Global Port Development Report (2018)

Shanghai International Shipping Institute(SISI)

May 2019

Preface

In 2018, as the world economy continued to register mild growth with a loss of momentum, some economies represented by the United States announced protectionist policies, raising global trade barriers and complicating the world trade relations. As a result, the trade growth slowed down gradually. This had a cascading effect as the global seaborne trade growth also declined, putting the port and shipping industries under multiple pressures. In view of this, it is necessary to pay close attention to global ports development, analyze the latest characteristics and trends of the industry development, summarize and promote new concepts, advanced technologies, the latest methods and new modes emerging during port development to support the healthy progress of port industry.

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 2018 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 2018; 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 efficiency of Global container ports, which aims to appraise the comprehensive service capability of Global container ports; and Chapter 9 forecasts global ports' development focuses and trends in 2019. 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 Port Development Report (2018)* 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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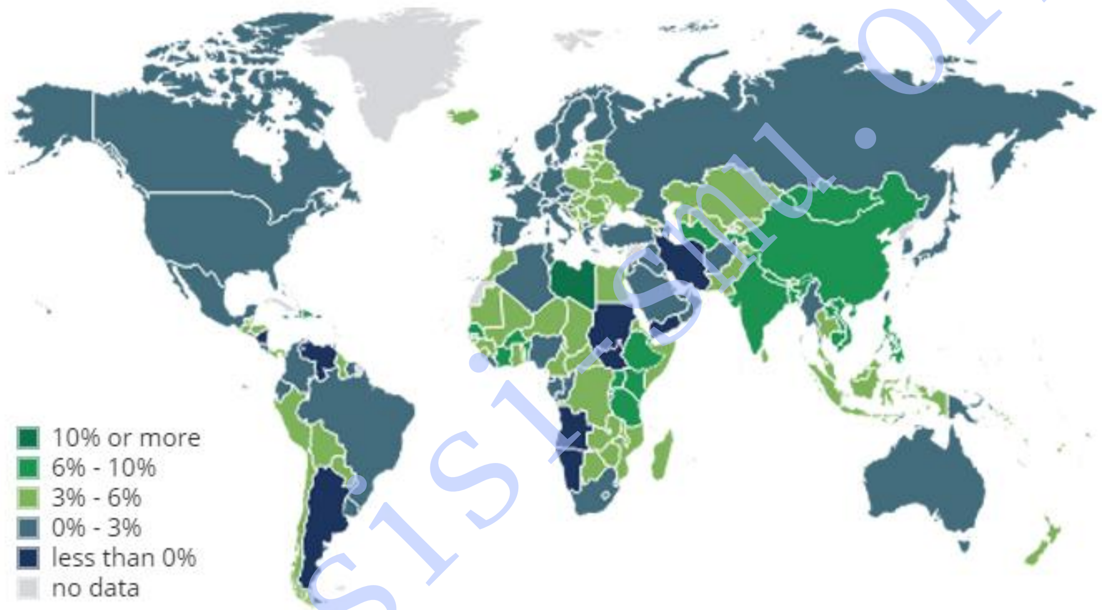
I. Overview of Port Development Environment in 2018

1.1 Overview of Global Economic Development

In 2018, the world economy continued to register mild growth with a loss of momentum. The World Economic Outlook released by the International Monetary Fund (IMF) in January 2019 projected that the global GDP growth rate in 2018 will level off compared with that in 2017, maintaining at 3.7% growth rate. But the global economic performance has been sluggish since Q3 2018, losing the steam for growth. Overall, the world economy is suffering a weakening upside momentum and economic risks may rise.



Source: International Monetary Fund (IMF).

Figure 1-1 GDP Growth Rate of Major Global Economies in 2018

Global economic growth may further slowdown in 2019. The year 2019 is envisaged to witness difficulties in Sino-US trade friction negotiations, no final agreement on the United States-Mexico-Canada Agreement (USMCA), which aims to replace the North American Free Trade Agreement (NAFTA) and uncertainties in the international economic and trade relations, creating negative impacts on the global economic development. Besides, global debts remain high, geopolitical tension may intensify in the Middle East and East Asia, the US Fed may continue to raise interest rate, and the financial markets in emerging economies may be under stress, all of which will contribute to a higher downside risk for the global economy.

1.2 Overview of Global Trade Development

The global trade in 2018 came off early highs. International trade continued to report favorable rise at the beginning of the year, and IMF even projected trade growth of 5.1% for the year in April, the highest projection following the European Union debt crisis in 2011. But since the middle of the year, the global trade barriers have been rising with the US implementing new tariff sanctions against China-exported solar panels, washing machines, steel, etc., triggering countermeasures from China. Though the situation seemed to de-escalate at the end of 2018, world trade relations were becoming increasingly complex due to the trade frictions.

According to WTO, global cargo trade volume grew by 4.2% in 2018, down by 0.5 percentage points year-on-year. Global trade weakness was mostly a result of the declining growth of import trade volumes in developing economies.

Table 1-1 World Trade Growth Trend in 2014-2018

	2014	2015	2016	2017	2018*	Change（%）
World trade in goods	2.7%	2.5%	1.8%	4.7%	4.2%	-0.5
Export: developed countries	2.1%	2.3%	1.1%	3.5%	3.7%	+0.2
Developing countries	2.7%	2.4%	2.3%	5.7%	6.0%	+0.3
North America	4.6%	0.8%	0.6%	4.2%	—	—
Asian region	4.5%	1.5%	2.3%	6.7%	—	—
Import: developed countries	3.4%	4.3%	2.0%	3.1%	3.4%	+0.3
Developing countries	2.4%	0.6%	1.9%	7.2%	4.7%	-2.5
North America	4.3%	5,4%	0.1%	4.0%	—	—
Asian region	3.7%	4.0%	3.5%	9.6%	—	—

Note: * indicates projections.

Source: WTO.

