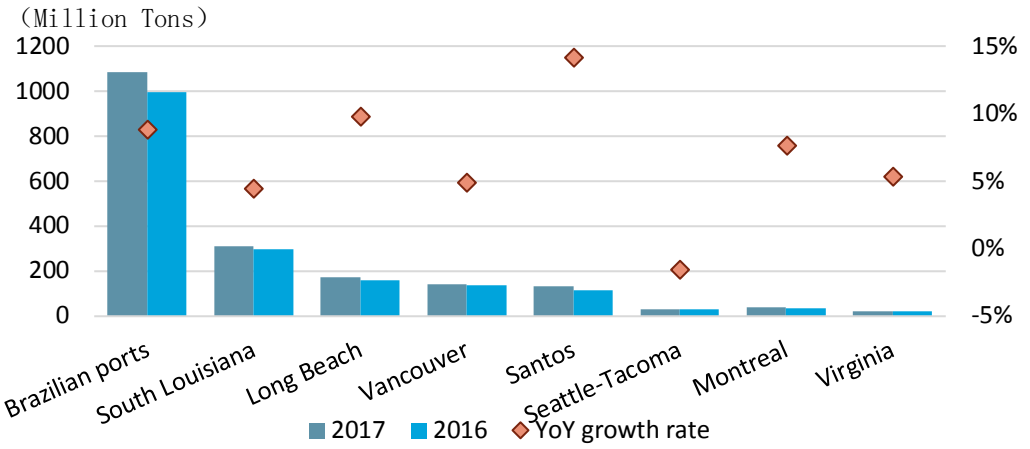
Note: * represents forecast.

Figure 2-3 Throughput and Growth Rate of Major European Ports (2016-2017)

2. Cargo throughput of American ports bottoms out

Benefit of the improving US economy in the short term and increasing trade of bulk commodities, major ports in Americas saw cargo throughput surge to 1.9 billion tonnes in 2017, up 7.98 percent year-on-year.

Among the major ports, those ports in northern Brazil posted a robust growth in exports of agricultural products, but Brazilian ports' overall growth rate of cargo throughput was not high due to bad weather and strikes at the southern ports. Cargo throughput of the Port of South Louisiana of the US hit 338 million tonnes, breaking the record of 324 million tonnes set in 2016, mainly due to the high throughput of grain, which registered a year-on-year growth of 31 percent. Cargo throughput of the Port of Long Beach of the US was 158 million tonnes, up 8.95 percent year-on-year, with all cargoes showing a momentum of high growth – the dry bulk throughput, in particular, jumped by 24.86 percent. The Northwest Seaport Alliance of the Port of Seattle and Port of Tacoma was dealt a blow by an overall decline in the North American car import market, resulting in an 11-percentage-point fall in the annual car handling volume, while log throughput soared by 57 percent to 278,000 tonnes due to strong demand from China.



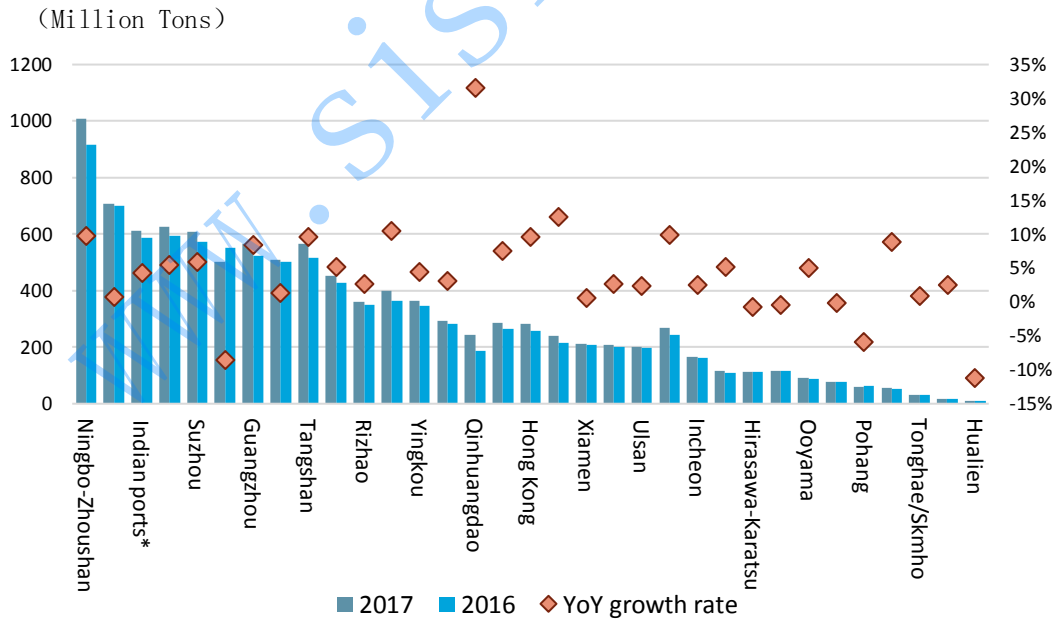
Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-4 Throughput and Growth Rate of Major American Ports (2016-2017)

3. Cargo throughput of Asian ports dramatic increases

In 2017, cargo throughput of major ports in Asia hit 9.3 billion tonnes, up 7.2 percent year-on-year, 5.2 percentage points higher than that of the previous year.

Among the major ports, China's Tangshan, Huanghua, Ningbo-Zhoushan and Shenzhen saw a high growth in throughput. The hub ports of Singapore and Busan also posted extraordinary growth rates in throughput, at 5.6 and 10.5 percent, respectively. Notably, Qinhuangdao achieved a strong growth in annual cargo throughput, at 31 percent, following a slump of more than 26 percent in 2016, and became the world's fastest growing port with the biggest fluctuations.



Source: Websites of Various Port Authorities, sorted by SISI.

Note: * represents forecast.

Figure 2-5 Throughput and Growth Rate of Major Asian Ports (2016-2017)

(1) The overall growth rate of Chinese port throughput ran high

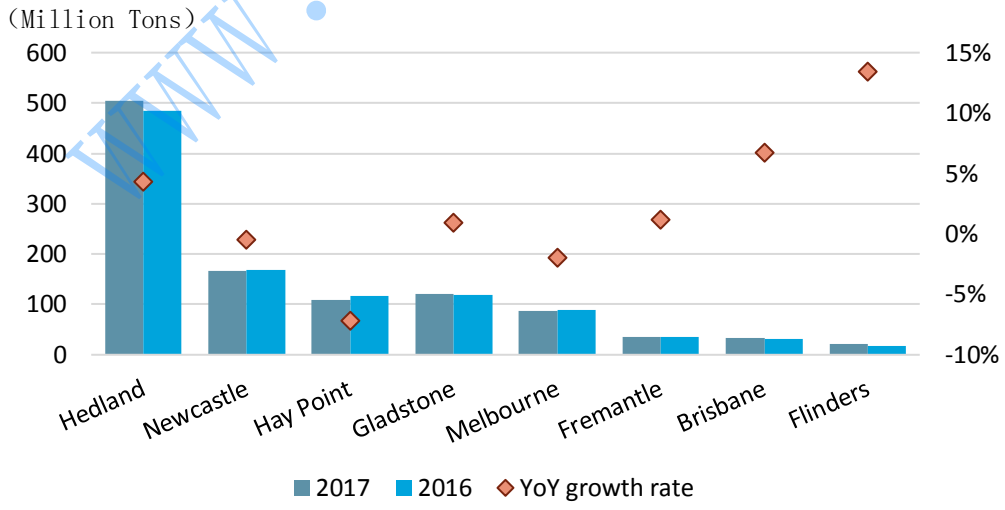
In 2017, Chinese ports continued a momentum of steady growth. Cargo throughput of the country's ports above a designated scale reached 12.64 billion tonnes, up 6.88 percent year-on-year, 3 percentage points higher than that of the previous year. The first half of the year had better performance than the latter half. The year-on-year growth rates in February and July hit 10.1 and 10.3 percent, respectively, the highest rates in 2017. Moreover, 11 months of the year saw cargo throughput of the country's ports above a designated scale exceed 1 billion tonnes.

(2) South Korean ports' cargo throughput saw steady growth

In 2017, South Korean ports' cargo throughput hit 1.57 billion tonnes, up 4.1 percent year-on-year, 0.9 percentage points higher than that of the previous year. Among major ports, Busan's cargo throughput, driven by the growth of trade in Southeast Asia's emerging markets and South Korean companies' intensified marketing efforts targeting regions such as Southeast Asia and Iran, hit 400 million tonnes, jumping 10.5 percent year-on-year. The port was closely followed by Kwangyang and Ulsan, with cargo throughput falling slightly to 290 and 200 million tonnes, respectively. Incheon's throughput reached 160 million tonnes, with a year-on-year growth rate on par with that of the previous year.

4. Cargo throughput of Australia ports grown slowly

In 2017, major ports of Australia handled 648 million tonnes of cargo, up 2.3 percent year-on-year. Due to the impacts of the hurricane and the long spell of rainy and humid weather, Hay Point's coal throughput nosedived, resulting in a 7.2-percent fall in the port's annual throughput. Coal exports of Newcastle totaled 160 million tonnes in 2017, with coal exports to the Chinese mainland, Japan, Chinese Taiwan, Vietnam, the Philippines and India all growing slightly. Gladstone's three port areas achieved total cargo throughput of 121 million tonnes, in which coal exports, hitting 68.29 million tonnes, continued to take a dominating position, while the volume of LNG exports handled by the port reached a record high of 20.23 million tonnes as LNG plants continued to increase output.



Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-6 Throughput and Growth Rate of Major Australian Ports (2016-2017)

5. Container throughput of African ports rally

In 2017, major African ports handled a total of 230 million tonnes of cargo, up 3.46 percent year-on-year, compared to a 4.4-percent fall a year earlier. Among the ports, with the exception of Durban, East London and Mossel Bay, which continued to see negative growth rates, the others posted positive growth rates of varying degrees. Richards Bay and Saldanha Bay grew 2.58 and 8.57 percent to 100 and 72.23 million tonnes respectively，Enkala deep-water port, in particular, had the most outstanding performance, growing more than 100 percent. Besides, Elizabeth, the only port that registered a positive growth rate in the previous year, handled 9.569 million tonnes of cargo in 2017, up 4.35 percent year-on-year, a 2.15-percentage-point fall from that of the previous year.

Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-7 Throughput and Growth Rate of Major African Ports (2016-2017)

2.1.4 Faster growth of Chinese ports, fiercer competition among global ports

More than half of the world's top 20 ports in terms of cargo throughput in 2017 were Chinese ports. Ningbo-Zhoushan attained the goal of becoming a big port with a handling capacity of 1 billion tonnes and also became the only one in the world that handled more than 1 billion tonnes of cargo. Shanghai's throughput recovered from a previous negative growth, rising by 0.8 percent to 710 million tonnes, and was ranked second. Suzhou, China's No. 1 port in inland areas, achieved a throughput of 608 million tonnes in 2017, up 4.9 percent year-on-year, and became the world's fourth-largest port. Tianjin, dealt a blow by stricter environmental policies, became the only port with a negative growth rate in the top 20 list as its throughput fell 8.4 percent.

Table 2-1 2017 Global Top 20 Ports by Cargo Throughput

(Unit: Million Tons)

Ranking			Port	Cargo Throughput		Year-on-Year Growth Rate
2017	2016	Trend		2017	2016	
1	1	→	Ningbo-Zhoushan	1007.11	917.77	9.73%
2	2	→	Shanghai	705.63	700.05	0.80%
3	3	→	Singapore	626.17	593.3	5.54%
4	4	→	Suzhou	607.74	573.76	5.92%
5	6	↑	Guangzhou	566.19	521.81	8.51%
6	7	↑	Tangshan	565.4	515.8	9.62%
7	8	↑	Qingdao	507.99	500.83	1.43%
8	9	↑	Hedland	505.325	484.51	4.30%
9	5	↓	Tianjin	502.84	549.14	-8.43%
10	10	→	Rotterdam	467.35	461.18	1.34%
11	11	→	Dalian	451.05	428.73	5.21%
12	12	→	Busan	400.51	362.35	10.53%
13	14	↑	Yingkou	362.39	347.02	4.43%
14	13	↓	Rizhao	360.02	350.62	2.68%
15	15	→	South Louisiana	307.86	294.91	4.39%
16	16	→	Kwangyang	291.83	283.04	3.11%
17	17	→	Yantai	285.6	265.36	7.63%
18	18	↓	Hong Kong	281.55	256.73	9.67%
19	19	↑	Zhanjiang	281.52	255.17	10.33%
20	20	→	Huanghua	269.57	245.11	9.98%

Source: Websites of Various Port Authorities.

2.2 Overview of container throughput of global ports

Thanks to an improving global trade environment, the international container market picked up in 2017, and major ports' container throughput maintained high growth rates and showed signs of further improvement. Global ports' container throughput totaled 740 million TEUs, up 6 percent year-on-year, the highest in the past six years.

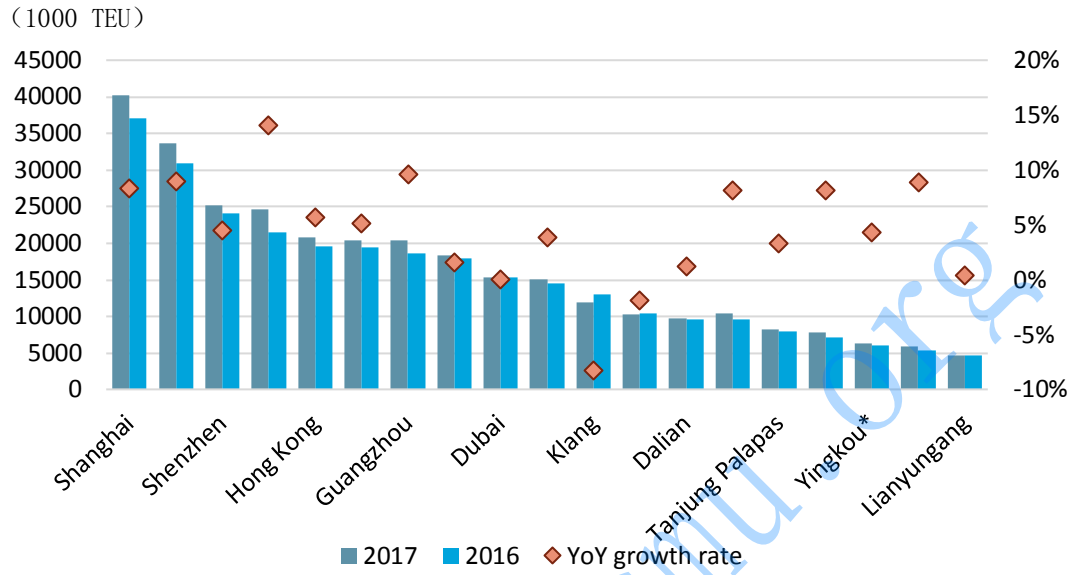
2.2.1 Regional container throughput improving totally

1. Total container throughput of Asia continues to grow

In 2017, major ports in Asia saw container throughput further increase to 400 million TEUs, up 5.79 percent year-on-year, 2.8 percentage points higher than that of the previous year.

Among Asia's top 20 container ports, there were 13 from China and there was little change in the rankings compared to a year earlier. Shanghai took the first place for the eighth year in a row, while Ningbo-Zhoushan became a dark horse, with the growth of its container throughput leading the rest of the world. Transshipment hub ports Singapore, Hong Kong and Busan all maintained a

steady growth in container throughput. Guangzhou's container throughput hit 20.37 million TEUs, becoming one of the world's only seven ports with an annual container throughput in excess of 20 million TEUs. Xiamen's annual container throughput topped 10 million TEUs, overtaking Kaohsiung on the rankings, while Suzhou, with a year-on-year growth of 8.89 percent, was the only inland river port on the list.



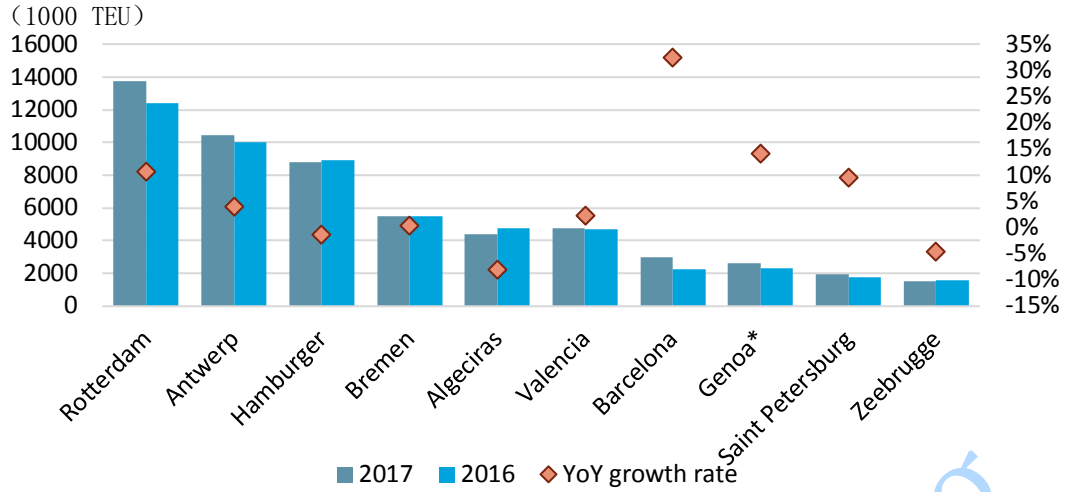
Source: Websites of Various Port Authorities, sorted by SISI.

Note: * represents forecast.

Figure 2-8 Asian Top 20 Ports by Container Throughput and Growth Rate(2016-2017)

2. Growth rate of European ports container throughput rise

In 2017, major European ports' container throughput totaled 128 million TEUs, up 4.99 percent year-on-year. Among the top 10 container ports in Europe in 2017, Rotterdam, driven by the robust growth of container volumes from Asia and Americas, achieved a total container throughput of 13.7 million TEUs, up 10.9 percent. Thanks to an improving economic environment and support from shipping alliances, Antwerp's container business maintained a steady growth as its container throughput rose 4.1 percent to 10.45 million TEUs.



Source: Websites of Various Port Authorities, sorted by SISI.

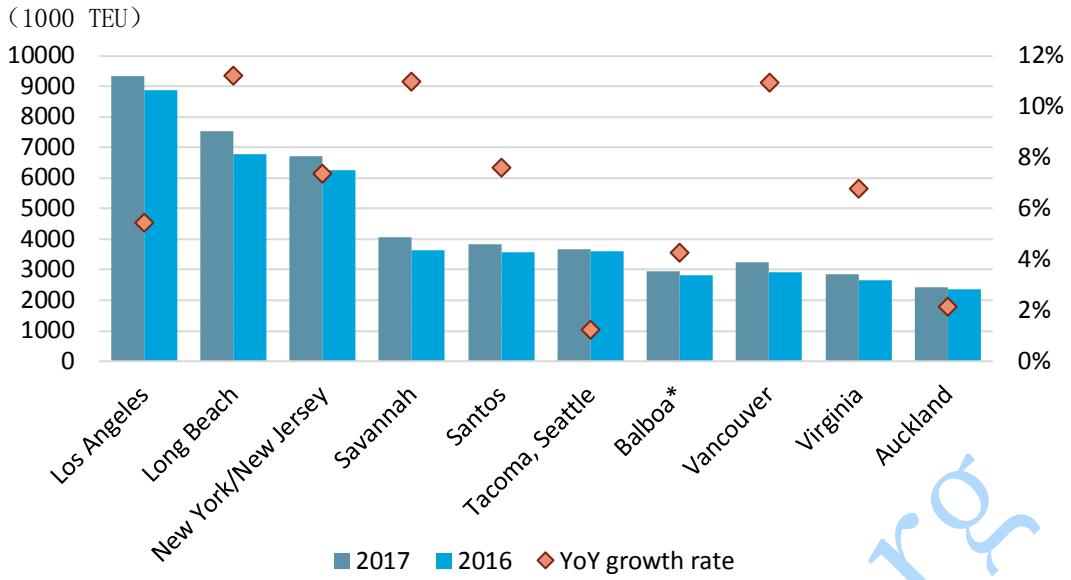
Note: * represents forecast.

Figure 2-9 European Top 10 Ports by Container Throughput and Growth Rate (2016-2017)

3.Growth rate of container throughput of American ports runs high

In 2017, the US economy was on track to strong recovery, with the overall economic conditions much better than a year earlier. Major ports in the Americas achieved a total container throughput of 109 million TEUs, up 7.41 percent year-on-year.

North America's top 10 ports in 2017 all registered positive growth rates in container throughput, ranging from 3.1 percent (Oakland) to 11.8 percent (Savannah). Among these, container throughput of Los Angeles of the US rose 5.42 percent to 9.34 million TEUs, while throughput of Long Beach hit 7.54 million TEUs, up 11.21 percent. The fast growing Savannah on the southeastern US coast reversed a fall suffered a year earlier and its container throughput grew 10.96 percent year-on-year to 4.05 million TEUs. The Northwest Seaport Alliance of the Port of Seattle and Port of Tacoma handled containers totaling 2.96 million TEUs. Vancouver on Canada's western coast posted a steady growth in throughput, at 10.92 percent. Virginia on the mid-Atlantic coast saw throughput increase by 7.9 percent year-on-year.

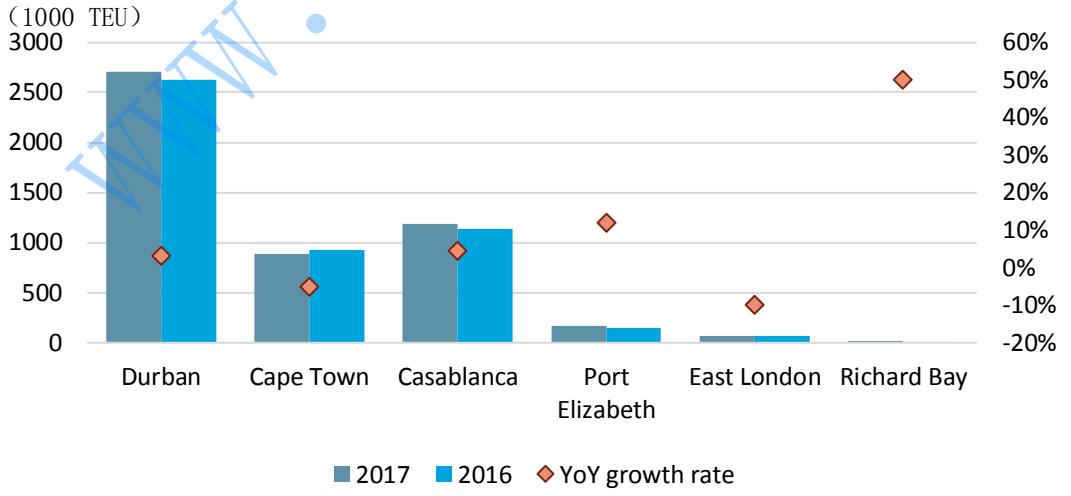


Source: Websites of Various Port Authorities, sorted by SISI, *Forecast.

Figure 2-10 American Top 10 Ports by Container Throughput and Growth Rate (2016-2017)

4. Container throughput of African port rebound

In 2017, African economy saw mild recovery from the previous year's sluggishness. Major African ports' container throughput totaled 260 million TEUs, up 5.57 percent from a year earlier. Among these, Durban, the largest container hub port in Africa, achieved a throughput of 2.7 million TEUs, up 3.05 percent year-on-year, compared to a negative growth a year earlier. Cape Town and East London suffered a fall in container throughput, while Casablanca, with a 4.39-percent growth, overtook Cape Town in total container throughput. Elizabeth and Richards Bay bottomed out and saw a rapid growth in container throughput, which increased by some 12 and 50 percent, respectively.



Source: Websites of Various Port Authorities

Figure 2-11 **Container** Throughput and Growth Rate of Major African Ports (2016-2017)

2.2.2 Global port rankings largely unchanged, higher growth for majority

There was no big change in the container throughput rankings in 2017. Klang, a regional hub port in Southeast Asia, was dealt a heavy blow by port rotation changes made by various shipping lines under major shipping alliances. As a result, the port's annual container throughput fell more than 8 percent in 2017 and its ranking slipped one spot in 2017. With the opening of the unmanned container terminal at the Yangshan Deep-Water Port in Shanghai and improved hardware facilities at various ports on the Chinese mainland, Kaohsiung's Chinese mainland container transshipment business fell sharply, leading to a 26.6-percent slump in the port's domestic container throughput, and its ranking slipped two spots.