Table 1-2 Major Economies with a Declined Imports Values in 2018

Country	Exports	Imports	Total	2018	2017	Changes (%)
	（Billion US Dollars）			Growth Rate of Import and Export Value		
Turkey	168.0	226.0	390.9	-0.10%	14.80%	-14.90
Argentina	61.6	65.4	127.0	1.40%	10.10%	-8.70
Russia	449.7	237.4	687.1	17.40%	24.80%	-7.40
Finland*	76.5	78.8	155.4	12.55%	16.50%	-3.95
India*	324.9	513.9	838.8	12.81%	18.70%	-5.89

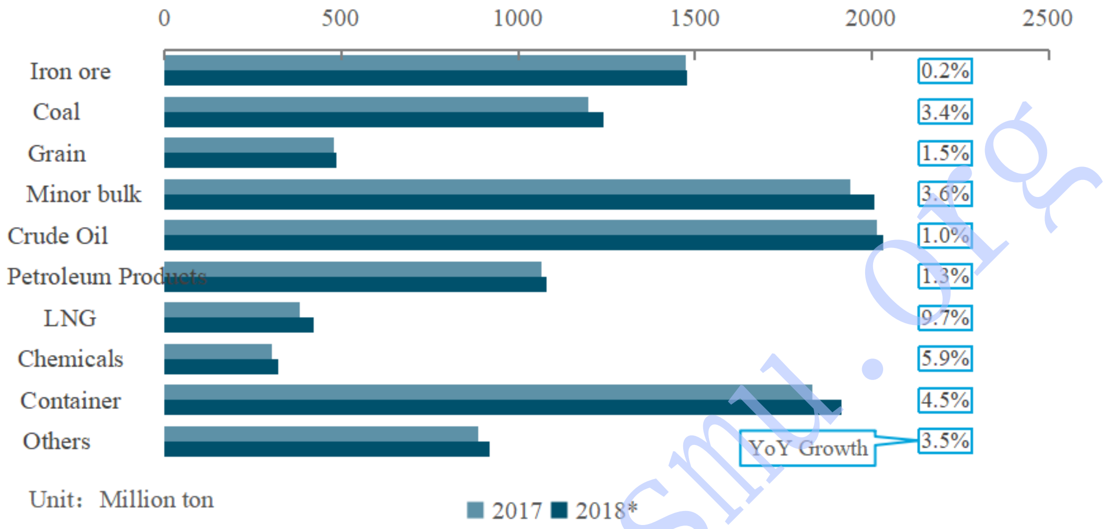
Note: * indicates projections.

Source: Country Report website.

1.3 Overview of International Shipping Market Development

1.3.1 The seaborne volume of global trade slows down

The international economic and trade was confronted with higher downside pressure in 2018 and the global trade barriers rose. As a result, the global shipping trade growth declined, with the projected growth rate at 3.1% to bring the gross trade volume to 12 billion tons. Cargo-wise, the reduced demand for major bulks was a dominant reason for the shipping market growth slowdown in 2018. Meanwhile, container trade growth also dropped, although it managed to sustain a favorable growth rate of 4.5%. Specifically, the North-South routes and intra-Asia routes enjoyed robust growth in terms of trade volume, namely higher than 6%, and the container shipping volume on trunk shipping routes between Asia and Europe edged down. Liquid bulks-wise, the seaborne trade of oil slowed down the growth dramatically, with the crude oil and product oil increasing by mere 1.0% and 1.3%, respectively. The crude oil imports of the US further went down as the shale oil production rose, and the decline in China's crude oil imports also brought growth down. However, the much-watched liquid natural gas (LNG) and liquid petroleum gas (LPG) continued to maintain rapid growth.



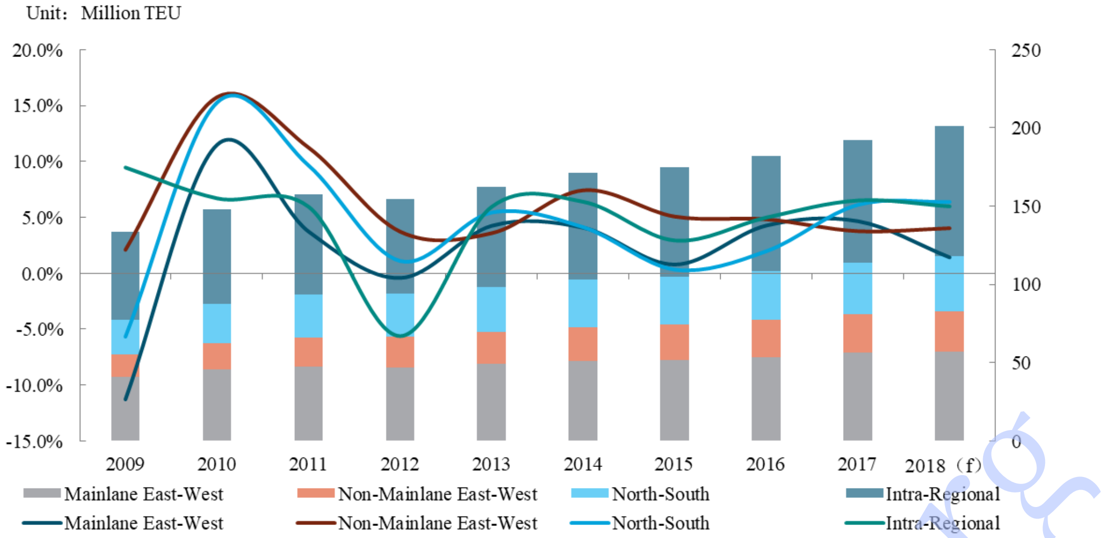
Note: * indicates projections.

Source: Clarkson.

Figure 1-1 Global Shipment Growth of Various Types of Goods in 2017-2018

1.3.2 The seaborne volume of global container rises steadily

The international seaborne containers are expected to grow by 4.5% to 201 million TEUs in 2018, which will be lower than the 5.7% growth seen last year. Specifically, the growth decline, namely by nearly 3.5 percentage points, on the East-West routes was the major contributor to the slowed growth of global seaborne containers. Apart from this, the North-South and East-West non-trunk routes registered stable performance against the lack of new growth momentums, increasing by 6.4% and 4.0%, respectively.

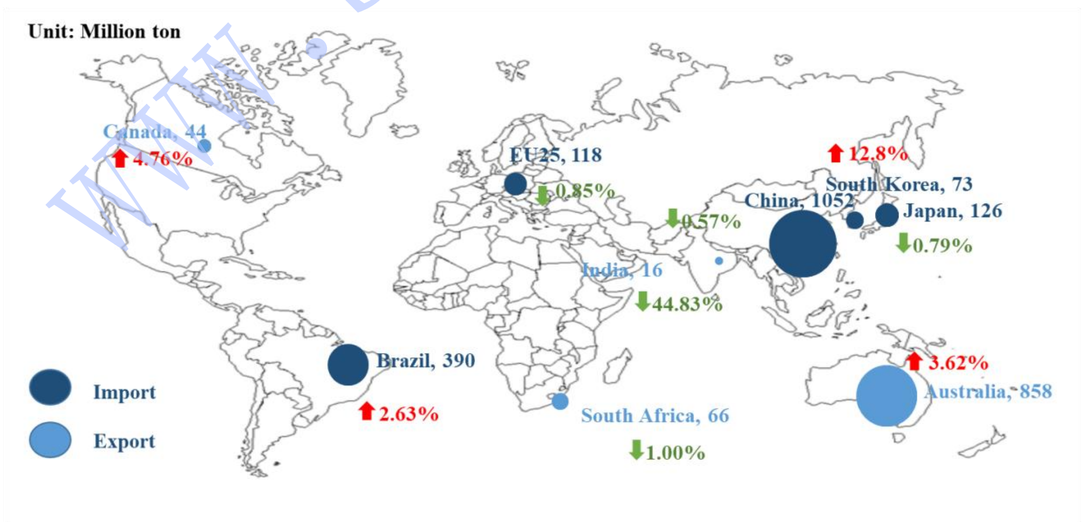


Source: Clarkson.

Figure 1-2 Container Shipping Volume and Growth Rate of Various Routes around the World in 2009-2018

1.3.3 The seaborne volume of global bulk cargo posts sluggish growth

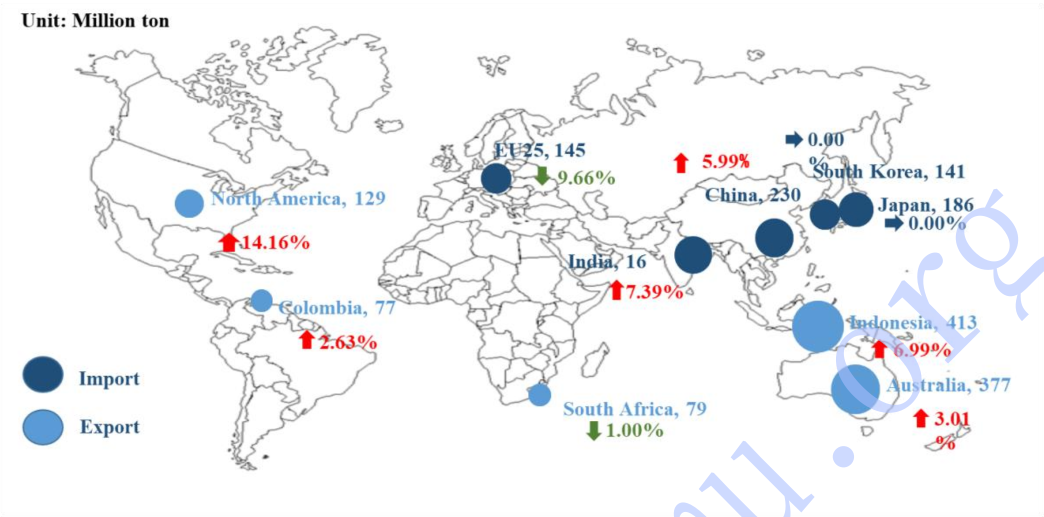
The global major bulks shipping market witnessed a significant decline in growth in 2018. At the beginning of the year, the international iron ore trade slipped back a little but maintained stable growth overall. However, with China's "supply-side" reform and the mounting concerns of steel plants over the external economic uncertainty in Q3, as well as the high stock of steel plants, most iron ore importers were cautious about the market, leading to a slight decline of China's iron ore shipping volume by 0.6% year-on-year. With the boom of infrastructure construction, India, however, enjoyed a skyrocketing demand for iron ores, with its iron ore imports in the first three quarters increasing by nearly 120%. Meanwhile, Southeast Asia and the countries involved in the Belt and Road Initiative also became new vibrant importers of iron ores.



Source: Clarkson.

Figure 1-4 Global Iron Ore Import and Export Volume in 2018

Global steam coal shipping volume grew slowly. EU and other regions started focusing on renewable energy sources, reducing their coal imports, and Asian nations also began to promote clean energy sources. As a result, the coal imports of major steam coal importers such as Japan and South Korea failed to grow in 2018.