Table 2-2 Global Top 20 Ports by Container Throughput (2017)

（Unit：Million TEUs）

Ranking			Port	Container Throughput		Year-on-Year Growth Rate
2017	2016	Trend		2017	2016	
1	1	→	Shanghai	40.23	37.13	8.35%
2	2	→	Singapore	33.67	30.90	8.96%
3	3	→	Shenzhen	25.21	24.11	4.56%
4	4	→	Ningbo - Zhoushan	24.61	21.57	14.09%
5	5	→	Hong Kong	20.75	19.63	5.73%
6	6	→	Busan	20.47	19.46	5.19%
7	7	→	Guangzhou	20.37	18.58	9.63%
8	8	→	Qingdao	18.30	18.01	1.61%
9	9	→	Los Angeles - Long Beach	16.88	15.64	7.93%
10	10	→	Dubai	15.40	15.39	0.06%
11	11	→	Tianjin	15.07	14.50	3.93%
12	13	↑	Rotterdam	13.73	12.39	10.82%
13	12	↓	Klang	11.98	13.05	-8.20%
14	15	↑	Antwerp	10.45	10.04	4.08%
15	16	↑	Xiamen	10.38	9.60	8.13%
16	14	↓	Kaohsiung	10.27	10.46	-1.82%
17	17	→	Dalian	9.71	9.59	1.15%
18	18	→	Hamburger	8.80	8.91	-1.23%
19	19	→	Tanjung Palapas	8.26	7.99	3.38%
20	20	→	Laem Chabang	7.78	7.19	8.21%

Source: Websites of Various Port Authorities

Special topic I: Rankings of the most promising container ports in the world in 2017

In 2017, as the world economy was on track to a relatively strong recovery and the global trade environment improved to some extent, the international container market rebounded from a sluggish performance in 2016, and the overall growth of global container throughput was faster than a year earlier. Among global ports, container ports including Ningbo-Zhoushan (China), Rotterdam (Europe) and Busan (South Korea) saw a robust growth, while Klang (Southeast Asia), Kaohsiung (Chinese Taiwan) and others posted negative growth rates. Due to differences in the economies to which various ports belong, major container ports had different growth potential. This article makes an analysis of multiple indicators regarding 100 global container ports, and produces a ranking list of the world's container ports with the greatest potential for development.

Shanghai International Shipping Institute (SISI) has figured out the rankings of the most promising container ports in the world in 2016 based on six major indexes of "the growth rate of container throughput", "the GDP growth rate in the region of the port", "the attracted investment value of the port", "the number of newly-added shipping routes", "the natural conditions (water depth and location) of the port" and "the influence of government behavior", which can reflect the real values and development potentials of ports as much as possible and be used as a reference for industry insiders.

Table 1 Global Top 20 Greatest Potential Container Ports (2017)

Ranking	Port	Country/Area	Score
1	Singapore	Singapore	89.08
2	Ningbo-Zhoushan	China	84.56
3	Rotterdam	Netherlands	76.30
4	Busan	Korea	74.64
5	Long Beach	The United States	79.30
6	Shanghai	China	72.89
7	Hong Kong	China	72.06
8	Colombo	Sri Lanka	70.25
9	Balboa	Panama	69.03
10	Savannah	The United States	68.73
11	Guangzhou	China	67.50
12	Dubai	The United Arab Emirates	67.30
13	Shenzhen	China	66.96
14	New York - New Jersey	Los Angeles	66.62
15	Taicang	China	66.48
16	Nagoya	Japan	66.29
17	Tianjin	China	66.22
18	Los Angeles	Los Angeles	65.98
19	Tanjung Palapas	Malaysia	65.51
20	Vancouver	Canada	65.00

- **Belt and Road initiative boosts China-ASEAN port cooperation, development**

In 2017, amid improving global container shipping market, China continued to push forward opening up and the implementation of the Belt and Road initiative. It reached cooperation agreements with ASEAN countries in environmental protection, bilateral trade and legal development. In 2017, China issued joint statements with countries including the Republic of Panama, the Philippines and Kazakhstan, and signed free trade agreements with Maldives and Georgia, an upgraded free trade agreement with Chile, and a fruit export agreement with Australia. Against the background of China's ongoing opening up, implementation of the Belt and Road initiative and enhanced trade exchanges with many countries, seven Chinese ports made the list of the top 20 global container ports with the greatest potential for development.

- **Improving trade situation facilitates rapid development of US ports**

In 2017, US economic recovery drove up the value of the US dollar, which in turn put pressure on US exports. Nevertheless, thanks to global economic growth and the Trump administration's protectionist policies, US trade enjoyed a good growth momentum. US container ports had outstanding performance, with four ranked among the global container ports with the greatest potential for development. Trump's new policies on tax reduction and relaxed supervision attracted US manufacturers back to their homeland, which led to a rebound in the prices of imported and exported US-made products together with a rise in the trade volumes in this regard. On the other hand, Trump's new policies also included many protectionist policies, which might hamper the growth of global trade, as well as that of the US container ports.

- **Political, economic uncertainties hamper EU ports' development**

Rotterdam was the only European port that made the list of the global container ports with the greatest potential for development in 2017. With lingering effects of the Brexit vote, barriers were imposed in trade between the UK and the remaining EU countries, which led to a fall in the UK's foreign-exchange trading volume and dealt a blow to the country's position as an international financial center. Besides, political uncertainties also had implications on multinational companies' investments, and international trade will face more uncertainties in future. As a result, Europe's overall economic and trade development was not satisfactory, ports' container throughput maintained a steady growth, and the number of ports that "made the list" was too small.

- **Accelerated industrial process leads to fast development of Southeast Asian ports**

Several Southeast Asian ports, including Singapore, Colombo and Tanjung Pelepas, made the 2017 list of global ports with the greatest potential for development. In 2017, Southeast Asian economies recorded robust growth, and most countries in this region were in the process of fast industrialization, which brought huge production and consumption demand. Due to low production costs and cheap labor, an increasing number of companies shifted their production facilities to countries in Southeast Asia, such as Vietnam, Myanmar and Malaysia. Therefore, Southeast Asian countries kept attracting investments from foreign companies, the region's potential in cargo shipping demand grew fast, terminal investments became highly feasible, and ports had huge development potential.

2.3 Overview of dry-bulk cargo throughput of global ports

In 2017, the total seaborne volume of dry bulk and minor bulk maintained a slow growth, rising 1.9 percent to approximately 4.979 billion tonnes. Among the major dry bulk ports, Qinhuangdao, benefiting from rebounding BDI, improved dry bulk market, the partial shift of coal transportation to Qinghuangdao following Tianjin's ban on coal trucks, saw its annual dry bulk throughput hit 222 million tonnes, signaling recovery to the level before 2016. Dry bulk throughput at Hedland, driven by demand from Chinese steel mills, grew 5.51 percent to reach 505 million tonnes in 2017. Rotterdam's coal throughput slipped slightly and dry bulk throughput fell 2.6 percent to 80.17 million tonnes due to Europe's stricter environmental policies and energy transformation and upgrading. Also due to weak growth of the coal market, Antwerp experienced a slight fall in dry bulk throughput, which dipped 3.7 percent year-on-year to 12.18 million tonnes. While ores handled by the port saw a robust growth of 12.7 percent to 2.386 million tonnes, coal tumbled 54.2 percent to 478,000 tonnes.

Table 2-3 Dry Bulk Throughput of Major Ports in 2017

(Unit：Million Ton)

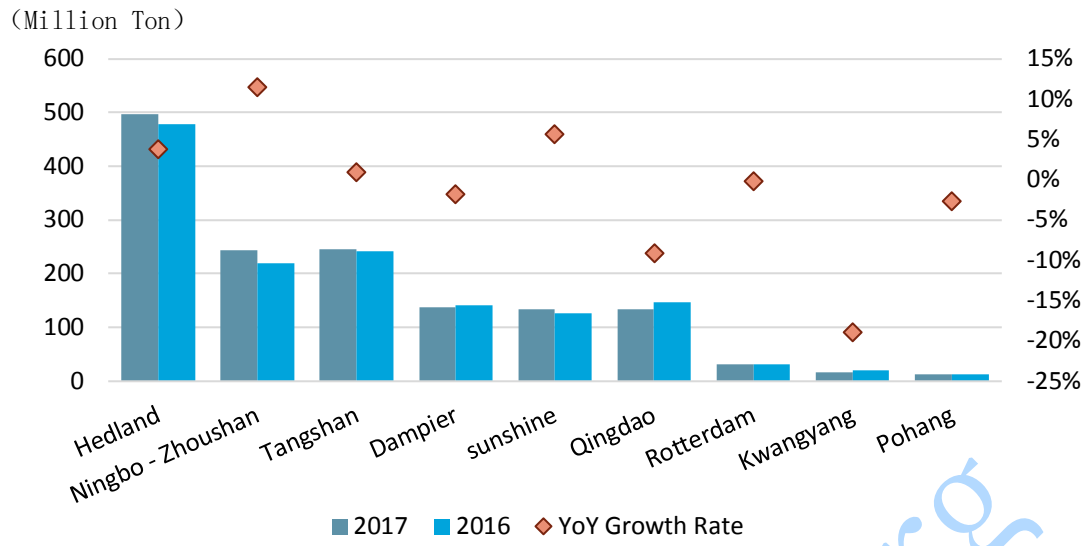
Port	2015	2016	2017 年					2016 YoY Growth Rate	2017 YoY Growth Rate
			1Q	2Q	3Q	4Q	Total		
Hedland	446.26	478.93	116.03	131.76	126.28	131.26	505.33	7.32%	5.51%
Qinhuangdao*	217.4	151.77	56.09	53.85	55.91	55.65	221.5	-30.19%	45.94%
Rotterdam	87.74	82.3	21.72	19.63	19.8	19.02	80.17	-6.20%	-2.59%
Santos	58.75	54.19	13.39	15.53	20.64	14.45	64	-7.77%	18.11%
Singapore	18.15	18.64	4.4	4.95	4.38	4.86	18.59	2.70%	-0.27%
Antwerp	13.8	12.55	3.15	2.97	3.08	2.98	12.18	-9.04%	-3.70%

Source: Websites of Various Port Authorities, sorted by SISI.

2.3.1 Overview of global iron-ore port development

Thanks to recovering manufacturing and international trade, rebounding prices of commodities and increased infrastructure investments in many countries, iron ore throughput at the world's major iron ore handling terminals posted remarkable growth. Benefiting from Chinese steel mills' increased preference for higher-grade ores, Australia's iron ore shipments maintained a steady growth. In 2017, India's iron ore exports skyrocketed by 105.56 percent year-on-year, but the high growth was mainly attributable to a low base figure a year earlier, as well as the government's relaxed restrictions on mining and export and other supportive policies.

Among the major iron ore handling ports, Hedland, driven by Chinese steel mills' demand for high-quality iron ores, saw its dry bulk throughput maintain a growth rate of 3.8 percent to reach 497 million tonnes in 2017. Iron ore throughput at Rotterdam dipped slightly but remained above 31 million tonnes.

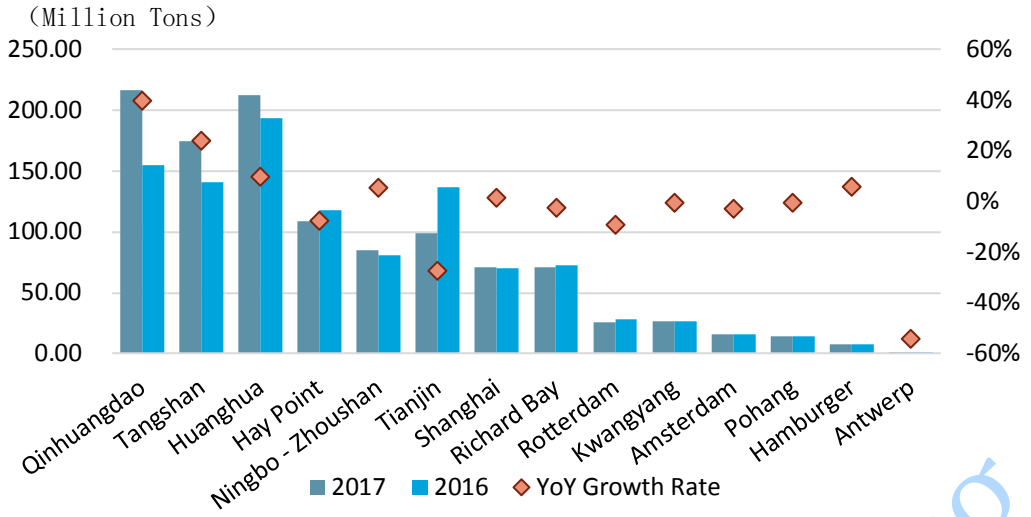


Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-12 Iron Ore Throughput and Growth Rate of Global Major Ports (2016-2017)

2.3.2 Overview of global coal port development

In 2017, Russia produced 400 million tonnes of coal, up 4 percent from 2016, signaling a steady recovery of the Russian coal industry. In 2017, Russia's coal exports rose 8 percent from the previous year, to 185 million tonnes. Among the world's top 10 coal handling ports, there were six from China, which reported robust growth in coal throughput. Among these, Qinhuangdao's coal shipments, after a 27.7-percent slump to a five-year low in 2016, rebounded and grew at 39.6 percent year-on-year, but it still had the potential for further growth. Tangshan grew 23.9 percent year-on-year, and the growth was mainly attributable to the main coal handling terminal of the port, the Caofeidian Port Area, which achieved a year-on-year growth of 49.07 percent thanks to a rebound in the transport volume on the Datong-Qinhuangdao Railway. Rotterdam's coal throughput fell 9.5 percent and throughput of coke for steeling making, also dipped slightly, due to the shutdown of eight coal-fired power plants (two in the Netherlands and six in Germany) and output cuts at other power plants.



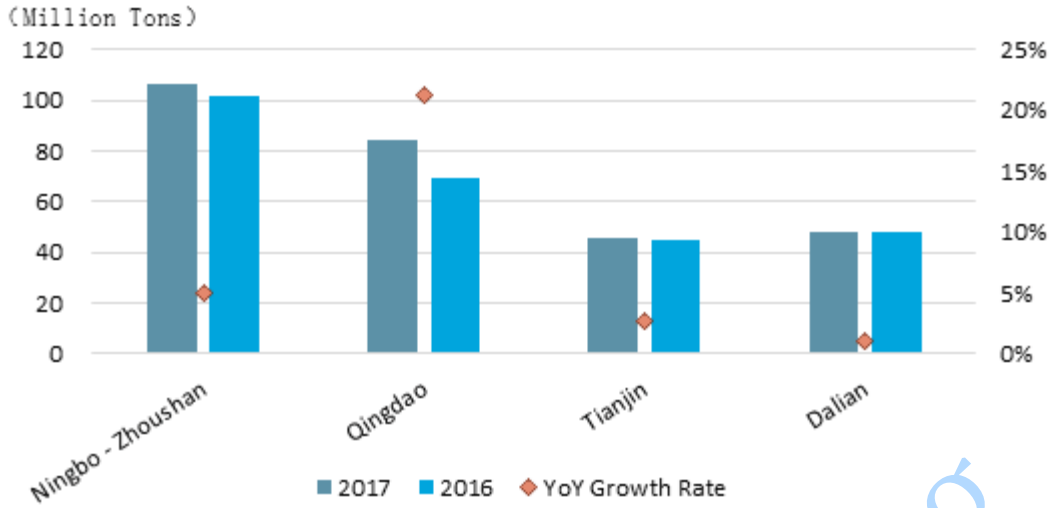
Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-13 Coal Throughput and Growth Rate of Global Major Ports (2016-2017)

2.4 Overview of liquid bulk cargo throughput of global ports

In 2017, the overall growth rate of the global volume of liquid bulk transported by sea was low, with the seaborne volume up 0.8 percent year-on-year to 3.027 billion tonnes, of which the volume of crude oil transported by sea was on par with that of the previous year. Ports in different regions had varied performance regarding throughput growth. Thanks to strong overseas demand for petrochemicals, Singapore, Barcelona and other major ports for crude oil storage saw liquid bulk throughput climb. In 2017, Barcelona's liquid bulk throughput grew 26.9 percent year-on-year to 14.48 million tonnes. Against the background of Asia's strong demand for LNG, Barcelona's LNG throughput skyrocketed by 64.1 percent year-on-year to 4.04 million tonnes. South Korea's major liquid bulk ports Kwangyang, Incheon and Daesan had good performance in liquid bulk throughput, which grew 2.3, 7.0 and 6.4 percent year-on-year, respectively.

In 2017, China's crude oil imports grew rapidly, which totaled 419.57 million tonnes, up 10.1 percent from 2016. China imported crude from 46 countries, the top ten of which took up a share of about 80 percent in the total volume imported by China. Moreover, the share of crude China imported from the US was also on the rise.



Source: Ministry of Transport of People's Republic of China, sorted by SISI.

Figure 2-14 Crude Oil Throughput of Major Chinese Ports (2016-2017)

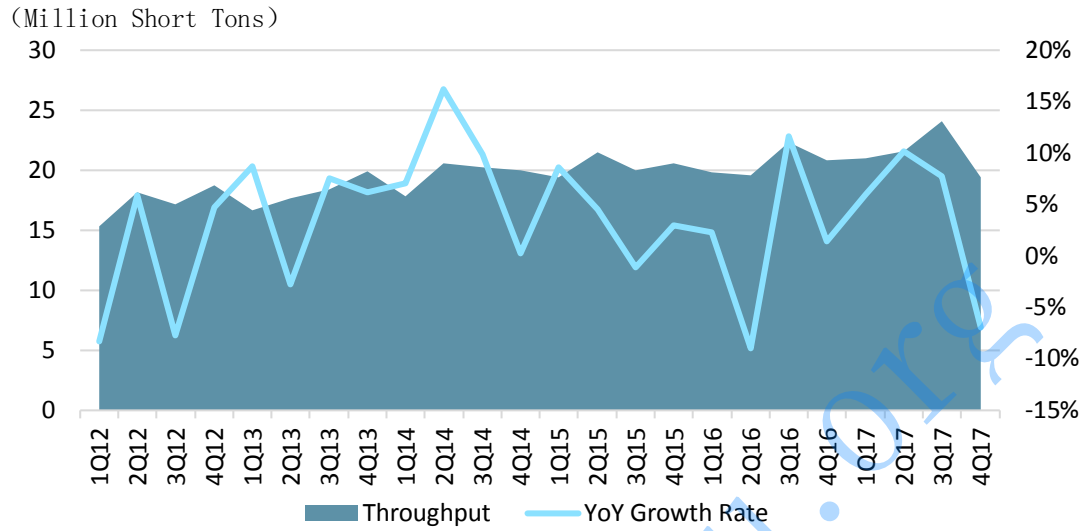
In 2017, Rotterdam saw crude throughput grow steadily to 104.2 million tonnes, up 2.3 percent, while LNG throughput at the port jumped 16.5 percent to 1.99 million tonnes thanks to its natural gas network's increased delivery volume and the development of LNG fuel facilities. In Russia, a fall in fuel oil exports led to a 10.8-percent decrease in the throughput of mineral oil and petroleum. At Antwerp, liquid dry throughput had a good performance, growing 5.7 percent year-on-year to 73.13 million tonnes, which was mainly attributable to a 49.9-percent increase in crude to 5.96 million tonnes.

Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-15 Liquid Bulk Throughput of Major European Ports (2016-2017)

The newly-increased US oil and natural gas production capacities in recent years are mainly located in the Gulf of Mexico. Hurricane Harvey caused 11 major US ports in the Gulf of Mexico to close and dealt a blow to the refining capacity, which in turn led to reduced supply of gasoline and other fuels. The hurricane also had an impact on energy markets outside the US. For example, Mexico, which had previously seen half of its gasoline imports come from the US, now had to

turn to Europe because of inadequate supply from the US. In such a backdrop, the US crude throughput fell 6.9 percentage points year-on-year in the fourth quarter of 2017. At South Louisiana, crude throughput, which accounted for 28 percent of the total volume of all cargoes handled by the port, jumped 4.17 percent year-on-year to 86.04 million tonnes.



Source: Websites of Various Port Authorities, sorted by SISI.

Figure 2-16 Crude Oil Throughput and Growth Rate of South Louisiana Port (2012-2017)

III. Comments on port operation and management in 2016

3.1 Development trend of port logistics

3.1.1 Belt and Road initiative's impact on port logistics

In 2017, with the ongoing implementation of the Belt and Road strategy, the order of global ports and logistics industry networks underwent gradual changes. China had signed bilateral maritime shipping agreements with 36 countries along the Belt and Road and the EU, while the National Public Information Platform for Transportation and Logistics had also achieved interconnection and sharing of logistics information with 31 ports around the world. In 2017, the total volume of China's imports and exports with Belt and Road countries increased by 20.1 percent, while its trade with Russia, India and Malaysia, among others, also maintained fast growth. The Belt and Road initiative not only helped China expand logistics partnerships and demand, but also brought new changes to global ports' logistics models.

◆ **Railway logistics may have impact on maritime logistics**

The Belt and Road initiative connects China with Central Asia and Europe's inland regions through the New Eurasian Land Bridge, facilitates exportation of China's excess capacities to countries and regions along the Belt and Road by rail, pipes and various other transport means, and promotes industrial and energy exchanges between Asia and Europe.

China Railway Express, a key part of the Belt and Road development, enjoys certain advantages in logistics and transportation. Compared to air and maritime transportation, China Railway Express is more cost-effective. The Belt and Road Big Data Report showed that goods transported via China Railway Express reach Europe in about 12 days, just 30 percent of the time by sea. Although cargo transport by rail is more expensive than by sea, the cost is just 25 percent of that by air. Moreover, because China Railway Express presets stops, routes, train numbers, freight spaces, schedules and prices, and can provide more convenient logistics operation models regarding customs declaration, inspection and clearance, as well as door-to-door services, it can better meet the needs of global supply chains compared to maritime logistics.

Currently, railway transport represented by China Railway Express still faces problems including difficulties in customs clearance coordination, different gauge standards, empty containers on backhaul trips and poor infrastructure along the railways. However, with further implementation of the Belt and Road initiative, rail logistics will tap its huge potential for further development and have certain impacts on maritime logistics.

◆ **Integrated development between dry ports and seaports**

Dry ports are inland logistics centers providing port services including customs declaration, application for customs inspection and the issue of bills of lading. Dry ports, usually located in cargo hubs on inland transport networks, are intermodal terminals in international logistics

systems and also facilitate international logistics supply chain services in inland regions. As important logistics terminals along the Belt and Road, dry ports facilitate interconnection among Belt and Road countries and regions through integrated development with seaports.

The integrated development of dry ports and seaports not only plays a key role in maintaining seaports' long-term development, but also has realized a partial shift of seaports' functions. Previously, cargo transported by rail, after it arrived at the port, had to undergo customs declaration, inspection and clearance for a second time, and the cargo handover and inspection procedures were redundant, complicated, time-consuming and costly due to the absence of a seamless connection between sea and rail transport. Through customs clearance cooperation with seaports, dry ports are enabled to complete customs declaration and inspection procedures for cargo within them. On one hand, with the opening of maritime trade routes, seaports and other infrastructure can meet the needs of trade activities. On the other, dry ports will become a key part of the effort for the integrated development of sea and land logistics services, with the opening of the Eurasian Land Bridge, the New Eurasian Land Bridge and the Third Eurasian Land Bridge railways as well as the expanding demand in trade with other countries along these land bridges.

Special topic II：Objective understanding of development of container rail-sea intermodal transport at ports

Railway transport, with its efficiency, convenience, low pollution and low costs, has been playing an important role in the comprehensive transport system. With the rise of international trade that takes ports as pivots, the mode of container rail-sea intermodal transport is drawing increasing attention. China is a country with the largest trade volume at container ports in the world. In 2017, its port capacity reached 237 million TEUs, but the railway transport volume was only 3 million TEUs which accounted for only 1% of the port capacity. This proportion formed a sharp contrast with those of the European and American countries. Specifically, the proportion of the collection and distribution volume by railway was about 10% at Port of Rotterdam in Netherlands and Port of Antwerp in Belgium, 30% at Port of Hamburg in Germany, and up to 40% at Port of Los Angeles and Port of Long Beach in the U.S.

1. Development of container rail-sea intermodal transport based on local conditions

The emergence of transportation demands and the development of business modes all rely on the goods in the market. The most important factor for the success of container rail-sea intermodal transport in the U.S. is that the American economy is not only concentrated in the east and west coasts and the Great Lakes region, and more market demands are distributed in the inland areas of Central America where land transport is required. The transport distance of more than 500 kilometers allows railway transport to have greater comparative advantages over road transport. Meanwhile, due to the Panama Canal restrictions on the Sino-US trade, the trade goods between Asia and Central and Eastern America are substantially transported by Post-Panamax ships to the west coast, and then are transferred by the railway that stretches across the American Continent. Railway transport is just ideal for the distance of more than 3000 kilometers between the east and west coasts. This is why the famous San Pedro Bay Ports and Alameda Corridor in the U.S.

account for at least 30% of the container rail-sea intermodal transport volume in the U.S. Europe is a coastal continent, but its industries is distributed evenly. Of the top 20 greater administrative areas with the largest economic volume in the European countries, only 7 are coastal ones while other 13 are in the inland, with a great transport demand between the coastal ports and inland regions.