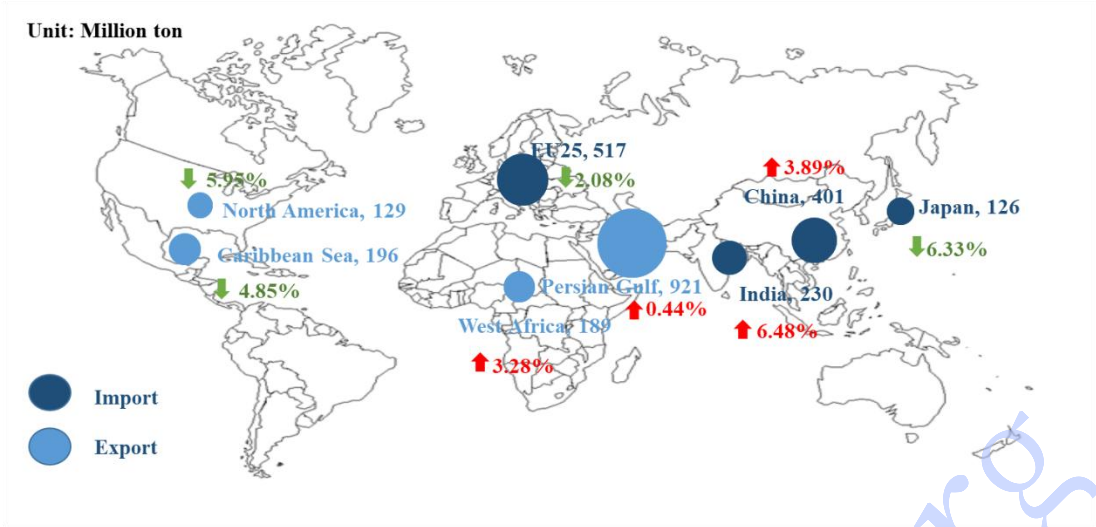


Source: Clarkson.

Figure 1-5 Global Coal Import and Export Volume in 2018

1.3.4 The seaborne volume of global liquid bulks slows down

The global crude oil shipping volume totaled 2.033 billion t in 2018, down by 1% year-on-year, 2.3 percentage points lower than that of the previous year. Due to the concerted production cut by OPEC and the escalating geopolitical risks in the Middle East among other factors, the crude oil exports from the Middle East edged up by 0.4%. The international oil price in the first three quarters of 2018 followed an upward curve, and suppressed the growth of international oil shipping demand. But as OPEC canceled the production cut plan in July, the international crude oil market embraced oversupply at the end of the year, with the oil price plummeting, and the shipping volume rose along with the booming demand.



Source: Clarkson.

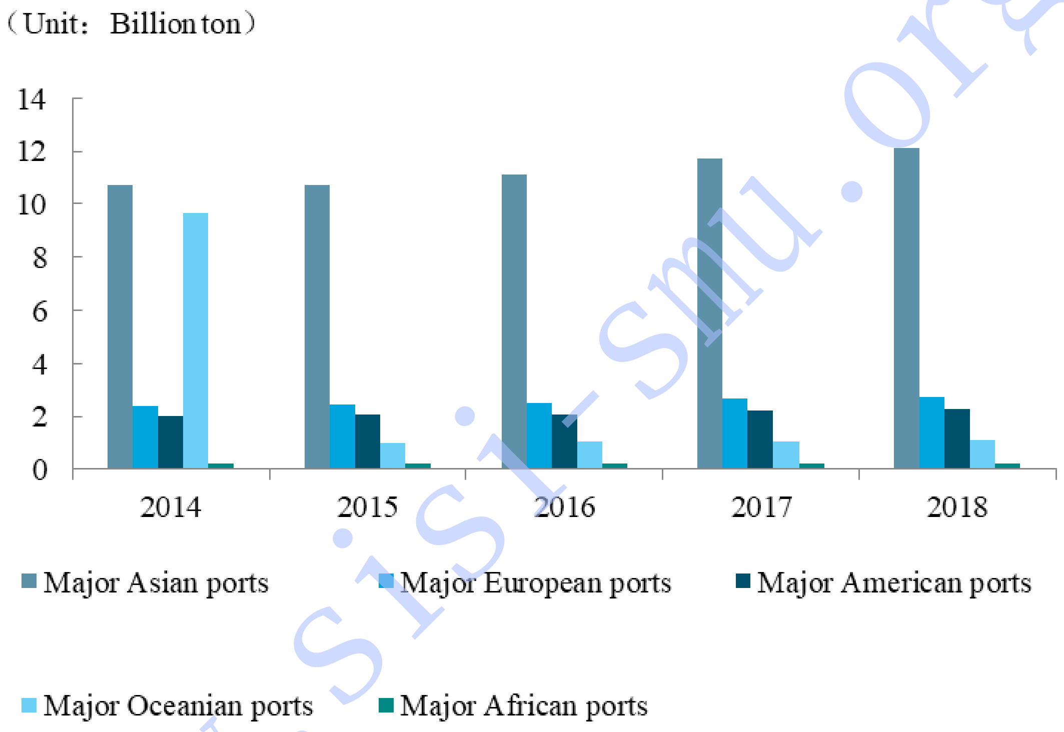
Figure 1-6 Global Import and Export Volume of Crude Oil in 2018

II. Comments on Port Production Situation in 2018

2.1 Overview of Cargo Throughput at Global Ports

2.1.1 Analysis of cargo throughput at global ports

Throughput growth of global major ports dipped. The throughput growth of global major ports in 2018 slowed down a little when compared with the robust growth last year, and the bulks trade posted feeble growth. Major ports in all regions, except Oceania, maintained stable growth. The throughput growth of major ports in Asia, Americas, Europe and Africa fell to some extent.