The container sources in China are mostly in the coastal developed cities around the ports, with insufficient demand in the inland regions, and relatively insufficient demand for container rail-sea intermodal transport. Data show that the urban import-export volume of the eight major coastal container ports in China has taken up at least 50% of the national volume. These ports are able to accommodate 20,000-ton ships that reach 60 cities within 200 kilometers, and aggregate 85% of the total volume of foreign trade. The economy in Central and Western China is still relatively undeveloped, with weak industrial and trade demand. At present 92.6% of the loaded foreign trade containers in China come from the coastal regions, and only 5.2% and 2.2% come from the offshore and inland regions. 85% and 91% of the foreign trade containers come from the regions that are less than 200 and 300 kilometers from ports and are suitable for road transport. As a result, the collection and distribution of the containers at Chinese ports are mainly accomplished by road. In addition, the competitive means of transport shows that those hinterland cities that have developed rapidly in recent years are mostly located in the Yangtze River Basin and the Pearl River Basin. Less expensive inland waterway transport may be chosen to transport the goods in such regions to the coastal ports, which therefore further decentralizes the demand for container rail-sea intermodal transport.

Table1 Amount of Transfer Container by Water from Yangtze River of Shanghai Port

Year	2013	2014	2015	2016
Transfer /000 TEU	8593	9616	9954	10066
Increase Rate	—	11.9%	3.5%	1.1%

2. Availability of modern infrastructure networks

The U.S. and the EU have well-developed container rail-sea intermodal transport, not only because they have the strong market demand, but also because they have built efficient transport networks. In the U.S. and the 28 EU states, the total mileage of railway reaches 230,000 and 220,000 kilometers respectively with extensive coverage. Meanwhile, the port railways are merged into regional railway networks, with a number of railway container terminals set up for effective coordination. The railway infrastructure in the U.S., in particular, can meet the transport demand of double-stack containers, which greatly increases its economical efficiency of transport.

In addition to road networks, efficient and complete goods vehicles are also an important guarantee for container rail-sea intermodal transport. Japan, an island country, relies heavily on sea ports for direct trade, but its domestic railway transport takes up a large proportion. The full-year railway transport volume may reach 40 million tons, 58% of which is container transport, and a considerable proportion of containers are collected and distributed at ports. This is because on the one hand, the operation of Japan Freight Railway Company (JR) covers the railway transport network across Japan. On the other hand, efficient rails and modern goods vehicles are used in Japan. The existing railway lines in Japan have a gauge of 1067mm. However, such channels as Seikan Tunnel adopt third rails and share the same line with the Shinkansen, which

ensures the transport capacity of the railway freight network. Meanwhile, the Japanese railways are now mainly using the koki series of container vehicles whose speed per hour may reach 110km, and JR has more than 7200 container vehicles of various kinds.

In contrast, the railway lines for Chinese ports are only 120,000 kilometers long. In addition, though the railways enter the port areas, a lot of reloading operations are still required, with no obvious advantages. Take the Yangtze River Delta with abundant supply of goods as an example. The railway lines are not sufficiently connected with the coastal, riverside and inland ports. Only 7 out of the 19 major ports (Nanjing, Lianyungang, Wuxi, Zhenjiang, Xuzhou, Ningbo, and Wuhu) introduce railways, accounting for only 36.8%. Container rail-sea intermodal transport is not yet available at such major coastal and riverside ports as Taicang in Suzhou, Longtan in Nanjing, Nantong, Wenzhou, and Taizhou. Even Port of Shanghai, the largest container port in the world, has not connected with railways yet.

3. Cultivation of marketized operation mechanism

In terms of the market operation system, the European and American countries where container rail-sea intermodal transport is developing well mainly give support in a number of aspects, such as investment, construction, market opening and price subsidies.

- **PPP construction mode**

In the U.S., the development of container rail-sea intermodal transport relies on the developed infrastructure construction which requires huge investment. Take the construction of the Alameda Corridor as an example. Port of Long Beach adopted the PPP mode as early as in 2002, and invested US$ 2.4 billion for corridor construction. Due to the big construction scale and long period of investment return of the port railway network, it is difficult for port or railway operation enterprises to make investment, and the infrastructure construction must be carried out in a more cooperative way. In the gross capital for the construction of the rail-sea intermodal transport corridor at Port of Los Angeles, long project bonds account for 47.7%, and the federal government loan accounts for 16.5%. The rest of the capital, which is 35.8%, is mainly contributed by 2 port authorities as project sponsors and Los Angeles and Los Angeles County Metropolitan Transportation Authority, and also includes the federal government grant of US$ 58.68 million and the grant from the California government. Relevant authorities make every endeavor to get support from all parties concerned. The capital provided by the federal government, in particular, accounts for 18.9% of the project capital.

The PPP mode is introduced to attract a large amount of private capital and foreign funds to solve the capital insufficiency. Normally only 5%-20% of the project capital needs to be input, and the rest of the project capital is input by social capital contributors or through financing. In China, it is the six model routes of container rail-sea intermodal transport, which are jointly run by governments and enterprises, that carry at least 75% of the volume of container rail-sea intermodal transport nationwide. Therefore, the infrastructure for container rail-sea intermodal transport must be jointly constructed by governments and enterprises so as to develop effectively.

- **Open operation system**

The government encourages, by passing laws, the development of multimodal transport and the

marketized operations of operators. For example, the U.S. enacted the *Intermodal Surface Transportation Efficient Act* ("ISTEA") in 1991. The EU issued White Paper 2011: "Towards a competitive and resource efficient transport system". All these have helped build a good legal environment for the development of multimodal transport. Meanwhile, a good marketized operation mechanism is also of vital importance. After long-term development, the developed economies such as the U.S. and the EU have developed relatively well-established market mechanisms and competitive players. For example, there are mainly 7 railway carriers for port containers in the U.S., namely BNSF, UP, CSX, NS, KCS, GTC and SOO. There are mainly six such carriers in the EU, namely Boxxpress.de, European Railways, IGS, Komblverkehr, Metrans, and TFG.

Meanwhile, many port handling companies cooperate with railway operators in the EU, for example, Eurogate Group (Germany) is a private enterprise that offers port handling and relevant logistics services in Hamburg and Bremen, occupying an about 30% market share of the port capacity of the two places. The "BoxXpress" container rail-sea intermodal transport services that it offers are specifically in the charge of Eurogate Intermodal under it. Eurogate Intermodal ensures its railway transport by buying train schedules from DB Netze, and by leasing locomotives, trucks and employees, etc. from Siemens AG, A-AE, and MEVE-V It cooperates with many truck companies in Germany to carry out pickup and delivery operations at both ends In terms of the terminal operation, Eurogate is responsible for the internal operation of the port, while the operation of the inland intermodal transport terminal is carried out by other cooperative enterprises The relatively flexible operation mode allows it to maintain good market adaptability, but the overall intermodal responsibility is still undertaken by the operator Eurogate.

■ **Necessary preferential prices**

Even the most successful container rail-sea intermodal transport system in Los Angeles in the U.S. must be funded in many ways in terms of prices. According to the *Agreement on the Use and Operation of Port Railway* signed by and between the Alameda Corridor authority and the railway companies UP and BNSF, the authority and the 2 port railway companies jointly set up an operation committee to take charge of operations. It is agreed that the railway companies should not only pay for the containers and other trucks that use the port railway for transport, but also pay for the transport volume of other railway containers to and from San Pedro Bay Ports that do not use the corridor.

In addition to the subsidies from port and railway operators for container rail-sea intermodal transport, market pricing plays a more important part. Take the current railway operations in China as an example. The freight costs for the railways from the inland cities in Central and Western China to coastal ports are still relatively high, and are even higher if handling costs are included. The economic haul distance also keeps increasing. From China's inland cities Xi'an and Zhengzhou to its coastal cities Shanghai, Tianjin and Qingdao, etc., the unit price of freight is relatively lower as the haul distance increases, but the overall cost is still about 4000 yuan. The cost is likely to get higher if the truck loading cost at departure stations and unloading cost at destination stations are included. As water transport of the Yangtze River and other collection and distribution ways are acting as substitutes, it is difficult for container rail-sea intermodal transport to expand its business scale. With the no load ratio increasing, the freight rate per unit will still

increase and be stuck in a vicious circle.

Therefore, marketized operations need single operators that can integrate various processes, offer a uniform price by replacing the profit rate in each process with a comprehensive profit rate, and create a less expensive and more competitive market environment.

4.Comprehensive policy support

Both the EU and the U.S. are relatively successful in container rail-sea intermodal transport in today's world. Their development history clearly shows that in addition to such factors as geographical locations, market distribution, industrial structure and infrastructure, their governments have all attached great importance to the development of the railway collection and distribution system, and guided or encouraged it by introducing policies. Specifically, in the "Roadmap to a Single European Transport Area– Towards a competitive and resource efficient transport system" and many other files, the EU points out that more road freight should be transferred to railway and waterway by developing multimodal transport. The U.S. is more active in this regard, and in the ISTEA, it proposes the construction of an efficient and environment-friendly national multimodal transport system. The U.S. Department of Transportation has regarded the increase of the multimodal transport efficiency as the primary objective and task in each of its five-year strategic plans.

In Europe and the U.S., international container rail-sea intermodal transport follows the principle that market breeds demands while demands promote development. China has a huge port system with its hinterland market gradually growing. However, the distribution of goods sources and the relatively cheap waterway transport competition in the Yangtze River Delta and the Pearl River Delta have hindered the development of the container rail-sea intermodal transport market to some extent. It cannot be denied that even in China, container rail-sea intermodal transport still has a large market demand, but it tends to follow a path featuring policy guidance, industrial transfer, infrastructure construction, gradual cultivation of market demands, and has greater difficulty in development compared to that in European and American countries. It is believed that the container rail-sea intermodal transport market in China will definitely develop gradually after a series of measures are taken in the future, such as streamlining the management system, decreasing intermediate costs, developing the information system, building up railway networks, optimizing the business environment, and enhancing policy support.

3.1.2 Development of automobile logistics at ports

Automobile logistics is comprehensive logistics that integrates transport of automobile parts and finished automobiles, warehousing, package, custody, handling, repacking, as well as logistics information. The core of automobile logistics at ports is ro-ro automobile terminals. In addition, as automobile logistics at ports is getting professional and as automobile users become highly decentralized, the mode that combines professional ro-ro terminals with global automobile logistics and building of a global ro-ro "port chain" have become an important breakthrough for port operations.

The development modes of international advanced automobile ro-ro terminals show that as the major logistics nodes, automobile ro-ro terminals are closely correlated with automobile

manufacturers and logistics providers, and their development modes, by dominator, are made up of the mode dominated by port groups, mode dominated by logistics providers, mode dominated by shipping companies, and free trade zone mode.

Port of Koper – the port operation mode dominated by port groups. Port of Koper is adjacent to such traditional automobile manufacturing countries as Germany, Italy, Czech, and Slovakia. Port of Koper is developing well in automobile logistics, because on the one hand, its industrial system in the hinterlands decides its focus on automobile services, on the other hand, Port of Koper Group actively promotes sales to customers in the hinterlands on a targeted basis, and signs transport agreements with key customers. It also actively contacts with shipping companies to set up fixed ship routes for customers, and to build a "portal" for automobile transport in the world.

Port of Bremerhaven – the port operation mode dominated by logistics providers. The automobile services at Port of Bremerhaven are mainly offered by BLG, a German automobile logistics company. Therefore, BLG regards a port as an important node in the entire logistics system. BLG sets up a series of processing and transshipment centers for finished automobiles and parts at Port of Bremerhaven. A large number of BLG-controlled finished automobile logistics centers cluster around the port, finishing Pre-Delivery Inspection (PDI), and installation and repacking of such optional components as air conditioners, navigation systems, and seats. BLG has built Port of Bremerhaven into a supplier that offers automobile transport, warehousing and delivery services in order to decrease costs of automobile customers and increase the efficiency of global automobile logistics.

Port of Zeebrugge–port operation mode dominated by shipping companies. The main business of Port of Zeebrugge is transshipment of global automobiles, and more than 2.2 million new automobiles are transported every year. Port of Zeebrugge's developed waterway transshipment business decides that it relies more on international automobiles in foreign cooperation. The international and intercontinental automobile forwarding agents of shipping companies set up their supporting logistics centers here for repacking in the form of joint ventures or sole proprietorship. The IOC automobile logistics terminal, in which NYK makes investment and controls at the port, is a typical example.

Port of New Jersey – free trade zone mode (processing materials supplied by clients). Relying on the preferential policy of New York Free Trade Zone, Port of New Jersey has built a characteristic automobile logistics mode. New York Free Trade Zone is one of the earliest modern free trade zones in the world. The almost free ultralow tariff rates for the factories in the free trade zone have attracted a number of automobile enterprises to settle down here, set up their core unit factories, and import relatively "cheap" parts from other parts of the world by relying on the policy of the free trade zone. The free trade zone creatively made the "inverted tariff policy" in order to further attract automobile manufacturers to settle down: the local customs' tariff for finished automobiles is lower than that for parts and raw materials. Therefore, after finishing assembly of the finished automobiles in the free trade zone, the automobile enterprises in New York Free Trade Zone may launch the products into the domestic market or export them at a low tariff rate, creating a unique automobile logistics service mode for the free trade zone of the port.

Driven by the global supply chain mode, a large number of automobile ro-ro terminals will transform from traditional terminals that offer handling services into comprehensive automobile

logistics centers that integrate collection and distribution, simple processing, assembly, finance, information, and multimodal transport. The automobile value-added service mode not only allows physical displacement of automobiles at automobile ro-ro terminals, but also allows distribution processing services to be offered at automobile ro-ro terminals according to customers' requirements. Such processing services add value to goods during port transshipment, thus increasing port functions.

3.2 Development trend of port integration

3.2.1 US ports resource sharing

◆ **Terminal resource sharing among the US ports**

The States enjoy a number of ports along its eastern and western costal lines. Under the landlord-model-dominant management, the US main ports, such as Port of Los Angeles, Port of Long Beach, Port of Miami, and Port of New York and New Jersey, have separated management and property rights. The regional terminal managers only manage the terminals under their jurisdictions, and do not have the authority to coordinate with the other neighboring ports in the region or ports outside of the region to provide coordinated services. It has led to shortages of berths due to limited shoreline and terminal capacities for some busy ports, and in the meantime vacancies of berths in over-capacity ports. The berth utilization rates among ports are highly unbalanced.

To address the heavy congestion brought by large-scale ships and under-capacity of a terminal, the US ports are adopting approaches including reducing the number of port operators, improving shared areas of rear port land, and constructing unified port authority so as to enable resources sharing for better utilization of the port resources. Under the landlord management model represented by the US ports, through leasing of port sources and services, without changing the ownership of the terminal operators, resource sharing can be realized.

◆ **Logistics resource sharing among the US ports**

The logistics operators provide services mainly through purchased free logistics infrastructures. But due to limited size and service capacities of owned logistics capacities, the ports are in heavy traffic when they do not have enough cranes and chassis. The US port industry, after outburst of labor disputes and congestion issues at the end of 2014, has built chassis fleets of proper size, increased the loading equipment, constructed shared logistics infrastructures in ports such as free cargo collection system, so that the terminal managers can offer leasing services and improve the efficiency of port resource sharing.

3.2.2 China port resource sharing

In 2017, the port resources from Liaoning, Jiangsu, Fujian and Guangxi were integrated with Tianjin & Hebei Port system and the world-class port groups in Guangdong, Hong Kong and Macao Bay Area. The port source integration now covers almost all coastal provinces in China.

There are three integration models based on the current port system in China: first is government-led model such as the Zhejiang Maritime Port Management Committee established by Zhejiang Province with cross-jurisdictional authority, and the administration resource integration in North Bay in Guangxi and three ports in Fujian; second is market-led model under guidance of the government, as in the case of merge of province-affiliated port and shipping companies and state-owned ports in Nanjing, Lianyungang, Suzhou and Nantong into the Jiangsu Port Group with the help of market mechanism; and third a pure marketized model which relies on the market mechanism in realizing resource integration via mergers and acquisitions, such as the "Yangtze River" strategy by the Shanghai International Port Group and "Dry Port" strategy of Ningbo Zhoushan Port Group. These are results of market-driven resource integration.

Though China's port integration is on the march as the integration models are improving. But in the process of integration, it encounters three resistances posed by administration, market and capital due to the intertwining entities, goals and resources. While port resource integration is a leading trend in port development, we should seek breakthroughs by enhancing the governance design and establishing diversified financing channels.

Special topic III: "Ubernization" trend in the port and shipping industry

In recent years, with fast emerging of e-commerce trades, many industries are being "e-commerce-oriented". In the transportation industry, a number of e-commerce platforms such as Uber and Didi are changing the ways things are done in this conventional industry. Thanks to expansion of information technologies, the port and shipping area has introduced in online trade and service platforms such as port network communications services network, matouwang.com, and PORTNET. In the transportation services industry, the platform sales are replacing the conventional freight forwarders, insurance agents, and ship brokers as a new state of business. The greatest advantages are in direct comparison and selection, as well as easy online ordering.

1.Utilizing port logistics information platform

Uber's fast expansion as a sales and customer experience platform is supported by industrial information technologies. The port and shipping industry happens to have good basis in this regard. Due to unique demands in goods trades, the technologies of internet of things, GPS, and AIS were first applied in the logistics and trades, then followed by information systems on goods monitoring and integrated trade systems. They have provided great support for the efforts in improving efficiency of online trades by the port and shipping industry.

Nowadays, both domestically and globally, there are good port logistics information platforms. For example, the TRADENET and PORTNET of Singapore, which has been in place for years, has helped to realize paper-less communications between government, shipping companies, shipping agents and shipowners. The TRADELINK platform used in Hong Kong, by connecting the local manufacturers and government authorities, provides functions such as export license declaration and digitalized export approvals, as well as trade procedural updates and customs

information search. Korea's KTNET platform enables online trade business which is completely realized in digital ways, including issuing letter of credit, arrival notice, payment notice, bank guarantee, purchase request, insurance request and customs request. Additionally, the US Customs offers a number of online systems such as ACE for tracking, controlling, and handling all goods entering the States, and keeps communications with the Customs and Border Protection Agency, relevant governmental agencies, and trade players.

2. "Internet+Port & Shipping" model upgraded by "Ubernization"

In the year 2017, the port and shipping companies have wide cooperation to break the limits of "Internet + Port &Shipping" model. The China Merchants Group (CMG) and Tencent have entered strategic partnership agreement to launch smart port, energy transportation and trades applications. It was followed by online booking platform which is a joint effort of Maersk and Alibaba. Other port and shipping companies are following suits and launching online booking and information sharing products and services with the internet companies. The "Ubernized" booking and shipping model is on the rise in the area of port, shipping and transportation.

Maersk is a typical representative. In 2017, though subject to severe online attacks, Maersk did not delay its progress in online development, and is more determined than ever to pursue the digitalized strategy. In December 2017, it launched the brand new online booking platform ship.maerskline.com, which provides real time price and booking for customers and issues shipping space and collection guarantee. Under this service model, it provides customers with end-to-end booking services, instant confirmation of booking information and prices, which can be revised with the help of the online chat tool. Customers are entitled to more controls with the help of this booking platform. Maersk makes redemption when the orders placed by customers fail to follow through. The booking service not only provides customer with better booking and search services, but also sets up new standards and rules in a "Ubernized" way.

The "Ubernized" service model offers convenience in booking. Clear pricing and service standards under this model improve the transparency in pricing and service commitment, thereby enabling better customer experience. At the same time, the port and shipping companies, in collective efforts, provide the goods owners with the best guarantee on shipping time and timetables, which contributes to stable supply chain on the customer end and mutual benefits to the customer and the port and shipping companies.

3.Port and shipping industry reform under "Ubernization" model

A "Ubernized" model, in addition to positioning and monitoring technologies such as GPS, AIS, internet of things, and platform integration IT techniques, relies on the market demands and industry development needs on an operational level. On one hand, "Ubernization" sets new rules to improve service quality and customer experience, enhance stability and reduce cancellation with the help of platforms. To do so, the key is to realize coordination among the ports, shipping, logistics, and warehouse companies, as well as communications with the port, customers, and border defense authorities. In this way, it utilizes the credit system, monitoring system and paperless declaration system for better administration and regulation efficiency to facilitate transportation. On the other hand, "Ubernization" revitalizes the resources on the supply end, reduces operational costs and improves service output with integrated upstream and downstream

resources. The "Ubernized" model meets specific demands of customer groups by utilizing the idle resources, and achieves win-win outcomes for the customer and companies. It helps with the congestion issues in hub ports, and cultivates new markets demands by revitalizing the small-and-medium-sized ports and shipping companies in the neighboring area.

3.3 Port management

3.3.1 Port fee-collecting reform in China

On September 15, 2017, China's Ministry of Transport, jointly with the National Development and Reform Committee, issued the Measures for Charging and Billing at Ports. Main changes made to the Measures include: reducing fee charging items using government pricing, reforming pricing of tug fee, improving the pilot fee structure, adopting market-adjusted fees on tally fee and service fee, and removing the multi-point parking fee discount on international shipping, and unifying regulation on free storage period. The revised Measures further reduces burdens on the companies and saves the port and shipping companies about 200 billion yuan annually by estimation. The market-oriented and regulated port fee collection system is in place.

In terms of the port fee-collecting structure, China's reform on port fee collection is consistent with the international practices. The tug fee adopted by the ports is mostly based on the conditions of the ships being tugged. China's approach in changing the fee collecting based on tug power and usage time to a model based on ship size and type is in line with the fee collection systems in a market-oriented system.

Table3-1 International Rules of Tug Fee Charges

Port	Charging Basis
Hamburg	Gross Tonnage
Bremerhaven	
Rotterdam	Ship Length & Towing distance
Le Havre	Ship Length
Lisbon	Gross Tonnage & Tug Power
New York	Net Tonnage
Los Angeles	Working Hours
Singapore	Gross Tonnage & Working Hours
Tokyo	
Yokohama	
Osaka	Tug Power & Working Hours
Nagoya	Gross Tonnage & Working Hours/ Tug Power & Working Hours

Source：*China Ports*,2017.11.

In terms of the port fee pricing, China's fees are overall lower than the other countries and regions. Take cargo loading fee as an example, Mainland China ports charge moderately lower fees than ports in Taiwan and Macao, and much lower fees than the developed countries.

Table3-2 Comparison of Container Handling Charges of Different Countries/Area

Countries/Area	Container Handling Charges ($/TEU)
Shanghai	85
Shenzhen	150
Guangzhou	100
Hong Kong	200
Singapore	250
Africa	250
Europe	150-200

Source：*China Ports*,2017.12.

3.3.2 PSR implications on ports

In March 2017, the Port Service Regulation (PSR) came into effect, which requires the member states to implement the legislation before March 24, 2019. The PSR mainly regulates the framework of port services, including mooring, trailer, refueling, and emission as well as the fiscal transparency arrangements on the core port network and comprehensive port network under TEN-T.

From the perspective of EU ports, the PSR will bring the port companies' profits. On one hand, the PSR allows exemptions on port services including refueling, emission, mooring, and tugging for EU ports; on the other hand, some ports run by operators can dispose the fee income at their own initiatives.

However, from the perspectives of private terminal operators and port users in EU, the implementation of the PSR may jeopardize their interests. The PSR requires enhanced transparency on ports, which may harm the funding and commercial information security of private terminal operators. Additionally, the PSR does not regulate passenger service, cargo, pilotage and dredging. If the PSR is accepted, the port users are in a passive situation. For the shipowner and terminal operators, the implementation of PSR may lead to port monopoly and downgrading of port service quality.

IV. Comments on development of global terminal operators in 2017

4.1 Overview of development of global terminal operators

In 2017, as the world economy is back on its feet and trade conditions are improving, with enhanced trades between Europe and US and China, the global terminal operators are witnessing steady growth of the port business. But under the backdrop of overcapacity of the port industry and restructuring of shipping alliance, their profitability is under threat. Some terminal operators are adjusting their own assets, and seeking new opportunities, extensive services, and diversified growth.

4.1.1 Changes in production capacity of global terminal operators

In 2016, the operator-controlled terminals generated about 59.8% of capacity around the world. Based on Drewry anticipation, in 2017, the global terminal operators will account to 61.2% of the overall capacity. The growth of operator-controlled terminals is attributed to the efforts into new overseas markets by operators such as Hutchison Whampoa, COSCO Shipping and CMG, and on the other hand, as well as the large-scale terminals jointly with Ports America, and SAAM Ports in Chili being included in the calculation of the capacity of operators. According to Drewry, the capacity controlled by global operators will peak in 2018, and further decline from 2020 and stabilize at 60%.

Table 4-1 Estimated Changes of Global Terminal Operators' Capacity and Market Share

Year		2016	2017	2018	2019	2020	2021	Ave. Annual Growth
Global Operators	Capacity	630.0	666.3	692.4	708.3	722.4	726.8	2.9%
	Share	59.8%	61.2%	61.1%	61.1%	60.8%	60.5%	—
Other Private Sector	Capacity	201.8	200.4	208.4	213.0	216.9	219.0	1.6%
	Share	19.2%	18.4%	18.4%	18.4%	18.3%	18.2%	—
State Sector	Capacity	214.2	215.3	222.8	227.6	235.3	238.9	2.2%
	Share	20.3%	19.8%	19.7%	19.6%	19.8%	19.9%	—
Other	Capacity	7.1	7.3	9.1	10.9	13.6	16.0	17.5%
	Share	0.7%	0.7%	0.8%	0.9%	1.1%	1.3%	—
Total (million TEU)		1053.2	1089.3	1132.7	1159.8	1188.1	1200.7	2.7%

Source: Drewry, Global Terminal Operators Report, Sorted by SISI.