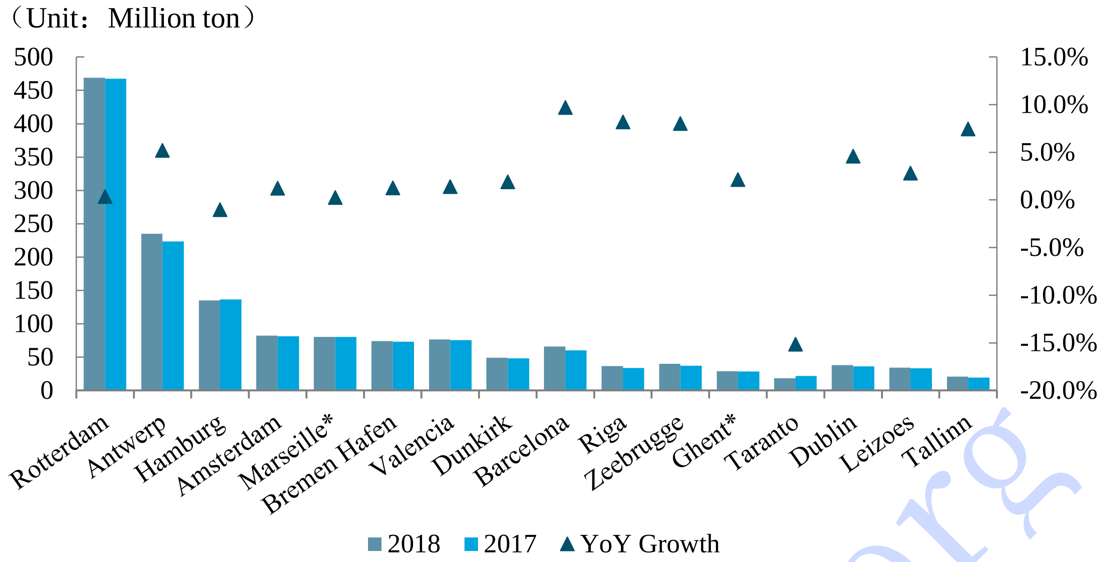


Note： The global major ports refer to ports which statistic data are available. The throughput of global major ports in this report accounts for about 65% of the global port throughput. Specific ports are detailed in the attached table.

Figure 2-1 Cargo Throughput of Major Ports in Various Regions of the World in 2014-2018

2.1.2 Analysis of cargo throughput at ports by region

Throughput grew slower at European ports. European economic growth dropped in 2018. In addition, Brexit and Italy's political instability among other factors contributed to the trade demand fall, dealing a blow to ports' throughput growth. Meanwhile, core shipping hubs in Europe, including Rotterdam and Antwerp suffered heavy congestion in the second half of the year, which also curbed further growth of cargo volumes handled by European ports.

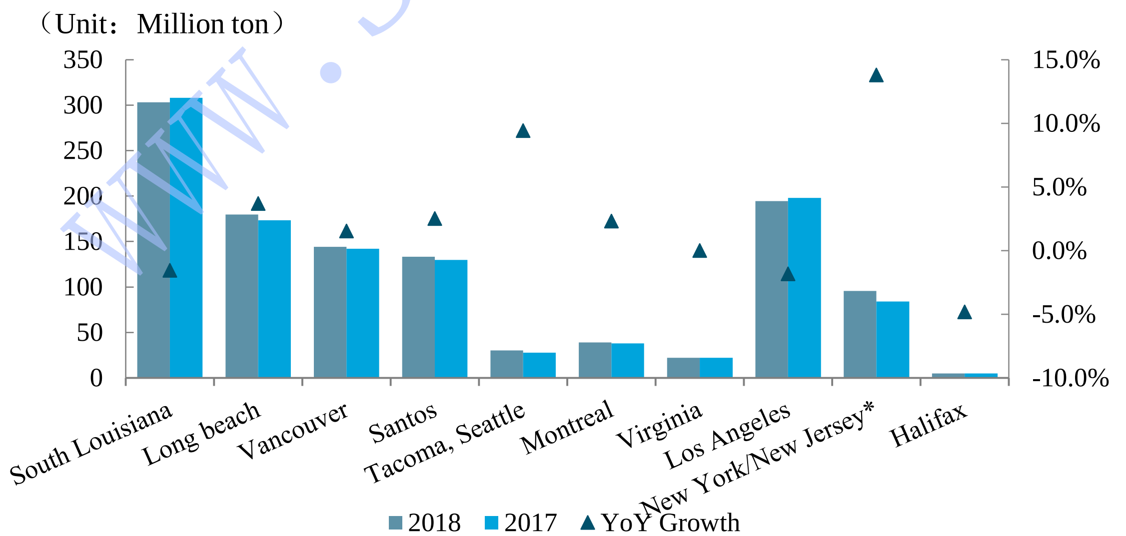


Note: * indicates projections.

Source: Websites of various port authorities, sorted by SISI.

Figure 2-2 Throughput and Growth Rate of Major Ports in Europe in 2018

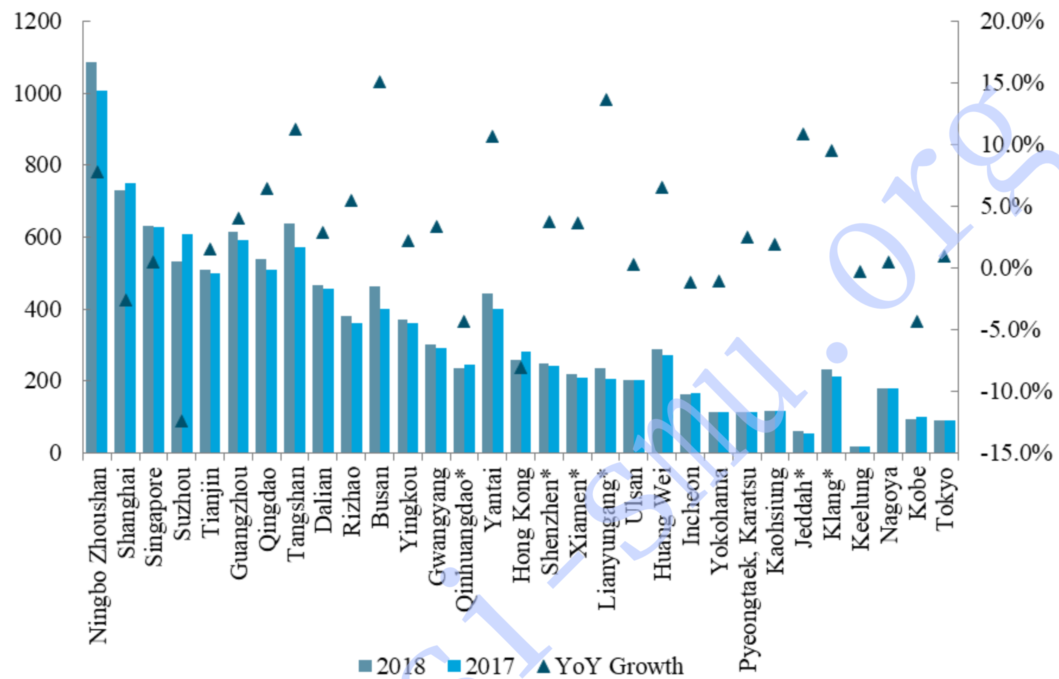
Throughput at North American ports grows steadily, while those at South American counterparts posted slower growth. Backed by policies to deal with trade frictions and encourage the return of American manufacturing, the US saw its economic growth gain strength slowly in 2018. The race against time to ship goods before the launch of new tariffs, as well as rising export volumes amid ongoing trade negotiations, gave a boost to trade at North American ports. However, the US' trade frictions with China, Canada, Mexico and other regions led to changes in the international economic and trade environment, dragging down the growth of North American ports to some extent. Meanwhile, South American ports saw slower growth in trade, due to a weak economic foundation and poor infrastructure. They made minor contributions to the growth of American ports.



Source: Websites of various port authorities, sorted by SISI.

Figure 2-3 Throughput and Growth Rate of Major Ports in North America in 2018

Throughput at Asian ports grew steadily. In 2018, Asian economies grew steadily on the whole. Trade within the region and seaborne trade between the region and the rest of the world grew steadily as well. In particular, imports and exports between China and ASEAN, India and countries involved in the Belt and Road Initiative increased by 11.2%, 13.2% and 13.3%, respectively. Thanks to the robust growth in regional trade, the cargo throughput of Asian ports grew steadily, but at a rate slightly lower than that of the previous year.

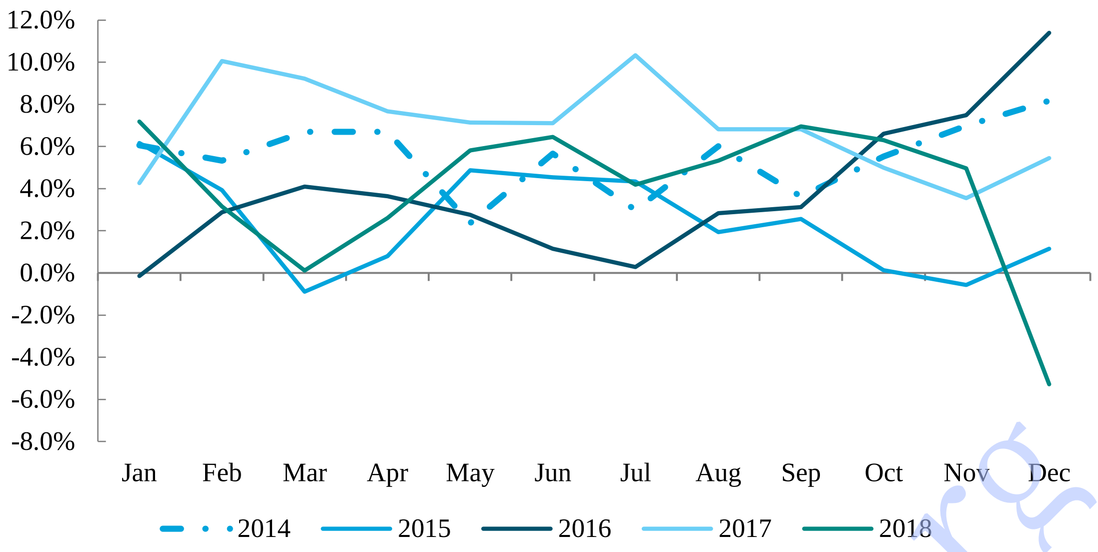


Note: * indicates projections.

Source: Websites of various port authorities, sorted by SISI.

Figure 2-4 Throughput and Growth Rate of Major Ports in Asian in 2017-2018

China's cargo throughput grew slower. In 2018, China's economy faced an increasingly greater downward pressure, with investment, consumption and industrial output all rising at a slower pace. As a result, China's economy grew by 6.6%. Besides, trade frictions between China and the US, as well as changes in international trade relations, impacted China's ports, with those above a designated scale registering a total cargo throughput of 13.1 billion tons, up by 3.9% year-on-year.



Source: Ministry of Transport of China.

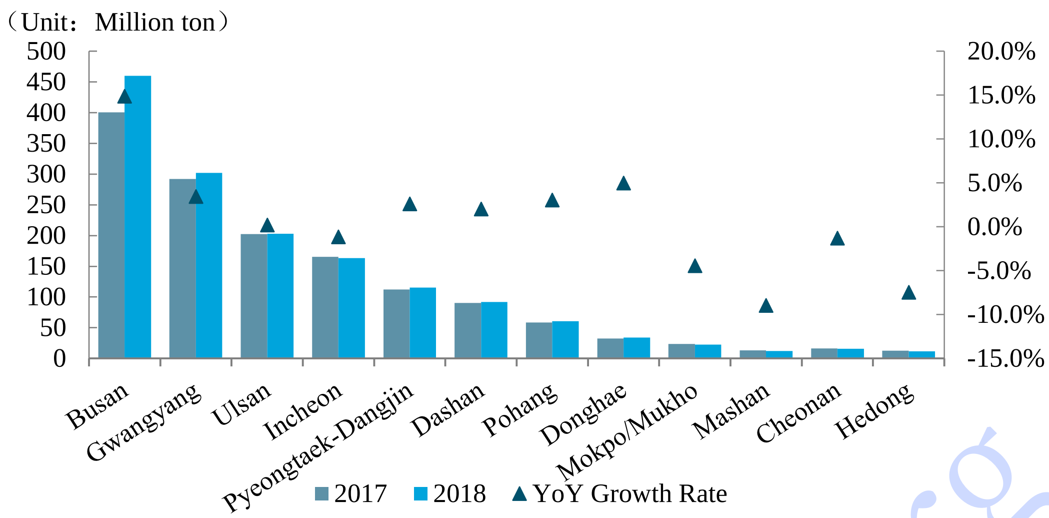
Figure 2-5 Cargo Throughput of China's Major Ports in 2014-2018.