4.1.2 Market share changes of global terminal operators in various regions

From the cargo handling capacities by regions in 2016, the highest operator-controlled capacities are in Asian, European, Mideast, and Indian subcontinent, all at over 65%. The merger and acquisition activities of global terminal operators have direct impact on the market share. In 2016, in North America, the operator's market share increased by 3%, while in Latin America, CMA CGM's merger with KCT drove the operator's market share in Latin America up by over 4%. In addition, the global terminal operator's good market shares in African markets, and Latin American markets (54.2%) indicated the preference of operators in emerging markets.

Table 4-2 Changes of Global Terminal Operators' Throughput by Region and Market Share

Region	Throughput /1000TEU	2016 Market Share (%)			Global terminal operators' market share change
		Global terminal operators	Other private companies	Public companies	
North America	59020	59.2	19.4	21.4	↑2.9%
Europe	121460	66.6	25.6	7.8	↑2.4%
Asia	377860	66.9	10.1	23.0	↓2.3%
Middle East and Indian subcontinent	62860	65.3	15.3	19.5	↓0.1%
Latin America	42270	54.2	33.0	12.8	↑4.4%
Africa	23960	53.6	6.7	39.6	↓0.2%
Oceania	11700	29.7	60.7	9.7	↓1.1%
Total	699120	64.2	16.2	19.7	↓0.3%

Source：Drewry, Global Terminal Operators Report, Sorted by SISI.

4.1.3 Profitability of global terminal operators

According to Drewry, in 2016, the main terminal operators all had declined profit per container but Philippines international and Dubai Global. Most of the operators have deteriorated annual profits. In 2017, although the operator-controlled ports have growth of handling capacities at varied levels and much improved port incomes, it is anticipated that the profit per container will drop further.

Table 4-3 Profitability of Global Terminal Operators in 2016

Terminal Operator	Revenue /Million USD	Growth (%)	Earnings /Million USD	Growth (%)	2016年		2015年	
					Unit Revenue /USD	Unit Earnings / USD	Unit Revenue /USD	Unit Earnings / USD
Eurogate	685	1.8	164	-3.0	46.9	11.2	46.2	11.6
HPH	4149	-5.8	1501	-2.9	52.4	19.0	54.2	19.1
ICTSI	1128	7.3	525	16.7	129.8	60.4	135.2	57.9
PSA	2577	2.0	1248	-1.8	38.1	18.5	39.4	19.8
APMT	4176	-1.5	764	-10.6	55.5	10.1	56.9	11.3
COSCO	556	1.1	185	-16.8	35.4	11.8	36.3	14.2
DPW	4163	4.9	2114	12.7	142.4	72.3	136.3	64.4

Note：1）All operators' revenues refer to EBITDA;

2）Unit revenue and unit earnings are calculated on the basis of equity throughput.

Source：Drewry, Global Terminal Operators Report, Sorted by SISI.

Table 4-4 ROIC of APM Terminals

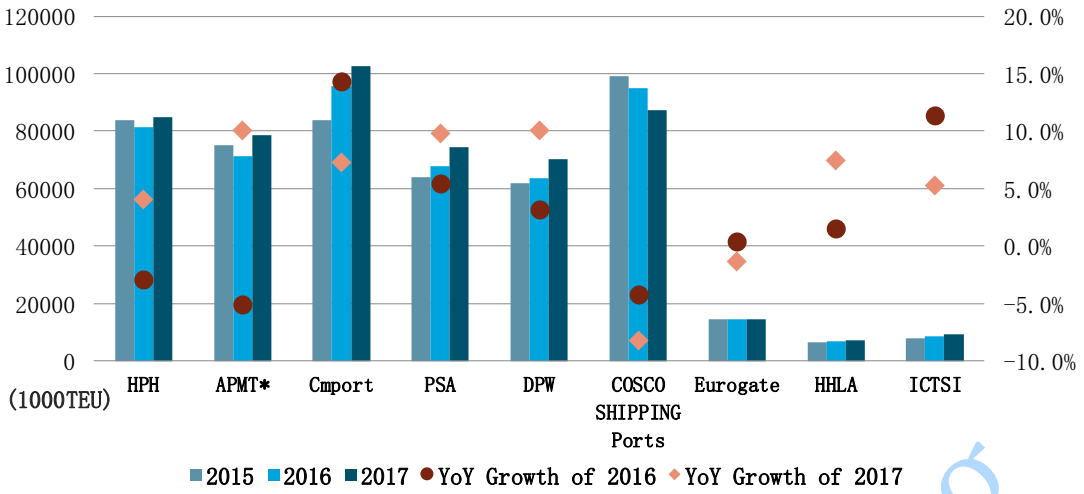
Year	ROIC/%	Year	ROIC/%
2008	7.3	**2013**	13.5
2009	10.0	**2014**	14.7
2010	10.4	**2015**	10.9
2011	13.1	**2016**	5.7
2012	15.2	**2017**	-2.1

Source：APM Terminals' websites.

4.2 Analysis on business performance of global terminal operators

4.2.1 The throughput of CMport ranks first in the global terminal operators

In 2017, the top 6 terminal operators all have good development but COSCO Shipping. Its handling capacity has dropped due to shareholding changes of the Qianwan Terminal. There is not much change in terms of ranking among the top 6. The CMG Port is ranked the top for the third year in a row in terms of capacity that exceeds 1000 million TEU for the first time. The Singapore International, overtaking Dubai Global, is the 5th largest operator with 9.8% increase of overall capacity thanks to terminal expansion and joint campaigns.



Note: *represents estimate;

Source: various terminal operators' websites.

Figure 4-1 Total throughput of Global Terminal Operators in 2017

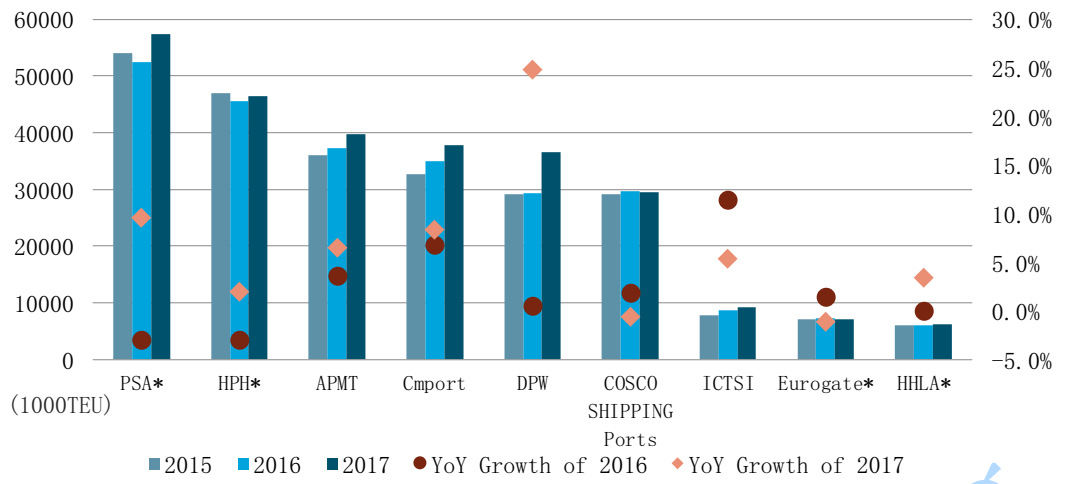
Table 4-5 Throughput Rank of Global Terminal Operators in 2017

Rank	Terminal Operator	2017 /1000TEU	2016 /1000TEU	YoY Growth/%
1	CMport	102690	95680	7.3%
2	COSCO SHIPPING Ports	87310	95070	-8.2%
3	HPH	84700	81400	4.1%
4	APMT	78600	71400	10.1%
5	PSA	74240	67630	9.8%
6	DPW	70080	63660	10.1%
Total	Six terminal operators combined	496220	474840	4.5%

Source: various terminal operators' websites.

4.2.2 Growth of equity throughput of global terminal operators picks up

In 2017, the top 6 collectively processed 2500 million TEU, and all have improved capacities but COSCO Shipping. By overall rankings, Singapore International is the top while Dubai International overtakes COSCO Shipping because new projects with Busan port and Ecuador Terminal in 2016 have improved its 2017 equity capacity by a large margin. The other operators' ranking remains consistent with last year.



Source: various terminal operators' websites.

Note: *represents forecast.

Figure 4-2 Equity throughput of Global Terminal Operators in 2017

Table 4-6 Equity Throughput Rank of Global Terminal Operators in 2017

Rank	Operator	2017/1000TEU	2016/1000TEU	YoY Growth/%
1	PSA	57400*	52400	9.5%
2	HPH	46500*	45600	2.0%
3	APMT	39700	37300	6.4%
4	CMport	37790	34900	8.3%
5	DPW	36480	29240	24.7%
6	COSCO SHIPPING Ports	29400	29610	-0.6%
Total	Six terminal operators combined	247270	229050	8.0%

Source: various terminal operators' websites.

Note: *represents forecast.

4.2.3 A good turn of Hutchison Whampoa

In 2017, agreements between Hutchison Whampoa and COSCO Shipping on the Hong Kong's Kwai Tsing No. 4, 6, 7, 8, and 9 terminals become effective. The joint operation approach not only mitigates the pressure from competition, but also plays an active role in promoting business growth. In 2017, Hutchison Whampoa realized an overall handling capacity of 84.70 million TEU, up by 4.05% year on year against under-performing markets.

In terms of equity handling capacity, Hutchison Whampoa has 46.5 million TEU, up by 2.0 percentage over last year. It is closely related to its overseas investment for expanded portfolios.

4.2.4 Steady operation of APM Terminals

AP Muller Terminal processed 39.7 million TEUs in 2017, up by 6.4% year-on-year and 2.8

percentage points over last year.

From an annual angle, operations of new terminals in Mexico Lhasa Rokadeas Port, Turkey Izmir Port, and Guatemala Quetzal Port invested by AP Muller and Maersk contribute to the increase of equity handling capacities for 4 quarters consecutively.

4.2.5 Continued growth of PSA International

In 2017, Singapore International processed 74.24 million TEU containers, up by 9.8% year-on-year. 40.89 million TEUs is realized in overseas, up by 10.4% over last year. In Singapore, domestic terminals realized 33.35 million TEUs, an increase of 9.0% year-on-year.

From equity handing capacities, it is estimated that Singapore International had 57.6 million TEU in 2017, up by 9.5% year-on-year. The robust business of Singapore International is due to continuous expansion of domestic port, improved level of automation that has driven up terminal operation efficiency and operation income, and the operation of group's invested terminals in Port Rodman, Panama and IDTPP, Tanjung Priok that have pushed the overall business directly.

4.2.6 Spiked growth of DP World

In 2017, Dubai Global had overall capacity of 70.079 million TEU, up by 10.1% year-on-year, and by 6.9 percentage points over last year. The prospects are good. In 2017, it had equity capacity realized at 36.476 million TEU, up by 24.7% year-on-year.

Its growth is fueled by the operation of terminals in Prince Rupert Port in Canada and in Ecuador that has driven up the group's market share and increased its container handling capacity, and by the approach in seeking new opportunities in global supply chain and making diversified investment portfolios that improves the collection and transportation efficiency of goods in port area and enhanced demands for shipping.

4.2.7 China COSCO Shipping Group ports runs low

In 2017, COSCO Shipping's overall container handling capacity is 87.312 million TEUs, down by 8.2% year-on-year, and further down by 4 percentage points over last year. The underlying reason for the decrease is that the handling capacity of Qingdao Qianwan Container Terminal is no longer counted as the COSCO share. If we take out the Qingdao Qianwan capacity from last year's data and make the comparisons, COSCO's capacity is up by 12.6% year-on-year, and exhibits a positive growing trend.

By regions, the equity handling capacity of COSCO Shipping has suffered from a 43.1% drop in the Bohai region due to exit from Qingdao Qianwan Terminal, but has positive growths at 3.4%, 16.8%, 19.2%, 11.6% and 32.3% in regions of Yangtze River Delta, Eastern Costal Area, Pearl River Delta, Southwestern Costal Area, and Overseas. Among them, the overseas markets have contributed new market growth momentum thanks to high quality balanced distributed terminal network by buying in multiple terminals in 2017. The overseas handling capacity increased by 32.3%, marking the best performance among regions.

From the profitability, excluding the special items, the terminal business of COSCO for the first half of 2017 has a profit at 1270 million USD, down by 4.5% year-on-year. The income of the company, mostly from the Piraeus Terminal in Greece and the Nansha Container Terminal in Guangzhou, has declined with both terminals.

4.2.8 Breakthroughs of China Merchants Port Holdings Ports

In 2017, CMG Port's container handling capacity exceeds 1000 million TEU for the first time, accumulatively at 10.2687 million TEU, which is a record high. The CMG Port's container handling capacity has been steady, for it has been expanding the presence by buying out terminals in and outside of China to improve its port arrangements.

By regions, the equity handling capacity of 6 main regions for CMG Port all have growth. First, the overseas region, thanks to the operation of Doraleh Multipurpose Port in Djibouti, and good business with the Port of Colombo in Sri Lanka, Lome Port in Togo, and Kumport of Turkey, it has seen a growth rate at 9.4% with improved equity handling capacity for the overseas area. Domestically, though the Qingdao Port has negative growth, the high growth at 32.5% with Dalian Port area drove up the positive growth the region at a rate of 2.3%. With the Yangtze River Delta area, the equity handling capacity realized growth at 8.9% with increase of import and export lead by trade recovery and re-alignment of shipping alliance. In the Eastern Costal Area, the CMG Port has a growing equity handling capacity by 69.2% thanks to its purchase of 60% ownership of Shantou Port. The Pearl River Delta and Southwestern Costal Area also have fast growth respectively at 6.9% and 24.1%.

4.2.9 Downward performance of EUROGATE Container Terminal

In 2017, terminals owned by Eurogate Group achieved handling capacity of 14.413 million TEU, down by 1.4 percentage points.

By regions, the three main ports of Eurogate Group in German have overall capacity at 7.778 million TEU, down by 5.5% year-on-year. The alliance change has led to changes of shipping routes and loss of customers, and in turn caused drastic decline of container capacity in the Port of Hamburg at 25.6% and overall decreased regional capacity. It is the same case with the Italian region which has a capacity at 4.637 million TEU down by 7.5% year-on-year. Though the group has poorer performance in German and Italy, the Portugal and Morocco terminals have high growths at 25.9% and 22.9%.

4.2.10 Robust operation of ICTSI

In 2017, the Philippines International processed 9.153 million TEU containers, up by 5.3% year-on-year. Though down last year, it has been growing for the 8th year in a row. The overall trend is good.

Since 2017, the Philippines International's business has been supported by the new routes launched at the Port of Manzanillo in Mexico, as well as new terminals at Matadi Port in Congo, Port of Melbourne in Australia, and Port Agua Dulce in Columbia. In addition, the Philippines

International, in joint efforts with Evergreen, piloted the direct shipping routes that connect South Korea, Taiwan China and Philippines at Port of Subic Bay. It has contributed to the increase of the port capacities and trade activities among these areas.

4.3 Analysis on investment and construction situations of global terminal operators

4.3.1 Investment distribution of major terminal operators

In 2017, the capital investment of the world's major terminal operators in terminals still focused on the capacity expansion of the ports, especially those ports with development potential in the Americas and Middle East. Moreover, terminal operators further strengthened their cooperation with shipping enterprises. For instance, Singapore established joint ventures with CMA CGM and COSCO Shipping respectively to jointly promote the expansion of the ports.

Figure 4-3 Major Global Terminal Operators' Construction Investment in 2017

◆ **Hutchison Whampoa(HPH)**

Widespread investment was made to expand the global terminal network. In 2017, Hutchison Whampoa invested US$450 million in the Americas to support the construction of the new terminal at Veracruz Port, Mexico; in Europe, Hutchison Whampoa first explored the Nordic market and signed an operating contract with Norvik Port under construction in Stockholm, and then strived to improve the terminals at Felixstowe Port in the UK to adapt to large-scale vessels; in Asia, in addition to the construction of a new container terminal at the Laem Charbang Port in Thailand, Hutchison Whampoa obtained the franchise rights of two terminals in the UAE, which is an important node along the route of Belt and Road Initiative.

◆ **APM Terminals(APMT)**

The strategy was shifted to offloading non-core assets. In 2017, the reorganization of the

shipping alliance and Maersk Line's acquisition of Hamburg Sud resulted in the duplicate allocation of routes and terminal resources to some extent. In this context, APM Terminals made strategic adjustments in time and successively withdrew from several non-mainstream ports, such as Paranagua Port in Brazil, Zeebrugge Port in Belgium and Tacoma Port in the United States, focusing on developing the existing core assets and increasing the utilization rate and operation efficiency of existing terminals. In 2017, APM Terminals only expanded the Port Elizabeth and Port of Mobile in the United States.

Table 4-7 APM Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity /1000TEU	Investment /million dollars	Construction /Operation
Paranagua	—	—	—	—	Transfer
Zeebrugge	—	—	—	—	Transfer
Tacoma	—	—	—	—	Sublet
Elizabeth	—	—	—	200	Expand
Mobile	—	—	650	50	Expand

◆ **PSA International**

Existing terminals were consolidated and joint operation was realized. In 2017, Singapore's PSA International shifted its investment to capacity expansion and equipment upgrade of existing terminals, and further strengthened joint operation with shipping enterprises. In March 2017, Singapore's PSA International and France's CMA CGM jointly launched the Phase II Expansion Project of CMA CGM-PSA Lion Terminal (CPLT). At the end of the year, PSA International signed a memorandum of understanding with COSCO Shipping to build a third new berth in Singapore and consolidate the status of the Port of Singapore as a global container hub port. In overseas regions, PSA International completed the upgrading of facilities and equipment at the MPET and Noordzee terminals of Antwerp Port in 2017. In the meantime, the Phase II Expansion Project of PPIT terminal at Panama Port is also in steady progress.

Table 4-8 PSA Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity/1000TEU	Investment /million dollars	Construction /Operation
PSA Antwerp Terminal	+140	—	1340	—	Expand
PSA Panama International Terminal	800	—	200	4.5	Expand
CMA CGM-PSA Singapore Terminal	—	—	400	—	Expand
COSCO-PSA Singapore Terminal	—	—	300	—	Expand

◆ **DP World**

Stable operation was maintained and investment portfolio was diversified. In 2017, the capital investment of DP World exceeded US$1 billion. On the one hand, DP World steadily promoted the investment in and acquisition of the terminals and achieved complete control over

the Embraport Port of Brazil. On the other hand, DP World expanded and upgraded the Port of Jebel Ali in the UAE and Berbera Port in Somalia to expand the markets in the Middle East and Africa.

Table 4-9 DPW Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity /1000TEU	Investment /million dollars	Construction /Operation
Santos	653	—	1200	540	Shareholder
Berbera	400	—	—	440	Expand
Jebel Ali	—	15.5	19300	1600	Expand

◆ COSCO Shipping Ports Limited

Overseas terminals were expanded and mature ports were preferred. In 2017, as its overseas strategy, COSCO Shipping Ports Limited first took a share in Noatum Port of Spain, and later accepted a 76% stake of APM Terminals in Zeebrugge Port of Belgium, completing the company's first terminal holding in Northwest Europe. As its domestic strategy, COSCO Shipping focused its investment on the hub port, successively spent huge sums of money to acquire shares in Qingdao Port and Shanghai International Port Group, and continuously strengthened its control and operation capabilities over terminal assets.

Table 4-10 COSCO SHIPPING Ports Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity/1000TEU	Investment	Construction /Operation
Zeebrugge	900	15.2	1200	35 million Euro	Shareholder 76%
NOATUM	750	—	—	204 million Euro	Shareholder 51%
SIPG	—	—	—	18.9 billion CNY	Shareholder 15%
Qingdao	—	—	—	5.8 billion CNY	Shareholder 17%

◆ China Merchants Port Holdings

The scale was enlarged and the global network layout was strengthened. In 2017, China Merchants Port Holdings Co., Ltd. first completed its acquisition of Hambantota Port in Sri Lanka which had been under negotiations for years, and then reached out to the South America for the first time and acquired a 90% stake in Paranagua Port of Brazil. At home, China Merchants Port Holdings Co., Ltd. continuously improved the port network layout in the Pearl River Delta, successively acquired shares in Shantou and Zhongshan ports around Shenzhen Port, and thus formed a complete network of mainline ports and feeder ports in the Pearl River Delta region, and enhanced the port resource allocation capability and market influence of the Group in the region.

Table 4-11 CMPort Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity/1000TEU	Investment /million dollars	Construction /Operation
Paranagua	—	—	1200	6026	Shareholder 90%
Hambantota	—	—	—	6570	Shareholder 85%
Shantou Port	—	—	—	5432	Shareholder 60%
Zhongshan Port	1000	12	550	485	Shareholder 51%

◆ **ICTSI**

Steady investment was made and port capacity was continuously expanded. In 2017, International Container Terminal Services Inc. (ICTSI) acquired a 34.8% stake in Manila North Port from Petron Corporation, the largest oil refining enterprise in the Philippines. In the meantime, the good performance of Umm Qasr Port in Iraq prompted the ICTSI to invest US$100 million in a new round of expansion of the Basra Terminal in that port area. The annual throughput of this terminal will increase to 1.2 million TEUs, which can meet the demand of larger vessels. In addition, ICTSI's expansion project in Cortez Port of Honduras is in steady progress, which will add a new berth of 350 meters long.

Table 4-12 ICTSI Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity/1000TEU	Investment /million dollars	Construction /Operation
Basrah	600	—	1200	100	Expand
Honduras-Puerto Cortes	350	15.5	—	1600	Expand
Manila North	—	—	—	35	Shareholder 34.8%

◆ **Terminal Investment Limited(TIL)**

Timely investment was made to expand the market in the Americas. In 2017, TIL and HMM jointly acquired Hanjin Shipping's equity in ports on the West Coast of the United States, including the ports of Long Beach and Seattle, and expanded its port business coverage on the Pacific coast. In South America, MSC incorporated the remaining 50% stake in Brazil's Portonave into its portfolio and achieved full control of the port.

Table 4-13 TIL Terminal Construction Investment in 2017

Port	Quay Line Length/m	Water Depth/m	Design Throughput Capacity/1000TEU	Investment /million dollars	Construction /Operation
Portonave	—	—	—	390	Purchase
Long beach and Seattle	—	—	—	—	Purchase

4.3.2 Investment trend of global terminal operators

1. Diversified investment portfolios and extension to inland services

In 2017, the mergers and acquisitions of global terminal operators have weakened compared with the previous year. Apart from Hutchison Whampoa, China Merchants Port and COSCO Shipping that continued to expand their global port layouts, other global terminal operators put more emphasis on investment in logistics infrastructure and expansion of existing terminals, showing more flexible modes of investment. For example, APM Terminals, DP World and PSA International didn't build new terminals in 2017. Among them, APM Terminals transferred its shares in multiple terminals, and shifted its investment strategy to inland services behind the ports; DP World was also constantly seeking new investment channels, preferring the investment in logistics centers and industrial parks in the port area, expanding the scope of business services and driving the development of surrounding area of the port. Under the current situation of excess

capacity and intensifying competition at ports, diversified investment portfolios may become the dominant trend for the development of global terminal operators in the coming period.

2. Alliance and M&A among shipping enterprises promoted terminal cooperation and joint operation

In 2017, the reorganized shipping alliance began formal cooperation, Hapag-Lloyd and United Arab Shipping Company (UASC) completed their integration, and Maersk Line announced its acquisition of Hamburg Sud. A series of integrations and M&A among shipping enterprises led to their continuous re-adjustment of route distribution and affiliated enterprises, which directly affected the operating performance of global terminal operators. In this context, global terminal operators began to actively seek for cooperation and joint operation. In 2017, Singapore's PSA International first cooperated with France's CMA CGM to expand Pasir Panjang Terminal in Singapore, and later set up a joint venture with ICTSI to jointly operate the Buenaventura Port in Colombia. Joint operation can not only reduce the direct capital outflow of terminal operators, but also share resources with partners and realize coordinated development. At present, the integration and M&A among shipping enterprises remains undiminished, and it is expected that more terminal operators will develop toward joint operation in the future.

V. Comments on terminal investment and construction in 2017

In 2017, the global terminal investment and construction maintained steady progress on the whole. Affected by the incoming tide of the delivery of large container ships, the world has set off a boom in container terminal construction and waterway dredging investment. Among all the regions, Asia and Africa are the hottest spots of investment in container terminals. The construction of LNG terminals showed different trends with the changes in regional energy structure. The United States made investments in the construction of LNG terminals to achieve net exports of natural gas; China continuously built LNG terminals to meet strong demand growth; Southeast Asia planned to build LNG import terminals to cope with the boom in imports.

Figure 5-1 Distribution of the construction of major terminals in 2017

5.1 Construction of container terminals

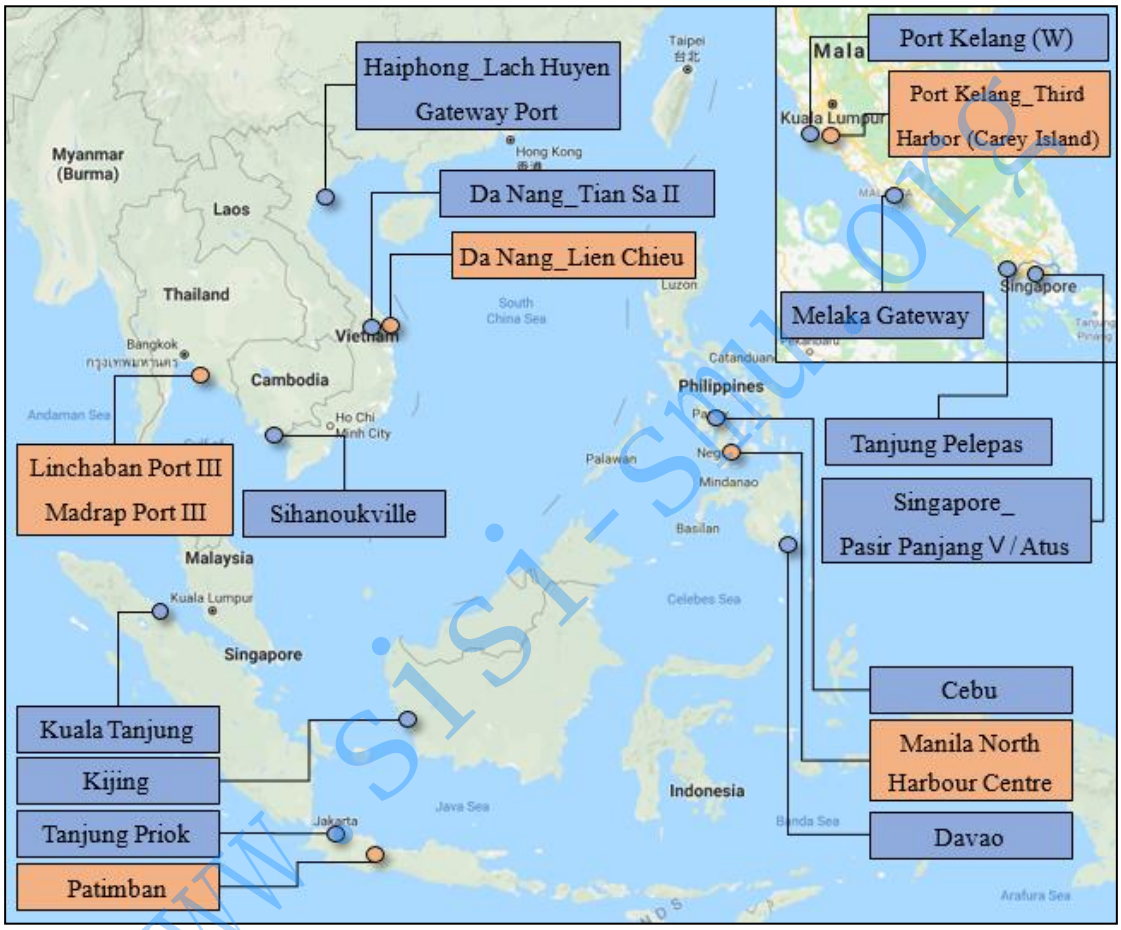
5.1.1 Asia

1. High enthusiasm for investment in terminal construction in Southeast Asia

With the investment aid of the "Maritime Silk Road" strategy of China and the "Asia-Africa Growth Corridor" infrastructure project of Japan and India, the terminals in Southeast Asia have maintained rapid construction. The major ports of Singapore and Malaysia continued to actively expand their capacities, competed for the status of regional hub ports and strived to obtain a larger share of transshipment cargo. Cambodia and the Philippines increased investment in port construction to cope with the transfer of global manufacturing industry.

In Malaysia, the expansion project of the Tanjung Pelepas Port is in steady progress, and Klang Port still received government investment in its expansion despite of any changes. Indonesia

actively invested in the construction of terminals, with Tanjung Priok Port and Patimbang Port receiving investment from China and Japan respectively and to be built soon. Singapore completed the expansion of Pasir Panjang Terminal and formulated a plan for the development of Tuas Port to showcase its development potential, but remains to be a hub port in Southeast Asia in the short term. The foreign investment environment in the Philippines has been gradually improved, and the country is ushering in the golden age of infrastructure construction. In Vietnam and Cambodia, the scale of manufacturing industry has expanded, the volume of exports has increased, and the construction of ports such as Haiphong Port and Sihanoukville Port is going on steadily.



Note: Planned Under construction

Figure 5-2 Overview of container terminal construction in Southeast Asia

2. Continuous advancing of port construction in South Asia and West Asia

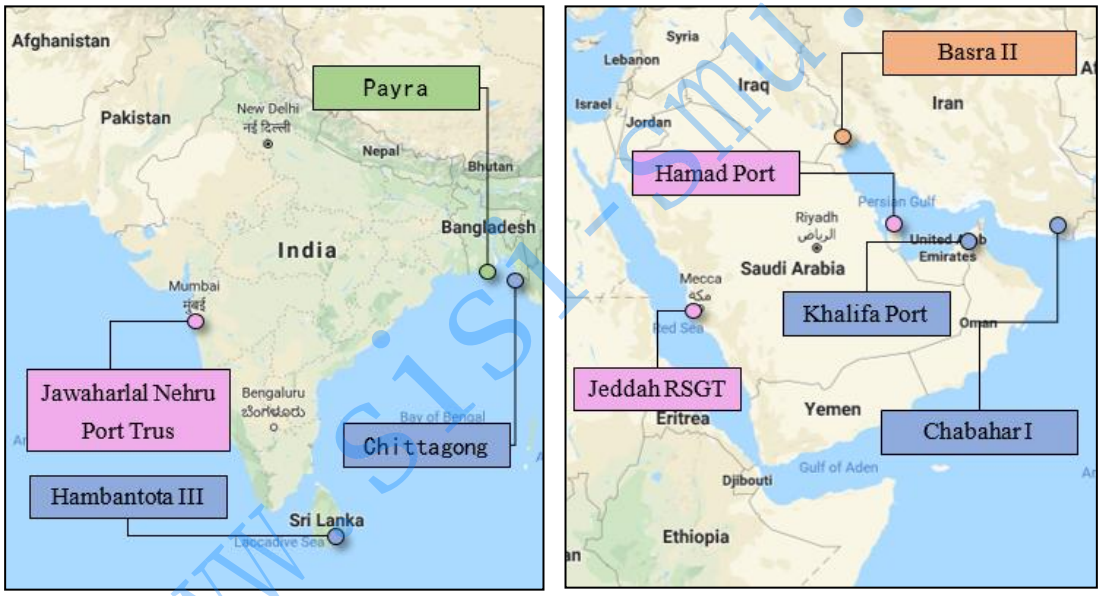
South Asian and Central Asian countries have shown rapid economic growth. According to the data of the World Bank, the GDP growth rates in South Asia and Central Asia are 6.8% and 7%, respectively. In particular, countries such as India, Pakistan and Iran have enormous development potential. However, these regions have relatively backward port infrastructure, poor cargo handling and circulation capacity and serious port congestion. Geopolitics may become the greatest impetus for the construction of terminals. China, India and Japan have invested in port construction in these regions to increase their influence in the Indian Ocean and seize the resources and future markets in Central Asia and the Middle East.

In South Asia, Indian Sagarmala programme continues to promote port construction, and the

fourth container terminal at Nehru Port, i.e. Bharat Mumbai Container Terminal is put into operation. Bangladesh has accelerated port construction to alleviate port congestion. Sri Lanka has made great breakthroughs in port construction, and China Merchants Port Holdings Co., Ltd. obtained a 99-year franchise of Hambantota Port.

In West Asia, the Red Sea Gateway Terminal (RSGT) of Jeddah Port in Saudi Arabia completed a part of shoreline expansion and river dredging projects, with the length of shoreline increasing from 1,070m to 1,350 m and the depth of the river reaching 16.5 m. The construction of the Khalifa Port in the UAE is in steady progress, and Fujairah Port and Delma Port projects have expanded the port business portfolio of the UAE. Iran's Chabahar Port received capital investment from India, and its Phase I project has been officially launched. It is expected to become an important seaport for Afghanistan and Central Asia after completion. International Container Terminal Services Inc. (ICTSI) in the Philippines signed an agreement on Phase II expansion of Basra Terminal in Iraq. An inauguration ceremony has been held for the Hamad Port, which will help Qatar break through economic restrictions.

In Central Asia, the Turkmenbashi International Seaport on the Caspian Sea was completed and officially put into operation in December 2017.



Note: Planned Under construction In operation Dredge

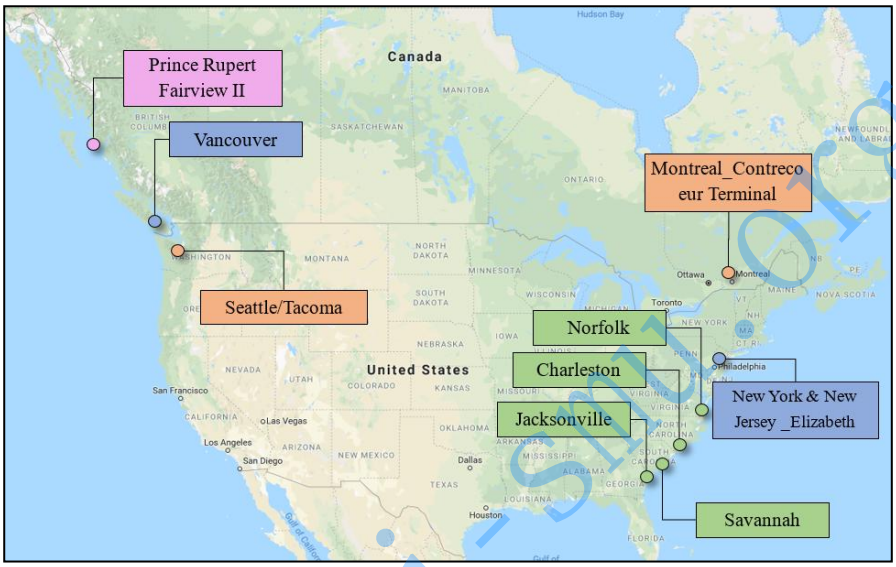
Figure 5-3 Overview of container terminal construction in South and West Asia

5.1.2 America

1. Differentiated development of ports in the west and east coast of North America

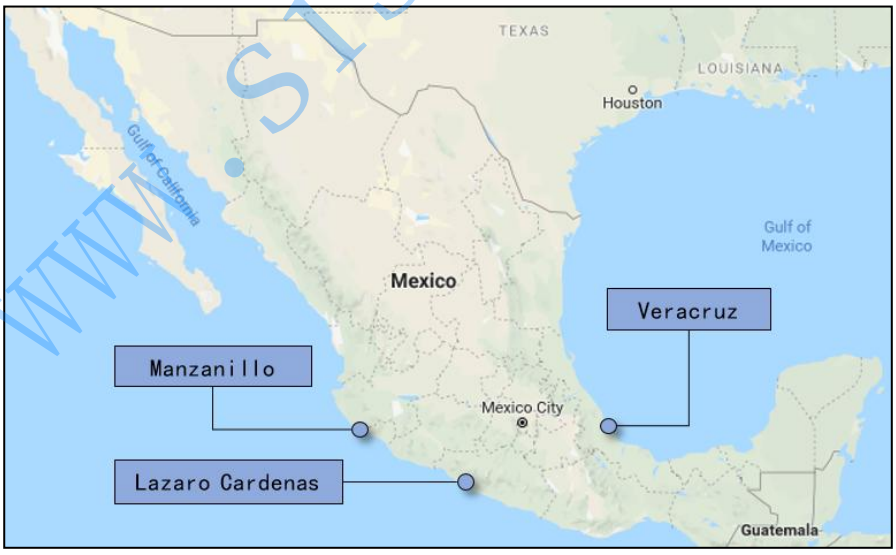
Since the opening of the Panama Canal after expansion, it has been one of the biggest challenges for U.S. ports to cope with the container ships of 8,000-14,000TEU. The terminals and navigation channels capable of handling large ships have become important manifestations of port competitiveness. Hence, the ports on the east coast of the United States entered the era of large-scale dredging, e.g. the ports of Savannah, Charleston and Jack Wilson have successively

launched channel dredging projects, while the ports of Quebec and Montreal in eastern Canada have built new container terminals to improve their competitiveness in the east coast of North America. The ports on the west coast of North America are less affected by large ships, but they compete more fiercely for cargo share. The ports on the west coast of the United States have accelerated the construction of ports and railways with an aim to regain their market share. The ports of Prince Rupert and Vancouver in western Canada completed their expansion projects and dramatically increased their handling capacity. In addition, the throughput of Mexican ports has been growing rapidly, with the ports of Manzanillo, Lazaro Cardenas and Veracruz being continuously built and striving to become the hub ports of the Americas.



Note: Planned Under construction In operation Dredge

Figure 5-4 Overview of container terminal construction in North America



Note: Under construction

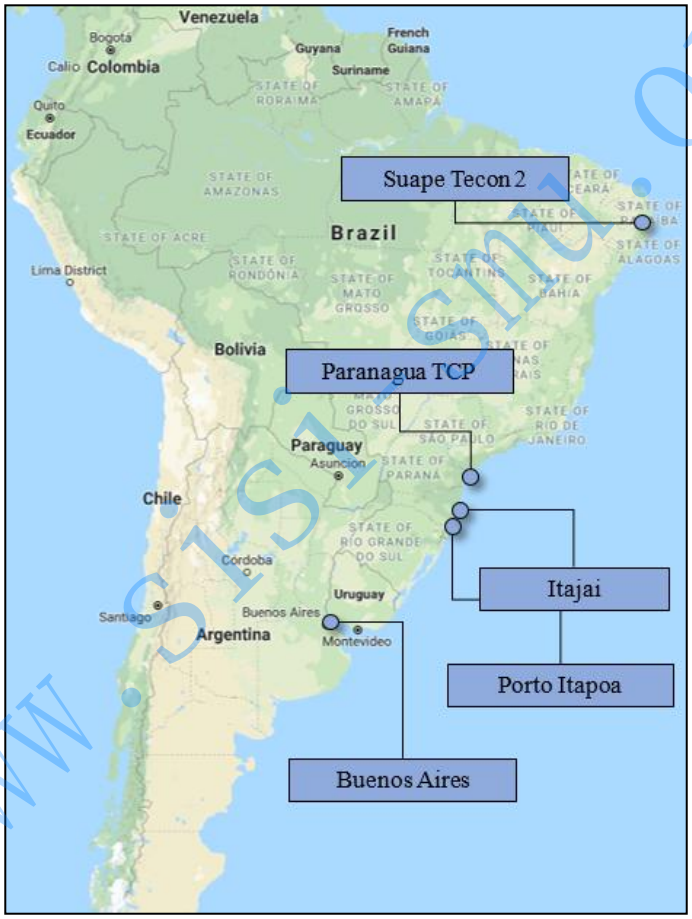
Figure 5-5 Overview of Container Terminal Construction in Mexican

2. Port construction driven by economic recovery in South America

In 2017, the economy of Latin America got out of the shadow of negative growth in the previous two years. The economy has recovered and the political tension has been eased. Each country has

adjusted its foreign policy according to its own needs and international situation. Countries like Mexico, Chile, Argentina, Brazil and Peru all expressed their willingness to participate in "the Belt and Road initiative" and connect with China's development strategy. However, President Trump has brought great uncertainty to the relationship between the United States and Latin America.

Various countries have also made corresponding adjustments in ports. Brazil obtained funds through mass privatization for the construction of ports such as Suape Port, Itapoa Port and Itajai Port. China Merchants Port and DP World have taken the opportunity to expand investment in the region and wholly owned Paranagua TCP and Santos Embraport. Argentina increased its infrastructure investment to embrace economic recovery, and the construction of the Port of Buenos Aires was funded by the government. Chile focused on the construction of Valparaiso Port and San Antonio Port to welcome giant ships.



Note: Under construction

Figure 5-6 Overview of container terminal construction in South America

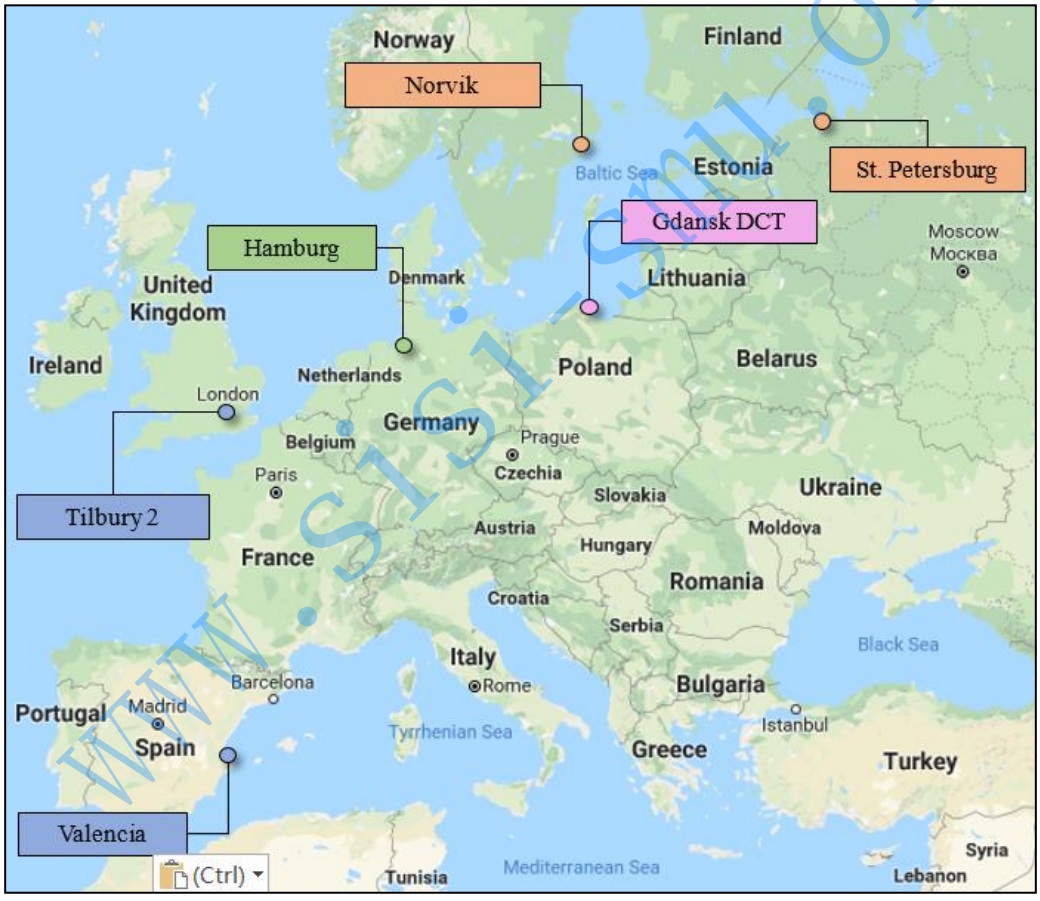
5.1.3 Europe

In May 2017, the European Union amended the EU state aid rules, allowing the ports of EU member states to receive up to 150 million euros of state aid for making investment without the need to be submitted to EU authorities for approval. This will prompt EU member states to enhance dredging and construction of ports, so as to cope with the wave of large-scale ships

around the world.

The number of large ships in Western Europe has risen sharply. Current ports such as Hamburg, Le Havre, Liverpool, London and Valencia have invested heavily in infrastructure construction. In February 2017, German Federal Court of Justice approved the Port of Hamburg to deepen the Elbe River by 1m to 14.5m. Five large gantry cranes were added to the HHLA Container Terminal Tollerort in Hamburg to handle the upcoming large ships. The Port of Tilbury London started the expansion of Terminal 2#, and London Gateway terminal opened the third deep-sea berth to welcome ships of the shipping alliance. Valencia, Spain planned to invest in the ports of Sagunto, Valencia and Gandia, building the first port that can handle container ships of 18,000 TEUs in the Mediterranean region.

The port construction on the Baltic Sea in northern Europe is neither too fast nor too slow. Poland expanded the DCT Gdansk terminal to compete for the position of the hub port on the Baltic Sea. The Stockholm Norvik Port in eastern Sweden built a new deep-water container terminal. Russia's St. Petersburg Port expanded its handling capacity to compete for its share in the Finnish market.



Note: Planned Under construction In operation Dredge

Figure 5-7 Overview of container terminal construction in Europe

5.1.4 Africa

African ports have insufficient handling capacities and have shown a polarization trend. Most ports have poor infrastructure, with handling capacity falling short of the export demand for a long time. At present, Africa mainly depends on a small number of large ports with complete

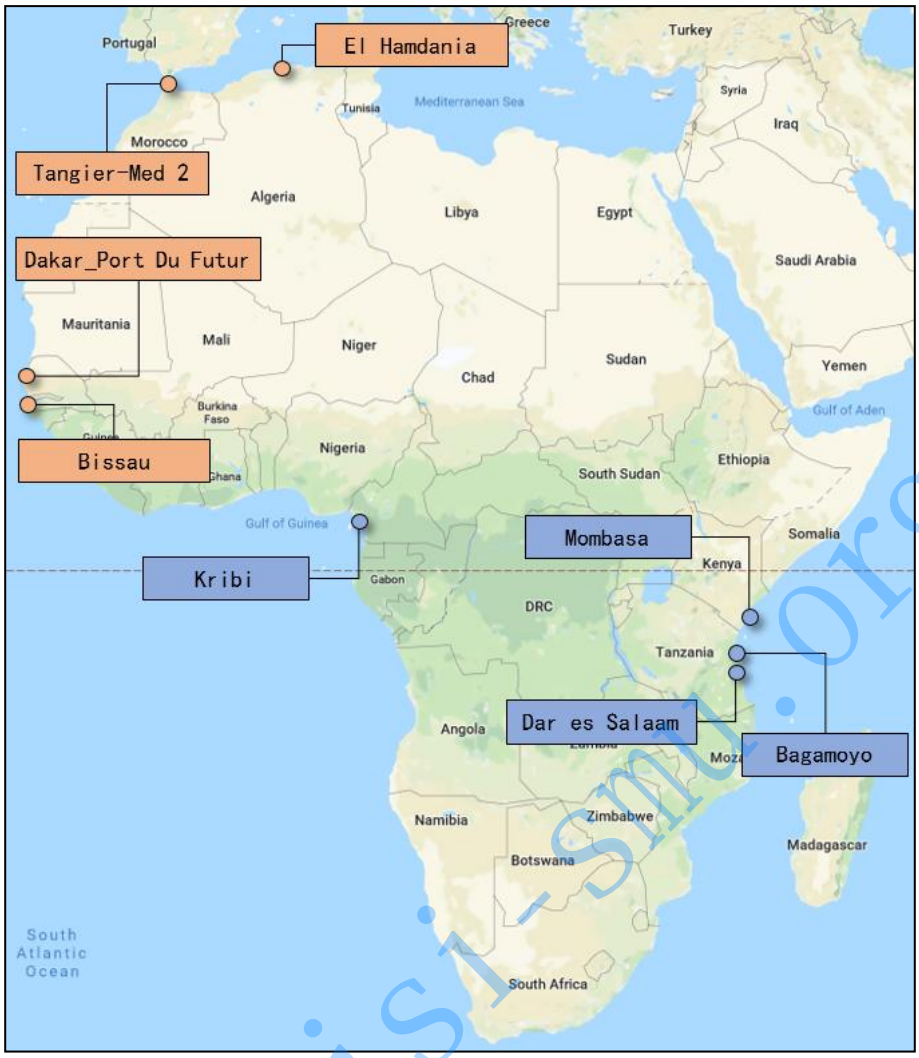
infrastructure and high level of modernization to meet the demand of cargo import and export. In order to take a dominate position in the African market in future, various channels of international capital have been injected into the port construction in Africa to compete for the operating right of strategic hub ports, and high-grade routes are also gathering in the region.

The ports in North Africa have relatively strong container handling capacities and inconspicuous conflict between regional demand and handling capacity. Algeria and Morocco built the El Hamdania and Tanger-Med 2 deep-water terminals respectively to compete for the trans-shipment business in the Mediterranean region.

The ports in East Africa mainly undertake the cargo transshipment business in Central Africa and neighboring countries, and serve as the main connecting nodes between China's "Belt and Road" strategy and Africa. The construction of Bagamoyo Port in Tanzania invested by China Merchants Port was officially commenced, and it will be built into a port with the maximum throughput in Africa. Dar es Salaam Port has launched No. 1-7 berth upgrading project. The second container terminal at Mombasa Port in Kenya is in the construction phase II.