Table 2-1 Cargo Throughput of Above-scale Ports in Mainland China in 2018

Ranking 2017	Ranking 2018	Port	2018 (million tons)	2017 (million tons)	YoY Growth Rate
1	1	Ningbo Zhoushan	1084	1007	7.67%
2	2	Shanghai	730	751	-2.67%
5	3	Tangshan	637	573	11.15%
4	4	Guangzhou	613	590	3.90%
6	5	Qingdao	540	508	6.30%
3	6	Suzhou	532	608	-12.46%
7	7	Tianjin	508	501	1.43%
8	8	Dalian	468	455	2.78%
9	9	Yantai	443	401	10.61%
11	10	Rizhao	381	361	5.34%
10	11	Yingkou	370	363	2.02%
12	12	Zhanjiang	302	282	7.01%
13	13	Huanghua	288	270	6.45%
17	14	Nantong	267	236	13.27%
16	15	Nanjing	252	239	5.38%

Source: Chinese Port Association.

South Korean ports' growth fell slightly. In 2018, the cargo throughput at South Korean ports totaled 1.6 billion tons, up by 3.2% year-on-year, which was slightly lower than the rate for the previous year. Specifically, the Port of Busan enjoyed a soaring throughput over the previous year by 14.9% to 460 million tons, primarily as a result of the growth of its transshipment cargoes which accounted for 52.9%. Meanwhile, the Port of Gwangyang and the Port of Ulsan also posted minor growth in 2018 boosted by their bulks throughput growth.



Source: Websites of various port authorities, sorted by SISI.

Figure 2-6 Throughput and Growth Rate of Major Ports in South Korea in 2017-2018

Southeast Asian ports maintained growth. In 2018, Southeast Asian economies experienced rapid growth, with Malaysia, Indonesia and the Philippines all recording GDP growth of above 5%. Moreover, thanks to the China-proposed Belt and Road Initiative, the region's trade with China hit a new high. But due to a slowdown in Europe's economic recovery, freight volumes on Asia-Europe routes dipped, resulting in slower growth of transshipments at Southeast Asian ports, dealing the heaviest blow to the Port of Singapore which recorded a throughput of 630 million tons.

Table 2-2 Throughput and Growth Rate of Major Ports in Southeast Asia

(Unit: Million ton)

Port	2015	2016	2017	2018	Growth Rate 2017	Growth Rate 2018
Port of Philippines	224	244	254	256	4.0%	1.1%
Port of Malaysia	568	567	534	546	-5.9%	2.3%
Port of Singapore	576	593	626	630	5.5%	0.6%

Source: Websites of various port authorities, sorted by SISI.

2.1.3 Rankings of global top 20 ports by cargo throughput

Among the global top 20 ports by throughput, except Ningbo-Zhoushan Port and Shanghai Port which were among the top three and posted stable performance, all the rest of ports saw their rankings change to some extent. Ports that enjoyed high growth in 2018 were mostly located in East Asia. Tangshan Port, Yantai Port, and Port of Busan saw their throughput rise by 11.1%, 10.6% and 15.0%, respectively, and Tangshan Port surpassed the Port of Singapore to grab the third spot globally. Suzhou Port, however, saw its throughput fall by 12.5% as a result of the curbs on coal and ore growth due to environmental policies.

Table 2-3 Global Top 20 Ports by Cargo Throughput in 2018

(Unit: million tons)

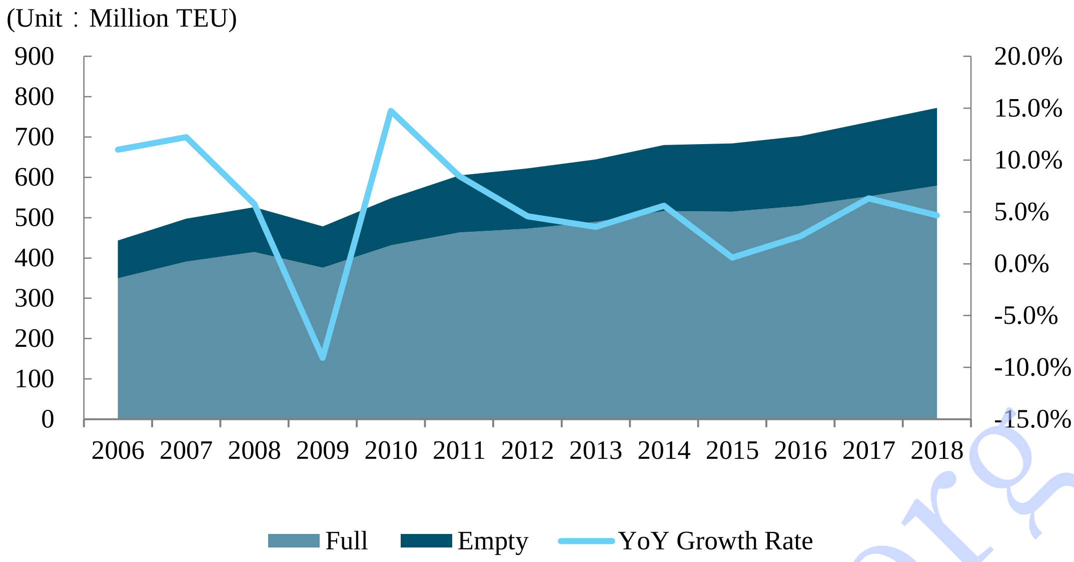
Ranking			Port	Throughput		YoY Growth Rate
2018	2017	Trend		2018	2017	
1	1	→	Ningbo Zhoushan	1084	1007	7.7%
2	2	→	Shanghai	730	751	-2.7%
3	6	↑	Tangshan	637	573	11.1%
4	3	↓	Singapore	630	628	0.4%
5	5	→	Guanghzou	613	590	3.9%
6	7	↑	Qingdao	540	508	6.3%
7	4	↓	Suzhou	532	608	-12.5%
8	8	→	Hedland	518	505	2.5%
9	9	→	Tianjin	508	501	1.4%
10	10	→	Rotterdam	469	467	0.3%
11	11	→	Dalian	468	455	2.8%
12	13	↑	Busan	462	401	15.0%
13	12	↓	Yantai	443	401	10.6%
14	15	↑	Rizhao	381	361	5.3%
15	14	↓	Yingkou	370	363	2.0%
16	16	→	South Louisiana	303	308	-1.5%
17	17	→	Gwangyang	302	292	3.3%
18	18	→	Zhanjiang	302	282	7.0%
19	19	→	Huanghua	288	270	6.4%
20	22	↑	Nantong	267	236	13.3%

Source: Websites of various port authorities, sorted by SISI.