West Africa is rich in resources, and its port throughput has maintained an overall growth, with rapid growth shown by large ports. However, the ports in West Africa provide poor services, and their construction process is slow since they have been long plagued by piracy and armed robbery incidents, as well as high levels of corruption in some countries. The ports in West Africa will develop in the direction of privatized operation, large-scale facilities and deep-water terminals. At present, there are several large-scale deep-water ports under construction, such as the Port of Conakry in Guinea, the Port of Abidjan in Cote D'Ivoire and the ports of Lekki and Badagry in Nigeria. A number of projects were put into construction in 2017. DP World learns from the business model of Jebel Ali Free Zone and will develop a multi-purpose port and comprehensive economic zone in Dakar. In addition to Tema Port, of which the construction was started in 2016, Ghana is also conducting a feasibility study of a multi-purpose container terminal. The International Container Terminal Services Inc. (ICTSI) in the Philippines will develop and operate Bissau Port in Guinea, West Africa to promote the economic development of the country. The Phase II project of Kribi Port in Cameroon has been launched.

In South Africa, Tamatave Port in Madagascar received a preferential loan from the Japanese government to start its expansion project.



Note: Planned Under construction

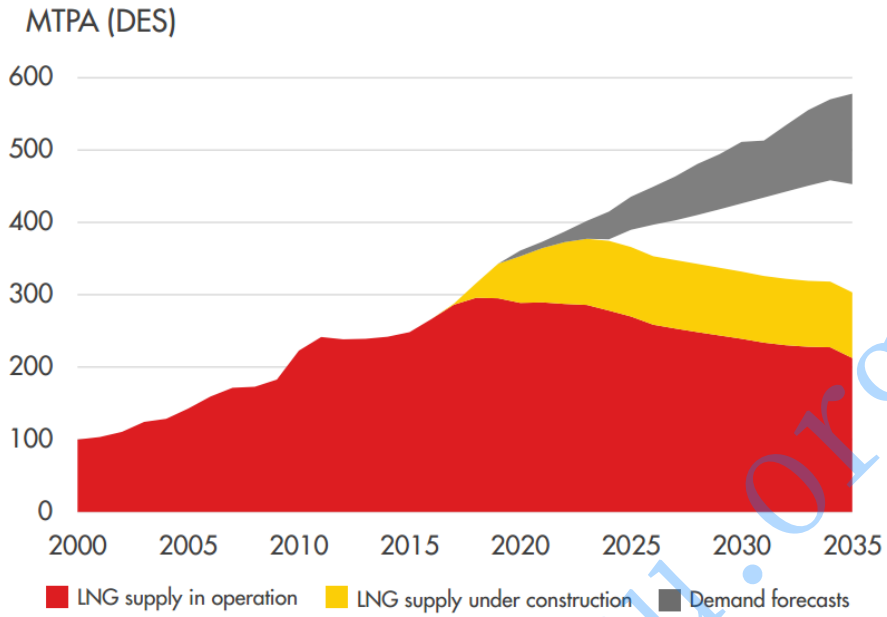
Figure 5-8 Overview of container terminal construction in Africa

5.2 Investment in LNG terminals

In 2016, the International Maritime Organization (IMO) made a decision on the sulfur emission limit in *the International Convention for the Prevention of Pollution from Ships*, i.e. implementing a 0.5% global sulfur limit from 2020. In December 2017, the IMO warned again that a non-compliant ship could be considered as "unseaworthy", thus affecting their charter party and also indemnity in the event of an insurance claim. Each state party to the Convention actively takes measures to fulfil its obligations under the Convention. The implementation of the "Sulfur Limit" will continue to affect the newbuilding market in the coming years, continuously increase the proportion of the orders of electric propulsion ships and LNG-powered ships in the orders of all new ships, and thus increase the demand for LNG fuel.

According to the data in *2018 Shell LNG Outlook* released by the Royal Dutch Shell Group of Companies on February 26th, the global demand for LNG increased by 29 million tons to 293 million tons in 2017, 30% higher than expected. Based on the current demand forecast, Shell issued a warning that it is expected that LNG will be in short supply in mid-2020 unless new LNG

production projects are put into operation. It is estimated that by 2030, the global LNG market may need an investment as high as 200 billion U.S. dollars to expand its existing LNG infrastructure, so as to meet rapidly-growing demand.



Source: Royal Dutch Shell

Figure 5-9 Global supply and demand forecast of LNG

5.2.1 Rapid construction of LNG terminals in China

In 2017, China's LNG import volume reached a record high of 38.13 million tons, jumping by 46% from 2016. As a result, China has surpassed South Korea to become the world's second largest importer of LNG only next to Japan.

In 2017, several LNG terminals were put into operation, such as CNOOC Yuedong LNG Terminal, Guanghui Qidong LNG Terminal and Tianjin Nangang LNG Terminal. In addition, the projects such as Fujian Zhangzhou LNG Terminal and Zhoushan Xin'ao LNG Terminal have been commenced. Construction agreements have been signed for Jingneng Caofeidian Port LNG Terminal and Zhongtian Energy Chaozhou LNG Storage and Distribution Station.

Among these LNG terminals, Sinopec Tianjin LNG project in Tianjin Nangang Industrial Zone was officially completed and put into operation in 2017. The total investment of this project is 13.6 billion yuan, of which the Phase I project has a LNG production capacity of 3 million tons/year and gas supply capacity of about 4 billion m^3/year; the LNG production capacity of Phase II project will be expanded to 10 million tons/year, with gas supply capacity reaching 13.6 billion m^3/year.

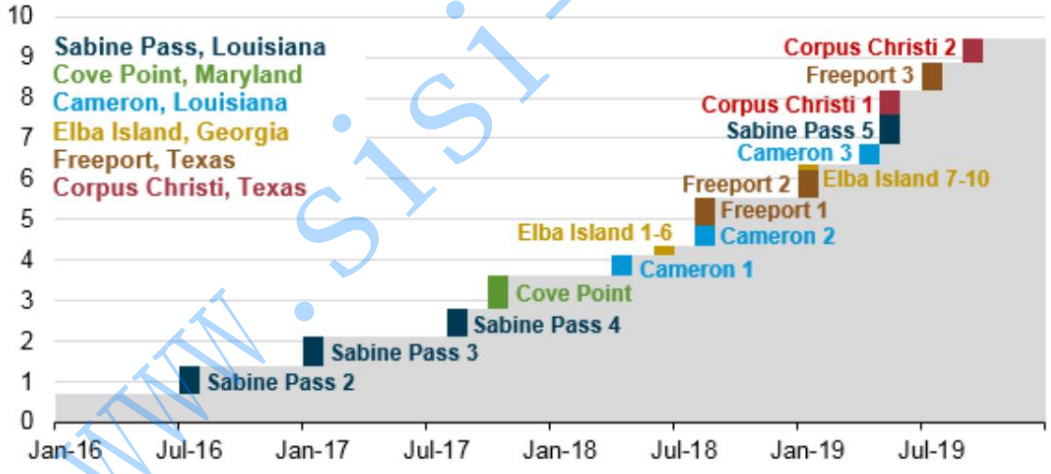
For the Zhangzhou LNG project in Fujian, the land reclamation works was completed in Longhai City, Zhangzhou in June 2017. The LNG terminal project was also approved in November and officially started, making great progress in different phases. The main construction contents of this project include three 160,000m^3 LNG storage tanks, one 80,000 to 270,000 m^3 LNG unloading berth and related supporting facilities. The LNG handling capacity of Phase I project is 3 million

tons/year. The total investment of this project is about 7.1 billion yuan. It is planned to be completed by the end of 2021 and put into operation in early 2022. Upon the completion of the project, a comprehensive natural gas infrastructure layout with "two terminals and one network" will take shape in Fujian Province, which will provide inexhaustible natural gas resources to the Western Taiwan Straits Economic Zone and even the surrounding areas.

The total investment of Jingneng Caofeidian Port LNG Terminal in Tangshan is 10.4 billion yuan. It plans to build two LNG unloading berths and one loading berth, with a total handling capacity of 10 million tons per year. This project has completed engineering survey and special study at the end of 2017 and plans to complete the application for project approval by May 2018. The project will be constructed in phases after approval. The Phase I project is planned to be started in May 2018 and put into operation by May 2021.

5.2.2 LNG facilities built in the United States to realize net export

The current U.S. LNG export terminals in use only include Cheniere Energy's Sabine Pass Export Terminal in Louisiana and Cove Point LNG Export Terminal in Maryland, which cannot meet the growing export demand. The strong demand has promoted the construction of LNG terminals. According to the US Energy Information Administration, as of January 2018, a total of 32 LNG export terminals have applied for construction in the United States, of which five terminals are under construction. The LNG export capacity of the United States is expected to reach 9.6 billion cubic feet per day by 2019.



Source: U.S. Energy Information Administration (EIA)

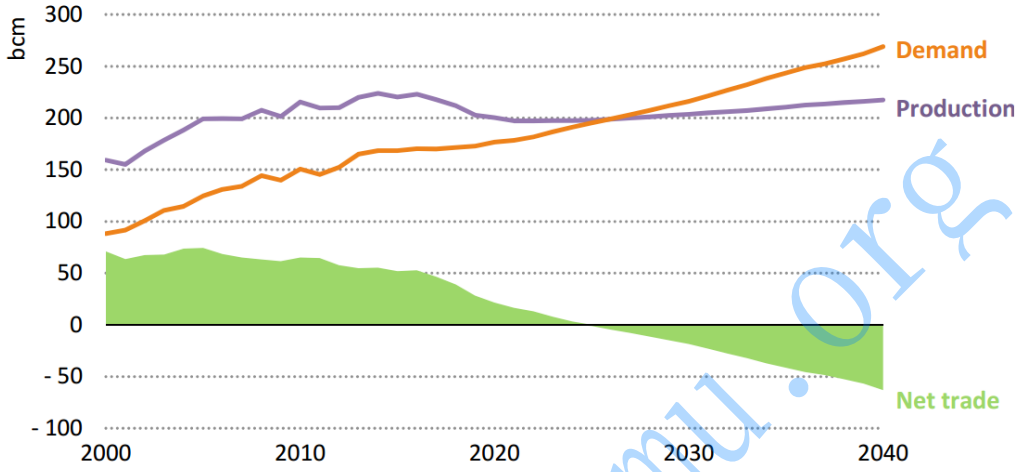
Figure 5-10 Progress of the construction of LNG export terminals in the US

5.2.3 Import terminals planned to be built in Southeast Asia to cope with the boom in imports

With the economic development and population increase in Southeast Asia, the demand for energy in the region is also increasing. According to the data of *Southeast Asia Energy Outlook 2017* released by the IEA, the strong demand growth will make Southeast Asia a net importer of natural

gas in the middle 2020s.

In response to this trend, countries in Southeast Asia have gradually increased their efforts to build LNG import terminals. In the first half of 2017, Southeast Asia initiated the production and capital expenditure plans for the upstream projects. 28 major crude oil and natural gas projects are expected to start operation in Southeast Asia by 2025. At that time, the planned natural gas projects will contribute an additional output of about 4.1 billion cubic feet/day to the world's natural gas demand.



Source: International Energy Agency (IEA)

Figure 5-11 Natural gas balance in Southeast Asia

5.2.4 Construction boom of FLNG terminals

FLNG facility is an offshore floating production platform that integrates natural gas extraction, liquefaction and LNG storage and unloading functions as a whole. It can be used to exploit natural gas resources in remote sea areas. The International Gas Union (IGU) stated in the *IGU World LNG Report 2017* that as of April 2017, there are a total of 24 FLNG projects worldwide, with a total production capacity of 20.7 billion cubic feet per day. Most of these projects are located in the offshore areas of the United States, Australia and Canada, and only a few are distributed in African countries, Iran and Russia. Among them, three FLNG projects are under construction, i.e. Australia's Prelude FLNG, Malaysia's PFLNG 2 and Cameroon FLNG, with a total production capacity of 1 billion cubic feet per day.

The world's first FLNG facility, PFLNG Satu, completed the delivery of the first batch of LNG on April 20, 2017. The facility can produce 1.2 million tons of LNG per year and is expected to be used for 20 years. The world's largest FLNG facility, Prelude FLNG, built by Samsung Heavy Industry, was completed and delivered to Shell, and will be put into operation in the Prelude gas field off western Australia in 2018 to begin the offshore natural gas extraction and processing operations. In July, Wison Offshore & Marine Limited announced that it had completed the final delivery of Caribbean FLNG, which has an annual LNG production capacity of 500,000 tons. Eni completed the financing of the Coral South FLNG project offshore Mozambique, with a financing amount of US$4.6755 billion. Upon completion, this project will possess a production capacity of 3.4 million tons/year.

VI. Comments on port technology and information in 2017

6.1 Port intelligence technology

6.1.1 New technical solution of automated straddle carriers

In 2017, ZPMC and Westwell made innovations in applying artificial intelligence technology based on visual positioning technology and millimeter-wave radar technology, and successfully created the world's first unmanned container straddle carrier. The straddle carrier can realize the unmanned functions of autonomous positioning and autonomous navigation, and can make intelligent decisions to automatically avoid obstacles while driving. Meanwhile, the unmanned straddle carrier can autonomously formulate the optimal driving route for horizontal transport of containers according to the actual road conditions of the terminal, autonomously detect the containers during the loading and unloading operations, and autonomously fetch, straddle and place specific containers with the precision of centimeter level. This new technical solution has avoided the construction cost of pre-embedded magnetic nails. Meanwhile, automated and unmanned operation can ensure high efficiency and safety, showing broad market prospects.

6.1.2 Remote monitoring and diagnosis system for port machinery

In order to improve the efficiency of port machinery, Shanghai Zhenhua Heavy Industry Co., Ltd. (ZPMC) and Shanghai Industrial Technology Institute launched a remote monitoring and diagnosis system for port machinery in June 2017. The system can basically realize the remote monitoring and diagnosis of port equipment by using sensors, big data, artificial intelligence, cloud computing, 3D simulation and other technologies. Through the "analysis system based on the intelligent connection master model", the data collected by various physical sensors on the port machinery can be input into the 3D simulation model and integrated with the data of "virtual sensors", so as to realize the real-time analysis of the overall load of port machinery and fatigue life prediction and analysis of key components. Meanwhile, the system also has the function of structural hazard diagnosis. The remote monitoring and diagnosis system can send "4 Levels of Hazard Warning", and provide the user with Equipment Health Assessment Report every month, as well as suggestions for equipment maintenance and parts replacement, so as to improve the operation efficiency and safety of port machinery.

6.1.3 VR and 3D visualization technology

To enhance the operation capability of the ports and operation safety of truck drivers at the terminals, Kalmar, a manufacturer of port container handling equipment, collected image data from 120 cameras installed on a remote-controlled RTG, and then conducted image processing, data analysis, model operation and 3D visualization, and finally presented the simulation situation of on-site RTG on the VR driving simulator in the laboratory, so that drivers can realize remote

and accurate control over the equipment.

In addition to providing drivers with a safe operating environment, this technology also has the following features. First, VR technology can provide drivers with real-time and immersive scenarios that enable drivers to directly apply working experience and knowledge in a familiar operating environment. Second, when carrying out safety design and verification, this technology can be used to simulate the scene and observe experimental results. Third, when conducting accident analysis, high-precision 3D playback video can be retrieved to enable technicians to make more accurate judgments on the details and causes of the accident and take measures to prevent the recurrence of similar accidents.

Special topic IV: Supply-chain data sharing of service-type ports

Port supply-chain data sharing is an effective way to upgrade port logistics efficiency. The port supply chains can fall into three types based on their functions:

The first is production-type port supply chain. This port type is regarded as an important link in the production supply chain, and the integrated development between ports and production bases can shorten transport time and reduce transport cost.

The second is service-type port supply chain. It refers to a network chain consisting of various types of service providers with a port enterprise as its core, including forwarding agents, shipping companies, shipping agents, land transport companies, customs, inspection and quarantine, warehousing, shipping finance service and insurance service. The network chain provides logistics and relevant services for customers by using the methods of integration and coordination, and adopting the means of information technology, so as to achieve the lowest overall supply chain cost and highest profits for customers.

The third is mixed-type port supply chain. It refers to a mixed-type supply chain with the port as a link being integrated into a production supply chain, which has the characteristics of both production and service supply chains.

This article mainly studies the application of data sharing in the service-type port supply chain. Considering the characteristics of the numerous members with different goals in a complicated service-type port supply chain, the port supply-chain data sharing can greatly improve logistics efficiency to a certain extent.

1. Application of typical international port supply-chain data sharing platform

(1) ESPCA port platform

The European Port Community Systems Association (ESPCA) port platform has connected most European ports including six main ports, namely the Port of Le Havre in France, the Port of Bremen in Germany, the Port of Felixstowe in the U.K., the Port of Hamburg in Germany, the Port of Barcelona in Spain and the Port of Rotterdam. The platform can concentrate and integrate relevant data of the cross-regional port supply chain for electronic port EDI information exchange,

and standardize unified customs declaration, logistics tracking, status control, and sharing of maritime and other data. The port supply-chain data sharing aims to serve port enterprises, which is a typical application of horizontal information sharing and interaction among port enterprises.

(2) INTIS system of the Port of Rotterdam in the Netherlands

The International Transport Information System (INTIS) is a public information service platform. All companies having business relations with the port can directly use the INTIS to complete business operations. These companies include shipping companies, cargo owners, shipping agents, forwarding agents, port authority, taxation department and banks. The INTIS has greatly improved the operation efficiency at the Port of Rotterdam, reduced the business operation procedures and upgraded the port's comprehensive competiveness. The INTIS is the typical application of longitudinal information sharing and interaction among enterprises with the port as the center and various types of other enterprises as the auxiliary parts.

(3) EDI center of the Port of Hamburg in Germany

The platform can provide various types of application systems, including various kinds of documentation system, customs communication system, ship information system, hazardous cargo management system, container management system, container multimodal transport platform and international communication network, which aims to offer more comprehensive, qualified and convenient information services to the port and other clients. The EDI center at the Port of Hamburg is the typical internal and external port information platform.

(4) TRADENET and PORTNET systems of the Port of Singapore

To achieve the mutual collaboration among different enterprises and institutions, the Singaporean Government has built the Singapore international shipping center information platform through heavy investment. The platform covers 35 institutions and enterprises, such as regulatory agencies, shipping companies, cargo owners, shipping agents, forwarding agents, warehousing companies, insurance companies and banking enterprises. The platform consists of two interdependent and interrelated subsystems, namely the TRADENET (National EDI trade network system) and the PORTNET (Singapore port EDI network system). The highly effective and convenient digital communication and collaboration among different shipping institutions and enterprises in Singapore have been achieved with the help of the system.

(5) International trade "single window" in Shanghai of China

A "single window" platform has been established in Shanghai of China, which has combined the assessment, approval and service functions of dozens of governmental departments, including customs, inspection and quarantine, maritime and border inspection. Over 100,000 enterprises can conveniently complete their cargo customs-clearance procedures on the highly efficient platform. But the drawbacks of the platform are that it is just the integration of data from governmental regulatory departments such as customs and maritime, which has not yet covered other relevant non-governmental entities including cargo owners, shipping companies, shipping agents and forwarding agents. In addition, there are no data sharing channels between the "single window" and other platforms, which can't meet the demands in the shipping sector.

2. Applications of port supply-chain data sharing

(1) Interconnection and intercommunication among port enterprises

Port enterprises can establish a port enterprise alliance based on the data sharing platform to conveniently achieve cross-regional cooperation, such as providing port-to-port whole-process supporting services for customers, which can maximize the use of port resources, upgrade the collaborative capabilities and services of port enterprises, and form a good pattern of mutual benefit and win-win cooperation.

(2) Auxiliary decision-making system for port enterprises

Port enterprises can fully utilize the shared big data to carry out data analysis and data mining, which can be used as important references in their internal decision-making. The constant expansion of the port supply-chain data sharing service platform will attract the participation of more users, enterprises and institutions, which can help port decision-makers obtain more comprehensive data and information in the industry. These data resources are conducive to the formulation of port development strategy and prevention of unexpected accidents such as port congestion.

(3) Application in LCL services

The port supply-chain data sharing platform can effectively provide less than container load (LCL) services for cargo owners to reduce transport cost and maximize the use of logistics resources, which can avoid the waste of logistics resources caused by the previous information asymmetry and the inadequate logistics resource management mode.

（4）Integrated customs clearance services

The port supply-chain data sharing has increasingly boosted the integrated customs clearance for cargos. For example, the “single window” platform in Shanghai has realized the information sharing between port enterprises and port departments including customs, maritime, and inspection and quarantine. The data sharing platform can help users reduce customs clearance cost and improve customs clearance efficiency by omitting some intermediary procedures.

(5) Financial risk assessment and prevention

Financial institutions such as banks and insurance companies can establish their risk assessment and detecting system based on the information sharing platform. The platform can also help them set up credit assessment systems by acquiring information on the assets and credit of relevant enterprises for designing specific financing products for different enterprises, which can overcome the financing difficulties for small and medium-sized enterprises with high credit scores. In addition, the platform can assist financial institutions to track and control the cargo and capital flows of an enterprise for financial risk prevention.

(6) Whole-process logistics tracking service

The port supply-chain data sharing system is an open platform for all users in the industry, including cargo owners, forwarding agents, shipping companies, shipping agents, port bureaus and other port departments. Covering all the links along the whole port and shipping logistics chain, the platform can be used to track all the cargo logistics information, including the cargo flow process, which can lower any possible logistic risk. It can also assist various enterprises to timely

arrange berths, vehicles, loading and unloading equipment for relevant cargos to improve port operation efficiency and achieve the optimized resource allocation.

3. Bottlenecks in port supply-chain data sharing development

(1) Isolated data resources

In the cargo transport process, relevant enterprises and institutions in a port supply chain are reluctant to share their high value information, and most of their useful data sources are not disclosed. As they worry that the released information may damage their own interests, most of their data sources are isolated, causing the information asymmetry.

(2) Lack of unified data standard

As there are numerous numbers of participants from different places with different data standards in the port supply chain, it is very difficult to integrate these collected data under the condition that no one is willing to bear the cost for establishing a unified data standard.

(3) Difficulties in coordination among complicated participants of various kinds

The upstream and downstream enterprises in the port-related industry include governmental regulatory agencies, shipping companies, cargo owners, shipping agents, forwarding agents, warehousing companies, insurance companies and banking enterprises. It is very difficult to establish large-scale collaborative relations among these geographically scattered entities with different characters in various industrial sectors, and such an attempt may result in the waste of resources.

(4) Higher risks in safety aspect

Due to the special nature of a port supply chain with numerous complicated participants from various places and the high cargo value for ocean transport, the problems at any link of a port supply chain will be the shipping safety hazard, which may possibly cause huge cargo shipping losses.

6.2 Port information technology

6.2.1 Automated platform with opened interfaces

To promote automated terminals in the globe to open their interfaces and strengthen operation collaboration and information exchange, Kalmar has launched its Kalmar Key automated platform. By adopting the general system architecture method, the Kalmar TLS-based platform can provide a more flexible development environment for terminal operators and development personnel to build the tailor-made automated terminal platform. Users can customize solutions for an automated terminal according to the actual requirements, which is conducive to better match the automated terminal solutions with existing application programs. The Kalmar Key automated platform is also compatible with various types of automated equipment, and terminal operators can build automated solutions most suitable for their business modes according to their own requirements for the automated equipment. Moreover, the Kalmar Key automated platform also

provides a visual interface to integrate the data from multiple sources, which can facilitate terminal operators' operation and monitoring, and provide support for decision makers.

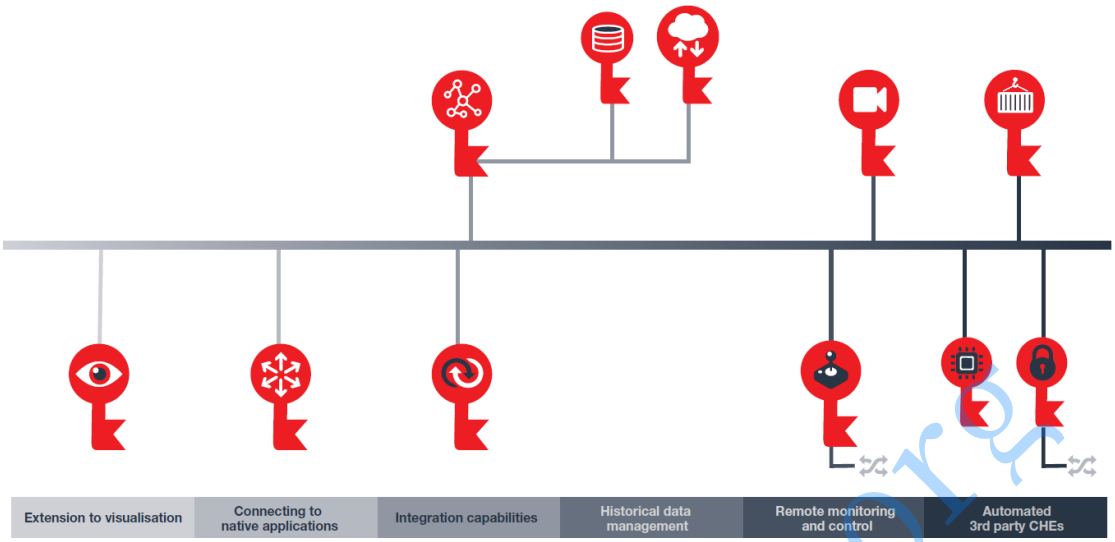


Figure 6-1 System architecture of Kalmar Key automation platform

6.2.2 Pit Stop

Because of the information asymmetry between ships and ports, the traditional low ship-docking efficiency at ports has led to ships' long waiting time before docking at a port, which has even caused port congestion. To solve the information asymmetry problem, Navis has launched the Pit Stop system. The system provides an information sharing platform for ship-docking-related parties such as ships, terminals and port bureaus, on which relevant information can be shared on real-time basis, including the estimated time of arrival (ETA) provided by ships, the ship-docking plan supplied by terminals and the pilotage schedule from the port bureau.

By adopting the Airport CDM concept, the Port CDM in the Pit Stop system has been launched, which can boost the unity and collaboration among entitles in the system, including shipping companies, terminals and agents, based on the resource sharing and information interaction, so as to jointly explore the optimized ship-docking process, improve ship-docking efficiency and greatly shorten ship's port-staying time under the restriction of port management departments.

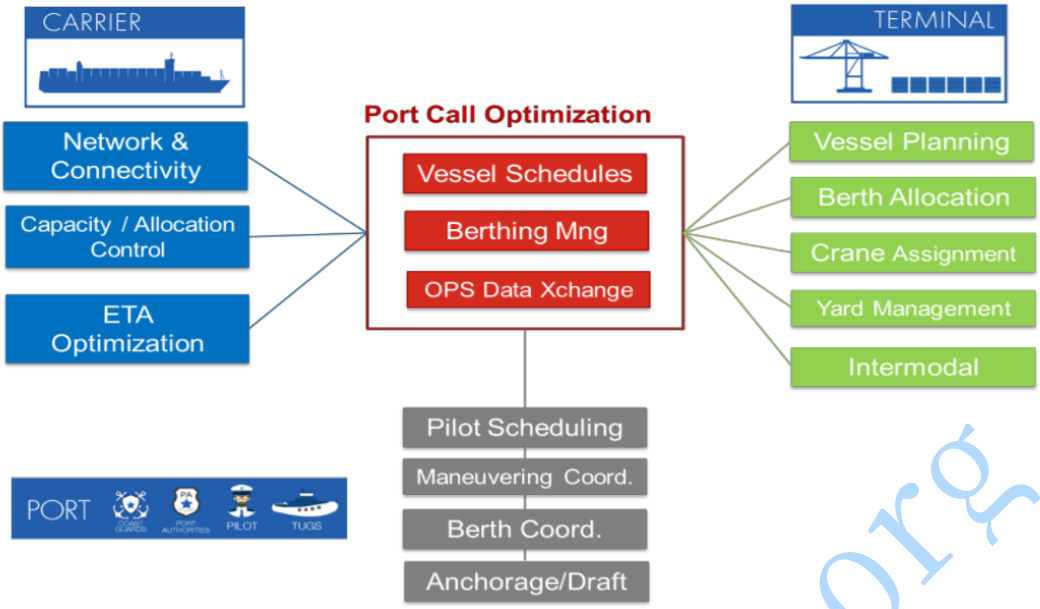


Figure 6-2 Port Stop Cooperation System

6.2.3 Block chain products help solve cargo damage disputes

To solve the cargo damage and loss disputes, Tcompanies has launched its block chain product PEIR™, which uses digital image processing and block chain technologies to record transport equipment status at each cargo handover link in the whole transport process and help interested parties determine the cargo damage reasons and those to be held accountable.

PEIR™ adopts a simple, fast, reliable mobile-app process, instead of the complicated recording and inspecting procedure in the traditional tally process. During a cargo handover between different transport equipment, an inspector only follows the instructions of PEIR™ app in a mobile phone to take photos of the truck, its chassis or container number, and PEIR™ can collect necessary information and transport equipment status from these photos, which will be stored in the system. It only takes a few minutes to complete a whole certification process. After the certification, customers can use the app to track all the transport equipment-related records and images. The exact time and location for each certification are automatically generated by the system, and the block chain technology is adopted in the verification system to prevent tampering, which can guarantee the authenticity of each certification in order to further reduce the possibility of disputes over cargo damage and loss.

Special topic V: Influence of block chain technology on port management

As an important part for cash flow and cargo flow in trade, the port usually faces a large number

of credit-related issues. The popularity of the block chain technology will subversively change the port management. With the characteristics of maintaining the information transparency and preventing the tampered data, the block chain technology can guarantee the cargo transport safety. Cargo owners, carriers and consignors can determine relevant responsible persons for cargo transport by tracking the real-time cargo status to ensure the cargo safety. Personnel from the customs, commodity inspection and hygiene inspection departments can complete their cargo inspection procedure according to the transparent record and data, instead of onboard inspection. In recent years, many port and logistics enterprises have begun to develop their own block chain technologies.

1. Application of block chain technology in container cargo shipping

As a key link of cargo flow and cash flow in the cargo transport process, the port has the function of dealing with the complicated business regarding the cargo flow and cash flow. With the characteristics of no trust dependence and decentralization, the block chain technology can change port management method and greatly simplify cargo transport process.

(1) Block chain application in 'cargo flow' system

In the cargo transport system, it is possible to use the block chain technology to record all the container cargo transport procedures, and all persons related to the cargo transport can record their respective procedures and access other information in the block chain with their mobile phones in which relevant block chain app is installed. The block chain consists of multiple blocks, and each block contains the detailed information of a procedure, such as seller, buyer, price, contract clauses and necessary information in the transport process. As all persons in the system have the information records of all the cargo transport procedures, the data safety can be ensured. Only if at least 51 percent of data in the whole system are modified, can block chain database be tampered, which is almost impossible to happen.

Some transport procedures will be simplified or cancelled. In container cargo import and export business, it is necessary to use a large quantity of related documents to support the cargo transport, which causes the high transport cost and time cost. Therefore, using the block chain technology in the port logistics can greatly improve the cargo flow efficiency. For example, it is necessary for the customs to carry out spot checks on import and export container cargos according to the declared cargo lists. If the block chain technology is adopted, all the cargo transport-related parties will share the big database in a block chain. As relevant cargo information has been recorded in the multiple procedures of LCL and FCL transport in the block chain, the customs can also use these data records, so as to simplify and even omit the spot check process. In addition, relevant processes for commodity inspection, hygiene inspection, quarantine of animals and plants, and other procedures can also be simplified with the help of the block chain technology.

Cargo transport process can be clearly seen. All cargo transport procedures including loading, transport and delivery can be clearly seen in the block chain. Using the block chain technology to record the traceable information in the whole cargo transport procedures can avoid the incidents of cargo missing or mistaken delivery. As the information for all the delivered express parcels have been recorded in the block chain, a courier's attempt to steal a parcel with a forged consignee

signature can't be realized, which is conducive to promoting the use of real name in the logistics process. Enterprises can also use the block chain to track their cargos destination against possible unauthorized cross-regional sales and counterfeit products, in order to guarantee the interests of their distributers at various levels.

Paper shipping documents can be streamlined. In the container shipping process, it is necessary to use paper documents, such as bill of lading, cargo yard receipt and cargo list. With the help of the block chain technology, all the paper documents in the whole transport process can be digitized and stored in the block chain. The data for each cargo transport process will be synchronously recorded. Because of the "trust mechanism" of the block chain technology, it is not necessary to use large quantities of paper shipping documents for cost reduction. In addition, the risk of paper document forgery can be eliminated, because the data in the block chain system can't be tampered.

(2) Block chain application in 'capital flow' system

The block chain technology also has the decentralization feature. All the current capital transactions depend on the third party platforms such as banks, Alipay and WeChat payment, while the block chain technology-based two-party or multi-party transactions do not rely on the third party platform.

Improvement of cross-border payment efficiency and cost reduction can be achieved. In the container import and export business, it is necessary to fulfill the cross-border payments including foreign exchange settlement for export. As compared with the traditional cross-border payment, the block chain can allow the two transaction parties to achieve the end-to-end payment without the involvement of any intermediary institution, which not only saves the time for settlement among different institutions, but also greatly shortens the transaction period. In addition, the block chain-based payment can be immediately received. As the main cost for the traditional cross-border payment is the fees for intermediary institutions, the block chain-based payment can save the cost for intermediary institutions. As the whole-process traceable payments will be recorded according to the time sequence, and the records can't be tampered in a block chain system, it is not necessary to establish a credit system, which can greatly reduce the credit-related cost.

With the nature of high liquidity, the capital usage time is shortened. Generally, cargos transported by ship are large in quantity and high in total value, which will use large amounts of capital. As the capital liquidity is low in the traditional cross-border payment, which reduces capital usage efficiency. As a decentralized point-to-point system, the block chain can allow the transaction to be completed immediately, which greatly shortens capital usage time and increases capital liquidity.

2. Other possible block-chain applications in port management

Financing difficulties for small and medium-sized port and shipping enterprises can be solved. The application of block chain technology in the port and shipping sector allows the transportation, as a kind of commodity, to have the capital nature. The block chain technology can turn information into commodities with the value and capital features. As the capital-featured traceable information recorded in a transport block chain cannot be tampered or forged, the cargo

ownership can be guaranteed. The block chain technology can allow port and shipping enterprises to effectively use their capitals and improve the business operation environments for small and medium-sized enterprises.

Cargo transport routes and schedules can be optimized. As block chain technology has the feature of transparency, it is possible to store transport information in the database, and related personnel can check the information at any link of a container shipping process and adopt the optimized container shipping route and schedule. Consignees can not only track the whole-process of the cargo transport from the port of departure to the port of destination, but also adjust the cargo transport schedule.

6.3 Green technologies employed by ports

6.3.1 Carbon dioxide capture system

The EU and its member countries have long actively supported the research, development and innovation of carbon capture and storage technology (CCS) to achieve green and sustainable development. The Port of Rotterdam Authority decided to apply CCS technology to reduce carbon dioxide emissions in the port area in 2017, eying for a green construction of the port. The Port of Rotterdam Authority is consulting with Dutch gas transportation companies Gasunie and EBN. The partners intend to take an investment decision in the course of 2018, allowing the system to become operational by 2020. Their ambition is to store 2 million tons of CO_2 per year from 2020 on. The process of the CSS project at the Rotterdam Port is that: first, liquefy carbon dioxide emissions captured in the port area by applying a pressure greater than 8 MPa, and then inject the sequestered liquefied carbon dioxide into empty oil and gas fields or unmineable coal seams, which will then be sealed by special concrete. The sealing layer of a natural gas field ensures the permanent storage of carbon dioxide underground.

6.3.2 Hydrogen-powered port equipment and tractors

Under the support of the Valencia port Foundation, the Port Authority of Valencia signed a cooperation agreement with the Fuel Cell and Hydrogen Joint Undertaking (FCH JU) to jointly develop hydrogen-powered port machinery. China also continues the R&D and launches of hydrogen-powered equipment. China National Heavy Duty Truck Group (Sinotruck) designed and manufactured a new type of green vehicle, a hydrogen-powered terminal tractor, with high efficiency, cleanness, zero pollution and zero emission. The Hydrogen-powered terminal tractors, mainly with hydrogen as fuel, and the power battery as an auxiliary system, can effectively solve the problems of low efficiency and environmental pollution of traditional vehicles; meanwhile, the hydrogen-powered terminal tractors can be fully filled with hydrogen in 3 to 5 minutes, solving the problems of all-electric vehicles that suffer from long charging time and short ranges.

6.3.3 Offshore wind power generation

Many ports have begun to weigh the use of offshore wind power, since the wind power generation

obtain the wind power from the nature and generates no radiation or air pollution, and ports have unique advantages in developing wind power generation. Guodian Power Hebei Renewable Energy Development Co., Ltd. and Tianjin Port & Channel Engineering Co., Ltd. signed a cooperation agreement on the offshore wind power project on breakwater of the Tianjin Port in February 2017. Under the agreement, the two companies will construct wind farms in the Gaoshaling and Dagukou port areas of Tianjin Harbor Economic Area. The Peel Ports Great Yarmouth announced in July 2017 that it would cooperate with Swedish energy company Vattenfall to explore the utilization of offshore wind power for ports in its latest expansion project in July 2017. The move is expected to bring actual economic benefits and future development potential for the Great Yarmouth.

VII. Comment on development of green ecological ports in 2017

7.1 Cognition and prospect of green ecological ports

At present, the relatively mature cases in building green and ecological ports are mainly in European and American countries, such as the Port of Los Angeles-Port of Long Beach in the US, and the Port of Rotterdam in Europe. These ports have long integrated the ecological concept of "port-people-nature" into the port planning and development, operation and production, and maintenance and management. Therefore, they can prevent and control environmental pollution and ecological damage, and protect the aquatic resources and port ecological environment from the very beginning. These moves minimize the negative impact of the port areas on the environment and the communities, and realize the win-win development of ports and the ecological environment. The most important reasons for green ports in European and American countries to make great progress lie in the policy support and comprehensive development plans, as well as the multilateral cooperation that can spontaneously bring into birth green port initiatives, such as the Green Marine in North America and EcoPorts in Europe, which encourage and monitor ports' green and ecological construction.

Green and ecological development is the only way for the sustainable development of ports, and it requires comprehensive planning and prevention and control to truly realize green and ecological development. With the gradual implementation of the global energy transformation and low carbon and emission reduction plans, green and ecological ports in the future will surely be low-carbon ports that truly achieve zero emission, resource recycling, and ecological balance.

7.2 Status quo of green ecological port construction

7.2.1 Green port construction in full swing in Europe

◆ **Rotterdam, the Netherlands**

The Port of Rotterdam launched an energy transition plan in 2017, and proposed initiatives such as heat alliance, biomass, LNG as the fuel, and waste recycling, to reduce its carbon footprint. The port is committed to reducing emission to virtually zero by 2050. The Port of Rotterdam also announced its membership in the North Sea Wind Power Hub Consortium in November 2017.It is devoted to the wind power development to speed up realizing the goals of the Paris Climate Agreement. Meanwhile, it has also introduced the Environmental Ship Index (ESI) to encourage ships to reduce emission, offering preferential taxation to ships whose emissions meet the corresponding ESI standards. In addition, the Port of Rotterdam Authority has also endeavored in terms of ecology, and has developed 21 hectares of "green gateways", providing a habitat for birds and fish, and creating a harmonious ecology and environment of humans and nature.

◆ **Antwerp, Belgium**

In 2017, the Port of Antwerp invested 300,000 euros to build three large-scale storage tanks with a total capacity of 240,000 liters to collect and store rainwater at port terminals. Before that, the port consumed 3 million liters of drinking water for equipment maintenance every year, and this green project will directly save the port a great amount of water resources. Besides that, the port authority announced at the end of 2017 that it will invest 1.4 million euros over the next three years in seven green port projects aimed at making port-generated freight traffic more efficient and sustainable. The seven projects, including construction of "zero-emission" barges, multi-modal transportation and digital platform, will together reduce the number of truck trips by up to 250,000annually.

◆ **Green construction of other ports in Europe**

The port of Gothenburg in Sweden, announced in 2017 that it plans to make use of dredged spoils to build a new freight terminal, which will recycle waste while cleaning up rivers, and form a benign cycle of port ecological development; the Port of London Authority launched its first Air Quality Strategy to reduce harmful emissions at ports along the tidal Thames. The strategy will be delivered through a Five Year Action Plan, covering 2018 to 2022. At the same time, the Port London also established the green tariff scheme to encourage vessels to cut emission. It offers a discount on port charges for vessels with lower emissions, where the vessels meet an ESI score of 30, or above; the British Port of Felixstowe, together with a railway department and terminal operators, jointly launched a 60.4-million-pound scheme, adding up to 47 pairs of freight trains to run per day. This new capacity will result in increased modal shift and radically reduce the impact of road vehicles on our environment and public health; Norway's Port of Sandefjord and an environmental protection equipment company jointly invented the PortBin to collect garbage in port areas. The PortBin is based on the research and development of oil spill technology. With simple and efficient operation, PortBins have been placed into use in five ports in Norway, including Sandefjord and Copenhagen, protecting the ecological construction in these port areas.

7.2.2 American Green Port Project Further Upgraded

◆ **Los Angeles - Long Beach, US**

The ports of Long Beach and Los Angeles joined to improve air quality by adopting the San Pedro Bay Ports Clean Air Action Plan (CAAP) in 2017, proposing 14 action projects. It aimed at reducing greenhouse gases (GHGs) to 40% below 1990 levels by 2030, and cutting GHGs to 80% below 1990 levels by 2050. The California Energy Commission granted $9.7 million to fund the design and construction of 25 zero-emission vehicles to handle cargoes at terminals. It is expected to reduce more than 1,323 tons of GHGs and save 270,000 gallons of diesel fuel. The ports have invested nearly $400 million in shore power equipment for container ships. The Port of Long Beach and Port of Los Angeles announced to offer $1 million to solicit for new technology to reduce at-berth emissions for non-container vessels and thoroughly wipe off ship pollution.

◆ **Vancouver, Canada**

In 2017, the Vancouver Port Authority added new incentive criteria to its existing Eco Action program to include harbor due rate discounts for quieter ships, in an effort to lower underwater vessel noise affecting marine life. The move made Canada the first country in the world with a marine noise reduction incentive. The port has also launched a series of initiatives in energy

conservation and emission reduction, controlling the GHGs released by ships, trucks, cargo handling equipment and terminal activities. The port is accelerating the C$18 million shore power construction projects at the two container terminals of Deltaport and Centerm, and encourages shipping lines to use shore power through harbor dues discounts in addition, the port has also adopted other measures to reduce GHGs emissions, launching vessel slowdown trials and the environmental standards for port-bound container trucks.

◆ **Other ports in Americas**

The Port of Montreal in Canada completed its shore power project at the Alexandra Pier in 2017.This project is expected to reduce GHG emissions by 2,800 tons per year, making the port one step forward in green development; the Port of Virginia in the US ordered 16 hybrid shuttle carriers in 2017, after purchasing three in 2015. The container trucks are set to reduce fuel consumption and noise pollution; the Port of Oakland in the United States has set up a task force to revamp clean air roadmap, and invested $1 million for clean cargo handling equipment to achieve the goal of reducing diesel emissions by 16% by 2020.

7.2.3 Green harbor construction strengthened in Asia

◆ **Singapore**

The Maritime and Port Authority of Singapore injected another S$12 million to boost the construction and use of Liquefied Natural Gas (LNG) bunkering in 2017.It has also signed a memorandum of understanding with Shell to advance clean fuels technology and promote the green development of the port. It's noteworthy that to keep the waterway clean, the port authority organized the Clean-Up on Kayak activity in September 2017, gathering 120 volunteers to collect marine trash. It also added daily cruising vessels to clean up garbage in the waterway, promoting the ecological development of the port.

◆ **Ningbo-Zhoushan Port, China**

Ningbo-Zhoushan Port invested 400 million yuan to turn diesel-powered gantry cranes into electricity-powered ones, reducing GHG emissions by 98,000 tons annually. It then actively promoted the LNG container truck project, and has added 535 LNG trucks up to now. The port has made key tech breakthrough for "zero fuel consumption, zero emission, and zero noise". It has built China's first high-voltage frequency conversion shore power, with each berth saving 300 tons of fuel on average per year, and the move will reduce air pollution emissions by about 30 tons. In the future, the Ningbo-Zhoushan Port Group said that it will build 50 low-voltage ship shore-side power points and 4 to 6 high-voltage variable-frequency ship shore-side power points, and set up a special fund to encourage energy-saving emission reduction technology research and development and promotion to lead the construction of green ports.

◆ **Other Asian ports**

The Port of Shanghai in China started to construct the shore power demonstration zone for a green port in 2017.Shenzhen city located in South China's Pearl River Delta, actively builds its port into a "green model". It added shore power facilities for nine berths in 2017, boasting the most berths equipped with shore power facilities in China. Ports in the Bohai Rim in the northern region of China have completely banned diesel vehicles from transporting coal to and from container hub ports, greatly reducing the environmental pollution caused by diesel vehicles transporting coal. In

2017, the Port of Yokohama joined the Green Award scheme in 2017, offering Green Award certified ocean going vessels a discount of 15% on entrance fee of port dues when calling at the port; the Colombo Port in Sri Lanka has launched a $10m project to convert rubber tyred gantry (RTG)cranes from diesel to electric-powered, aiming to realize zero-emission operation.

7.2.1 Green port construction in steady progress in Oceania

The Port of Auckland in New Zealand partnered with local environmental company Enviro-Mark Solutions to launch the Certified Emissions Measurement and Reduction Scheme (CEMARS) in 2017, and has started to implement the scheme. Its first steps include a shift to LED lighting at terminals and preparation for a shore power project at a cruise berth. The shore power project has an estimated total cost of $18.3 million and the potential to reduce greenhouse gas emissions by 31% The DP World is working with port equipment supplier Kalmar to provide new equipment for its terminals in Australia, including Sydney, Melbourne, Fremantle and Brisbane. The equipment with the innovative K-Motion technology can significantly reduce fuel consumption, reducing 40% of emission, and will help in green port construction in Australia.

7.3 Development measures of green ecological ports

7.3.1 Establish a comprehensive evaluation index system

A comprehensive evaluation index system will be a necessity to verify whether a port is truly green and ecological, A green index system will not only indicate the direction of port development, and provide a scientific basis for port development, but also cap and constrain excessive development activities, which will be conducive to the sustainable use of natural resources in port areas and the sustainable soundness of ecological environment, accelerating the green and ecological port development.

7.3.2 Twin drivers of mandatory regulations and incentive policies

The green transformation of ports shall be guaranteed by authoritative mandatory regulations issued by governments, whose corresponding laws, regulations and standards of conduct can most directly promote the construction of green ports. In addition to mandatory regulations, governments and the ports also need to introduce relevant economic incentive policies to facilitate the implementation of these regulations. The concerted implementation of government regulations and incentives accelerate the green and ecological port construction.

7.3.3 Multi-party cooperation to promote green port construction

Green port construction is a systematic and comprehensive project involving a series of stakeholders, such as terminal operators, shipping companies, chemical plants, handling equipment suppliers, energy providers, governments and the public. It needs to coordinate all parties to accelerate the pace of green port construction.

7.3.4 High-tech leads ports' green development

The breakthroughs and innovations in environmental protection technologies have provided technical support and guarantees for ports' green transformation and upgrading. The investment and utilization of advanced and environmentally-friendly facilities and equipment are the booster for ports' shift to green and sustainable development lanes. The International Maritime Organization (IMO) launched the Maritime Technology Cooperation Centres (MTCCS) in 2017, and established maritime technology centers in Asia, the Caribbean, Africa, the Pacific and Latin America, aiming to fund the R&D and utilization of innovative environmental protection technologies in developing and underdeveloped countries alike. The project will constantly promote the innovation of green and environmental protection technologies for global ports.

VIII. Comments on comprehensive services of coastal container ports in China in 2017

8.1 Establishment of the comprehensive evaluation index system

1. Index framework structure

China's coastal container port comprehensive service evaluation index is an evaluation system based on qualitative and quantitative indicators. Some of the quantitative indicators are calculated using the AIS ship dynamic big data to objectively reflect the operational efficiency level of port terminals. The index system mainly includes two dimensions: two Level 1 indicators, namely the production advantages and service advantages, and 12 secondary indicators. Out of considerations for maintaining the authenticity of relationships between various indicators, the levels are merged one by one through indicator weight.

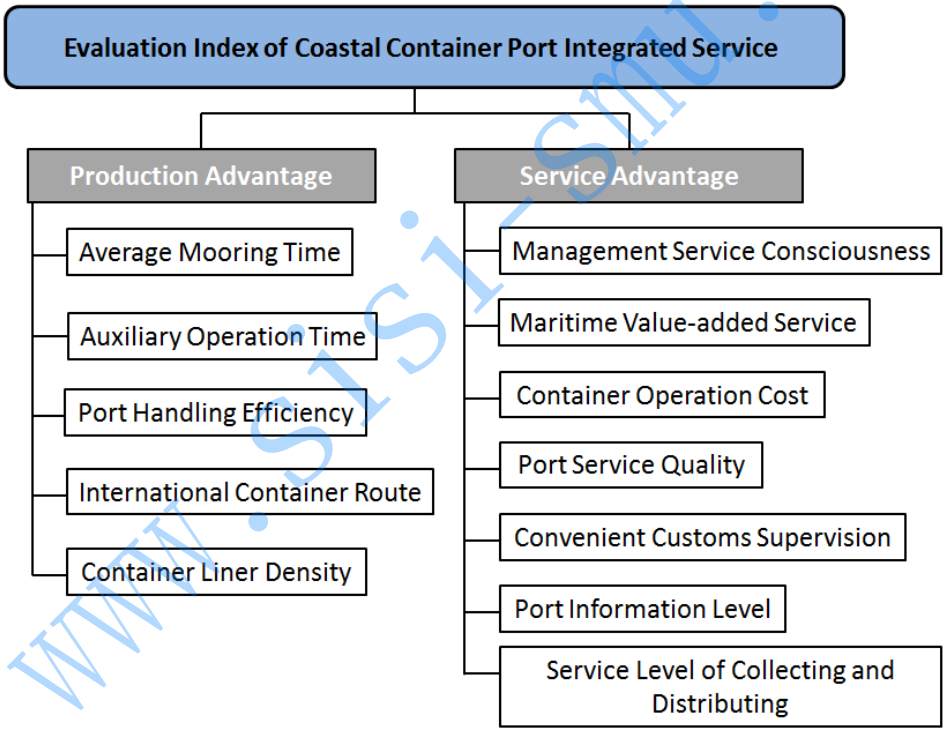


Figure 8-1 Evaluation Index Frame of Coastal Container Port Integrated Service

2. Instructions about refined indicator items

A—Production-type advantage indicators

A_1 Average anchoring time

This term refers to the time used for berthing at the anchorage by production operation ships, including the case that production operation ships cannot directly enter the port for operation and have to anchor and wait because of wind, snow, frost, rain, tide and operation wait among other

reasons. The value is mainly used to reflect the natural conditions and congestion situations at the ports.

Data source: calculated by real-time statistics of big data by the AIS system. The AIS data is provided by the Elane Inc.

A_2 Auxiliary operation time

This term refers to the time needed by the production operation ships from receiving port operation commands, sailing from the anchorage to the loading and unloading berth, and to completing the production operation and departing from the port, including the auxiliary production time for towing (dismissing and forming fleets), pilotage, berthing, shifting berth, and unmooring and mooring (excluding the loading and unloading operations). This value is mainly used for reflecting the production organization and water management capability of ports.

Data source: calculated by real-time statistics of big data by the AIS system. The AIS data is provided by the Elane Inc.

A_3 Loading and unloading efficiency at ports

This term refers to the time needed for loading and unloading operations when containers ships berth at container berths at the port. The production efficiency is not only affected by hardware facilities such as cranes, but is also related with the ship size, the number of supporting units and port logistics. Therefore, this indicator is based on the average ship hours' indicator that will affect ships directly. This value is mainly used to reflect the production technology levels and organization capability of ports.

Among them, the "average ship hours" refer to the average volume of cargoes loaded and unloaded by every ship berthed at the port per hour. The calculation formula is: $P\ ship \cdot hour = \sum_{k=1}^{n} Q\ ship \bullet loading\ and\ unloading / \sum_{k=1}^{n} T\ ship$

In the formula: $P\ ship \cdot hour$——average ship hours (TEU/ship hour);

$\sum_{k=1}^{n} Q\ ship \bullet loading\ and\ unloading$——aggregate of loaded and unloaded cargoes of ships to the port;

$\sum_{k=1}^{n} T\ ship$——the sum of operation ship hours (ship hour);

Data source: real-time statistics of the AIS system and data of the Ministry of Transport (MOT)

A_4 International container routes

This term refers to the number of international container liner routes that call at this port, including offshore and ocean-going routes. This value is mainly used to reflect the operation advantages of international routes of the port.

Data source: shipping enterprises, port enterprises, and route journals.

A_5 Container liner intensity

This term refers to the number of container liners opened every month at this port. This indicator is mainly used as a supplementary of the shipping resources. The higher the liner intensity, the

more concentration advantages of the port.

Data source: shipping enterprises, port enterprises, and route journals.

B—Service-type advantage indicators

B_1 Management service awareness

The term refers to the initiative and enthusiasm of port enterprises for providing services to ship companies. This value is mainly used to reflect the service awareness of ports. At the same time, it reflects the market openness of local ports to some extent. Ports in more open and freer cities usually have more than one operating terminal, featuring relatively sufficient market competitions and high enthusiasm of port enterprises to take the initiative to provide services.

Data source: scored by industry veteran route managers or experts familiar with the port and shipping industry.

B_2 Maritime value-added services

This term refers to that the port provides fuels, materials and fresh water to arriving ships and is capable of replacing parts and other ship maintenance functions. This value is mainly determined by the diversity and service level of ship maritime services provided.

Data source: scored by industry veteran route managers or experts familiar with the port and shipping industry.

B_3 Cost of single container operation

This term refers to all the charges collected by the port operator for loading and unloading a 20-foot TEU.

Data source: shipping enterprises and port enterprises.

B_4 Port service quality

This term refers to the degree of satisfaction of ship companies and cargo owners for loading and unloading operations and related services at the port. The port service quality is mainly embodied in the cargo damage and cargo difference aspects.

Data source: scored by industry veteran route managers or experts familiar with the port and shipping industry.

B_5 Convenience of customs supervision

This term refers to the degree of convenience for customs procedures in terms of ship and cargo declaration and supervision, for example, whether ships are often stranded in the port or cargoes are often dumped because of inspections.

Data source: scored by industry veteran route managers or experts familiar with the port and shipping industry.

B_6 Collection, distribution and transportation levels in the port area

This term refers to the comprehensive influences of the collection, distribution and transportation

conditions of the hinterland of the port on ship companies, such as demurrage because of poor collection and distribution.

Data source: scored by industry veteran route managers or experts familiar with the port and shipping industry.

B_7 Information level of ports

This term refers to the ship company and cargo owner experience about the information services at the port, such as the connection of ship and port information, and EDI information reporting.

Data source: scored by industry veteran route managers or experts familiar with the port and shipping industry.

3. Determination of indicator weight

A number of industry veteran operators and industry experts carry out rigorous evaluation and model processing to get the weight table of the indicator system.

Table 8-1 Evaluation Index System and Weight of Coastal Container Port Integrated Service

Level 1 Indicators		Level 2 Indicators	
Item	**Weight**	**Item**	**Weight**
Production Advantage (A)	0.55	Average Mooring Time	0.18
		Auxiliary Operation Time	0.20
		Port Handling Efficiency	0.30
		International Container Route	0.17
		Container Liner Density	0.15
Service Advantage (B)	0.45	Management Service Consciousness	0.17
		Maritime Value-added Service	0.08
		Container Operation Cost	0.15
		Port Service Quality	0.18
		Convenient Customs Supervision	0.12
		Port Information Level	0.15
		Service Level of Collecting and Distributing	0.15

Source: Websites of Various Port Authorities, sorted by SISI

8.2 Analysis on the comprehensive evaluation index results

1. Overall rankings of service levels

The index evaluation result showed that port groups of the Yangtze River Delta, Pearl River Delta, and Bohai Rim all have outstanding high-quality ports in terms of comprehensive services of container ports. With the integration of China's provincial ports, and the progress in the One Belt

and One Road national strategy, the comprehensive ratings of ports in Zhejiang and Fujian provinces as well as some northern ports have been significantly improved.

Table 8-2 Integrated Service Ranking of Domestic Coastal Major Container Port

Ranking	Port	Score	Port Group
1	Shanghai	87.2	Yangtze River Delta
2	Dalian	83.1	Bohai Bay Area
3	Shenzhen	82.3	Pearl River Delta
4	Xiamen	78.4	Southeast
5	Ningbo-Zhoushan	78.0	Yangtze River Delta
6	Tianjin	77.7	Bohai Bay Area
7	Qingdao	77.6	Bohai Bay Area
8	Guangzhou	77.1	Pearl River Delta
9	Lianyungang	76.2	Yangtze River Delta
10	Yingkou	74.0	Bohai Bay Area
11	Qinzhou	73.6	Southwest Coastal Areas
12	Fuzhou	73.2	Southeast
13	Yantai	72.7	Bohai Bay Area
14	Rizhao	72.5	Bohai Bay Area
15	Quanzhou	72.1	Southeast
16	Humen	71.1	Pearl River Delta

2. Analysis on refined indicator items

(1) Container shipping market improves in 2017

The report was based on the analysis of the AIS data of 16 major container ports in China's coastal areas by Shipping & Port Big Data Laboratory of Shanghai International Shipping Institute, and targeted hub ports with monthly container vessel calls greater than 300 on average-namely, Ningbo Zhoushan Port, Port of Qingdao and Port of Shanghai and Port of Shenzhen-to count these ports' container vessel calls from September 2016 to August 2017. Monthly changes in vessel calls show that vessel calls on each of the sample ports increased significantly after the second quarter of 2017. The use of idle capacity and the accelerated operations of vessels both improved vessel calls on these ports, indicating that the container shipping market picked up after the second quarter of 2017. Both the decline in vessel calls declined and the trough in port throughput can be attributed to the Spring Festival in February, which advanced or delayed a lot of trade. It was the peak time for container ship maintenance in June, bringing a slightly decline in vessel calls. However, a relatively high carrying rate of ships kept these ports' container throughput at a relatively high level.

(2) Small- and medium-sized container ships dominate the container shipping market

The Shipping & Port Big Data Laboratory's analysis on the proportion of container ship types at the 16 ports find that "small- and medium-sized" container ships no more than 5,000 TEUs dominated the current container shipping market, occupying 55% of the market. Container ships are in the trend of becoming bigger, rapidly increasing the capacity of large-scale container ships. However, the proportion of cargoes assigned to small- and medium-sized feeder ships also rose

correspondingly. Therefore, small-sized and medium-sized container ships outnumbered their larger peers.

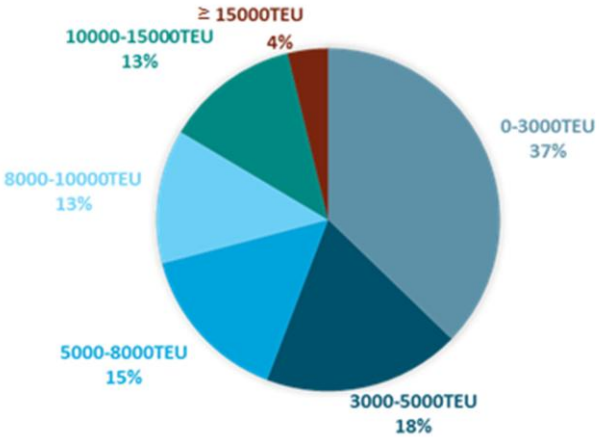


Figure8-2 Proportion of Container Ships Operating in 16 Ports in August 2017

Judging from container ships' "operation time in ports" and "operation time at berths", the average operation time each container ship of/below 3,000 TEUs was higher than that of each container ship above 3,000 TEUs. Generally, the smaller a ship, the higher the proportion of its containers in port operation against all the containers it carries. In addition, feeder barges often have to wait for the loading and unloading operations of larger ships. Therefore, small-sized container ships took a longer operation time on average.

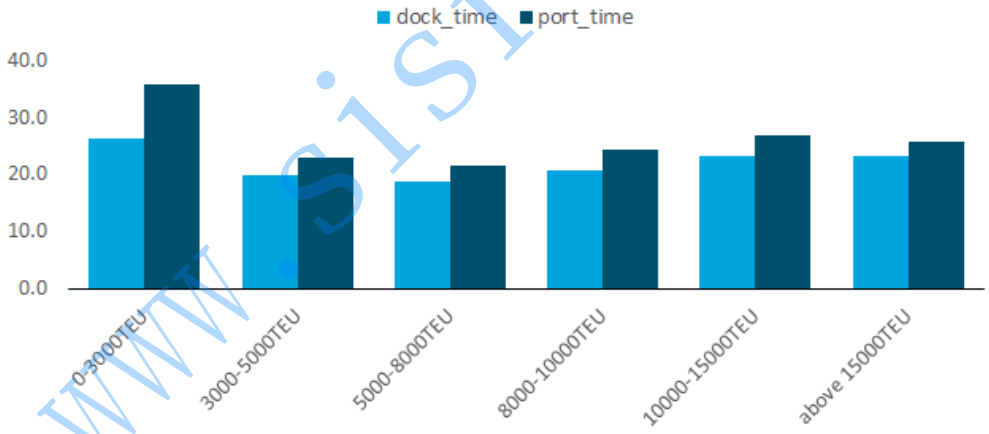


Figure 8-3 Dock Time and Port Time of Submarine Container Ships for 16 Ports in August 2017

(3) Ranking of container ports' operation efficiency

The ranking was based on statistics from the Shipping and Port Big Data Laboratory on ship operation efficiency at 14 container ports, and the efficiency were graded with two major factors of "operation time in ports" and "operation time at berths" as the evaluation indicators. The top five ports with the highest container operation efficiency were Port of Shenzhen, Port of Dalian, Port of Shanghai, Port of Xiamen, and Port of Lianyungang.

Table 8-3 Evaluation of Container Ports' Operation Efficiency

Ranking	Port	Dock_Time (hour/vessel)	Port_Time (hour/vessel)	Score
1	Shenzhen	19	21	88.2
2	Dalian	25	26	86.6
3	Shanghai	25	26	81.0
4	Xiamen	21	24	80.2
5	Lianyungang	27	30	78.9
6	Ningbo	21	35	76.1
7	Guangzhou	20	26	78.3
8	Qingdao	23	28	78.0
9	Tianjin	31	34	77.0
10	Qinzhou	29	37	76.4
11	Yingkou	48	53	75.4
12	Yantai	35	51	73.2
13	Rizhao	43	57	72.8
14	Fuzhou	30	55	72.6

Source: Shipping and Port Big Data Laboratory

IX. Development trend of global ports in 2018

9.1 Development trend of global ports

9.1.1 Global ports enter the phase of consolidation growth

After 10 years of moderate adjustment, the global economy will basically enter the stage of prosper from recovery in 2018. Indicators of the world's major economies have gradually improved and stabilized, the world trade is active continuously, and the global shipping and port industry is expected to enter the consolidation phase before growth in the new era.

The International Monetary Fund (IMF), in its most recent forecast, expected the world economic growth rate at 3.9% in 2018, showing a good growth momentum. However, the economic expansion of the world's major countries does not necessarily lead to the simultaneous growth of seaborne trade volume. As some countries pay excessive attention to economic recovery of their own countries, their policies, with a rising domestic-oriented tendency, would be inclined to support the development of domestic industries, which would inhibit the expansion of international trade and the import and export demand to a certain extent. In addition, despite a faster growth of the global economy, uncertainties remain for international trade growth, as international trade agreements, such as the North America Free Trade Agreement and the Trans-Pacific Partnership Agreement, lose momentum for further progress, and political issues such as the Brexit continue to impact the world. Judging from the economic growth, the background of steady trade and economy development, and the relatively large volume of seaborne trade, the growth rate of global ports is expected to exceed 5% in 2018, within the range of moderate growth to consolidate development.

- **Asian ports lead the growth, European and American ports' growth falter**

By regions, the US ports maintained a good momentum of growth under the Federal Reserve's loose monetary policy and "manufacturing incentive plan" in 2017, but with the severe trade protectionism and industry protectionism, the growth rate of trade under the Trump Administration may fall behind that of the US economy. There is great uncertainty and the growth rate is expected to drop. Thanks to the industrial revitalization and a rising demand in infrastructure construction, as well as overseas capital's heavier investment in European ports, European ports have seen steadily increase in cargo shipping demand, but the growth rate is expected to be around 4%. Under the policies and measures of reform and opening up and industrial restructuring in emerging economies in Asia, bulk cargo demand and container trade will maintain rapid growth, and the growth rate will be around 6%.

- **Container trade continues to expand and bulk cargo perform differently**

The global port container throughput will keep a moderate growth of more than 6%, thanks to the robust international commodity trade and consumer markets. The growth rate will be higher than that of cargo throughput, especially under the adjustment of business models, such as cross-border e-commerce and overseas online shopping, as well as the transformation modes, such as the "shift from bulk to container transportation". However, more goods will be shipped on direct routes for a

timely transportation, which will further reduce the proportion of containers transported via transfer ports, but raise the proportion of empty containers.

In addition, judging from market performance of ports and international industrial policies in 2017, and the oil output cut by the OPEC, the global liquid bulk shipping volume in 2018 may remain the same of last year, with a limited room for growth; however, under the background of limited oil trade and insufficient supply of new energy such as natural gas and shale gas, there will be a great trade demand for coal and other alternative fuels, which, though, will be phased out in the market due to environmental protection requirements. On the other hand, iron ore and other commodities, which enjoy a relatively large trade volume in the market, and basically meet the needs of national construction, will continue to grow at a consistent rate of about 5%, in line with previous years.

9.1.2 Rational investment in global ports leads to a slowdown in construction

In 2018, global port investment maintained moderate growth, and the progress of port investment and infrastructure construction in various countries slowed down. As the large-scale development of ships deepens, port reconstruction and expansion projects have already started or entered the operation stage, which dampen the demand for the new port construction and investment. Moreover, the relatively low terminal utilization rate and relatively high proportion of idle capacity in some areas, and the fluctuation in demand for dry bulk commodities, impede the zeal for port investment. As for the drives behind port construction, some regions renovate and construct local ports and terminals to promote investment and stimulate economic development, while overseas investment eyes more on port profitability. Therefore, massive terminal construction become increasingly rare. Judging from regions, underdeveloped regions, such as South America and Africa, shows a relatively high enthusiasm in port construction, and some of the terminal investment is led by shipping companies, mainly to reduce the logistics costs of shipping networks; some of the established port operators and global terminal operators prefer regional hub ports, and they renovate and expand terminals to achieve goods gathering within the region.

- **Developing country ports remain the focus of investment**

In terms of port construction, the developed countries' economic systems are relatively mature, trade growth has stabilized, and new trade has been modest; while there are still relatively large potentials for developing economic and trade cooperation with developing countries, and the relative backwardness of infrastructure has, to a certain extent, inhibited international trade. Development, once the port investment opens up freight transportation channels, has inestimable potential for the region's future development of logistics and commerce. In light of this, more and more terminal operators and investors have focused their attention on emerging markets such as India, Africa, and South America.

- **Developed country port investment focuses on functional terminals**

In contrast, port investments in developed countries have shown a tendency to focus on the construction of functional terminals. For example, the United States has accelerated the

construction of LNG terminals and multi-functional terminals. It has no longer fully paid attention to the improvement of port capabilities, and has paid more attention to port functions. Whether it is capable of unloading or relocating LNG and other special cargoes, it can realize industrial agglomeration and source agglomeration through port functions. At the same time, the investment and construction of special terminals such as LNG will also have a strong driving effect on the operating companies and local economic development.

9.1.3 Global terminal operators tend to differentiate

- **Terminal operators have different investment strategies**

Under different industrial backgrounds, global terminal operators gradually adopt different investment strategy. Some terminal operators will continue to spin off non-port assets to focus on terminal operations and enhance their operational efficiency; while others will gradually expand their business to the upstream and downstream of the industrial chain, absorbing service industries, such as railways, logistics, and parks. . At the same time, their investment targets also differentiate gradually. Some terminal operators have focused on port investments in developing countries, while some others still prefer mature due to their lack of experience. Therefore, with differentiated investment strategies, the situation will remain the same with a boom of terminal assets transfer and continuous terminal investment in emerging economies.

9.2 Development trend of Chinese ports

China's economy will maintain a good momentum in 2018, and continues to grow more than 6%. Besides that, the opening up policies and industrial restructuring will make China's foreign trade products more competitive, and China is still in strong demand for energy and building materials. These factors will bolster Chinese ports' economic growth in foreign trade. At the same time, domestic trade goods, drawing much attention from shipping companies, will maintain the steady growth. Chinese ports are expected to maintain the more than 5% growth rate in cargo throughput in 2018.

- **Container throughput continues to expand with foreign trade in good momentum**

As China accelerates economic transformation and upgrading, and heavy-duty processing and manufacturing industries are in the process of capacity cut and integration, only basic materials, such as energy and basic mineral materials, still saw high demand, and growth rate slowed down for ports' goods trade in massive imports and massive exports, plus a shrinking market share. In contrast, container trade at Chinese ports continued to maintain a good growth momentum, thanks to the opening up of China's consumer market, the requirement on environmental protection, and shift of transportation mode, such as the "shift from bulk cargo shipping to container shipping" for coal and other bulk cargoes. Among them, container transportation in the inland waterway of the Yangtze River and Pearl River gradually accelerated, and foreign trade container transportation in coastal regions will continue to grow along with the implementation of China's free trade pilot zones and free trade ports. To wrap up, China's container throughput is expected to maintain a high growth rate of about 8% in 2018.

- **Dry bulk throughput continues to increase, and liquid bulk growth stabilizes**

China's economic policies and industrial environment will continue in 2018, and the demand for bulk cargo will increase steadily. At the same time, as the international oil output cut hinders the import and export demand for liquid bulk cargoes, and domestic oil exploration and basic resources are limited, coal is still expected to serve as the main energy source to fill the oil gap. Therefore, throughput of liquid bulk cargoes is expected to increase steadily, with a growth rate more than 6%. Dry bulk cargoes will keep growing in general, but as the demand for infrastructure construction slowed, the demand for iron ore transportation will grow slightly with a withering growth rate, which is expected to maintain about 5% in 2018. Due to the shortage of other energy, coal, once faced with shrinking demand, will enjoy a relatively sound growth in 2018, and the demand for foreign imported coal will be relatively strong.

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Members： Zhang Jing, Chen Weijie

Zhou Xin, Wu Wenjuan

Wu Jiazhang, Lin Xiao

Xu Zhongchen

Shanghai International Shipping Institute

Shanghai International Shipping Institute Port Development Institute

Add: No.150 Huoshan RD. Shanghai China Zip code：200082

Contact: Lu Weiling

Email: luweiling@sisi-smu.org

TEL: +86 21 65853850*8038/65355897

Fax: +86 21 65373125

Website: http://en.sisi-smu.org/

Port Development Department Contract: Zhao Nan Tel:021-65853850-8033 Email:rockyzhao1986@163.com

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Introduction of Shanghai International Shipping Institute

July 14, 2008 witnessed the founding of Shanghai International Shipping Institute (SISI) inaugurated by government officials from Ministry of Transport and Shanghai Municipality. Han Zheng, the then Deputy Secretary of the CPC Shanghai Municipal Committee and Mayor of Shanghai sent a letter of congratulations.

SISI, affiliated to Shanghai Maritime University, is launched by 21 council members. The first session council chair unit was China Shipping (Group) Company. The second session council chair unit is Shanghai International Port (Group) Co. Ltd, while vice council chair unit comprises 22 institutions including China Shipping (Group) Company, Shanghai Group Port Administration Committee, Shanghai Maritime Safety Administration, Shanghai Municipal Education Commission, Shanghai Municipal Transport Commission, Hongkou District People's Government, Wuhan New Port Administration Committee, China Academy of Transportation Sciences, Transport Planning and Research Institute (affiliated to China's Ministry of Transport, hereafter referred to as MOT), China Waterborne Transport Research Institute, COSCO Container Lines Co. Ltd, Sinotrans Eastern Co. Ltd, Shanghai Jinjiang Shipping Co. Ltd, Shanghai Shipping Exchange, China Ports Association, Shanghai Shipowners' Association, Shanghai Freight Forwarders Association, World Maritime University, Shanghai Maritime University, Shanghai Jiaotong University, Ningbo University, Shanghai University of International Business and Economics, etc. The number of our registered council members hit nearly 400 as of September 2015.

Against the backdrop of Shanghai international shipping centre construction, SISI endeavors to contribute its share to China's maritime industry and Shanghai's rise as a maritime capital by establishing extensive ties with international maritime organizations, companies and colleges, networking top experts via our research platform which tracks fresh concept, technology and trend on the global maritime scene.

SISI is an international maritime consultation and research institute providing government agencies and industry players with decision-making information and consultation service.

SISI is open to government agencies, port authorities, maritime companies, educational institutions, research institutes, industrial associations and organizations etc, integrating efforts in maritime production, study and research.

SISI is one of the earliest institutions entitled Shanghai University Knowledge Service Platform & Center for Strategic Studies and Key Research Institute of Humanities and Social Sciences. In 2014, SISI was recognized as Collaborative Innovation Center of Shanghai University.

SISI serves as a key government think tank. In August 2012, Ministry of Transport (MOT) and Shanghai Municipal People's Government signed a Memorandum on Deepening Cooperation to Accelerate Shanghai's Rise as an International Shipping Center which specifies that the two parties will work together to support Shanghai's development into an international shipping center. Since then, SISI was co-sponsored by Shanghai Maritime University and Shanghai Municipal Transport Commission. Weng Mengyong, vice minister of MOT visited SISI in April, 2015.

Three Main Functions

- Function 1. Decision-making consultation

Analyze and grasp the growing trend of shipping and port industry; provide sound proposals for government agencies as well as shipping and port enterprises; become instrumental as government's maritime policy think tank and industry players' advisor; and strive for a world-famous consultancy specializing in shipping.

- Function 2. Information release

Collect and compile/analyze statistics and information regarding shipping and port business, aviation, shipping finance, seaborne trade, maritime judicature etc; publish regular reports on international and domestic shipping market as well as global port industry, and release China Shipping Prosperity Index; publish Global Aviation Industry Development Report, China Shipping Finance Development Report, China Cruise Industry Development Report, China Cruise Market Development Report, Shanghai Shipping Policy and Law Development White Paper etc.; launch China Shipping Database and Shipping & Port Big Data Laboratory; host international shipping and port conferences.

- Function 3. Talent service

Set up open platform for shipping communications and exchanges; network with top shipping experts, scholars and entrepreneurs and integrate their expertise in shipping research; and offer shipping talent training programs and lectures; establish bases for young teachers' practice, postgraduates' cultivation and college students' innovation to create a platform for the gathering of shipping talents.

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Shipping &Port Big Data Laboratory: Ph.D. Xu Kai

Shanghai International Shipping Institute

Add: Room 305. No.150 Huoshan RD. Shanghai China Zip code：200082

TEL: +86 21 65853850*8038/65355897

Fax: +86 21 65373125

Website: http://en.sisi-smu.org/