2.2 Overview of Container Throughput at Global Ports

2.2.1 Analysis of container throughput of global ports

In 2018, international container trade grew steadily, but seaborne container volumes grew slower, due to such factors as a slowdown in the world economy, escalating trade frictions, and weak consumer markets. Globally, ports' container throughput totaled 782 million TEUs, up by 4.7% year-on-year, which was slightly down from the previous year.

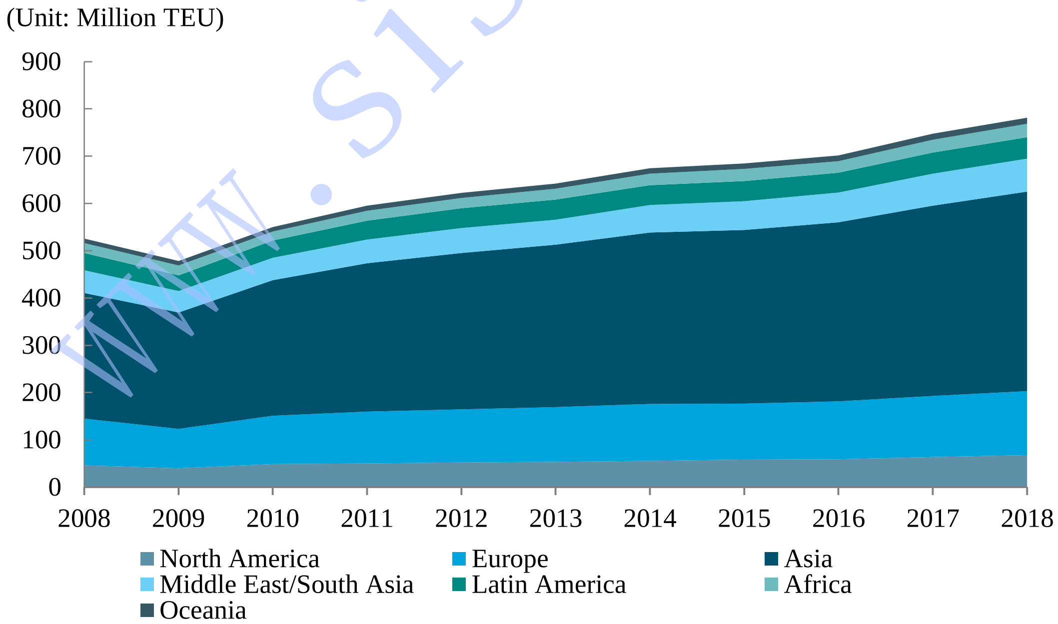


Source: Drewry.

Figure 2-7 Container Throughput and Growth Rate of Global Major Ports in 2006-2018

2.2.2 Analysis of container throughput at ports by region

The container throughput in various regions in the world recorded growth overall in 2018, yet most ports saw their growth decline year-on-year, and some even suffered negative growth. Asia still enjoyed absolute dominance in terms of market share in container throughput, and the share continued to rise.

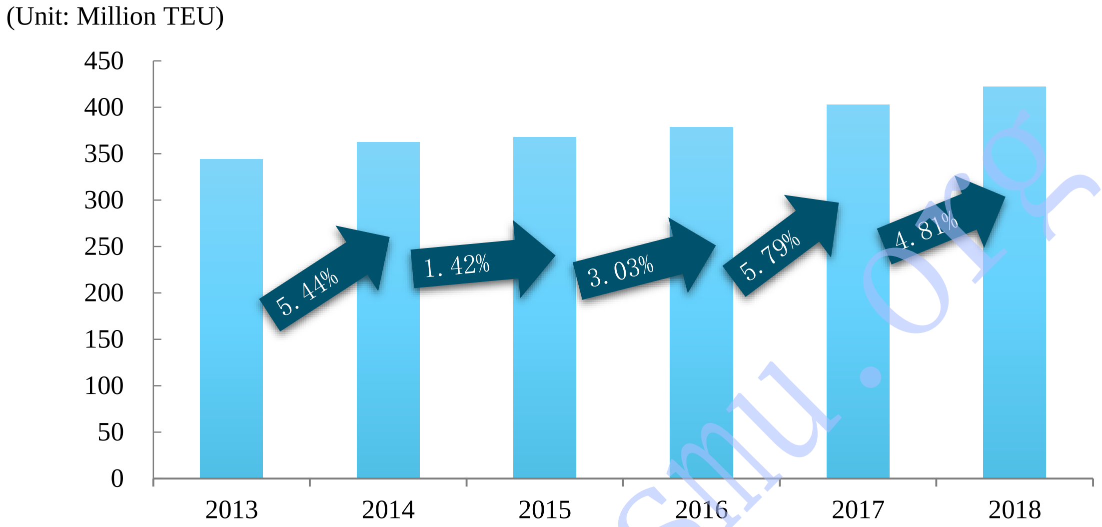


Note: * indicates projections.

Source: Drewry.

Figure 2-8 Container Throughput and Growth Rate of Ports in Various Regions in 2008-2018

Container throughput growth of Asian Ports continued to recover. In 2018, imports and exports between China and the countries involved in the Belt and Road Initiative maintained robust growth, with the trade values between China and emerging economies such as ASEAN and India on a rise. Ports in Japan and South Korea also grew steadily. As a result, Asian ports enjoyed sound growth in container trade on the whole but fell short of the previous year's performance, with the container throughput rising by 4.8% to 420 million TEUs, the rate being 1 percent point slower than that of last year.

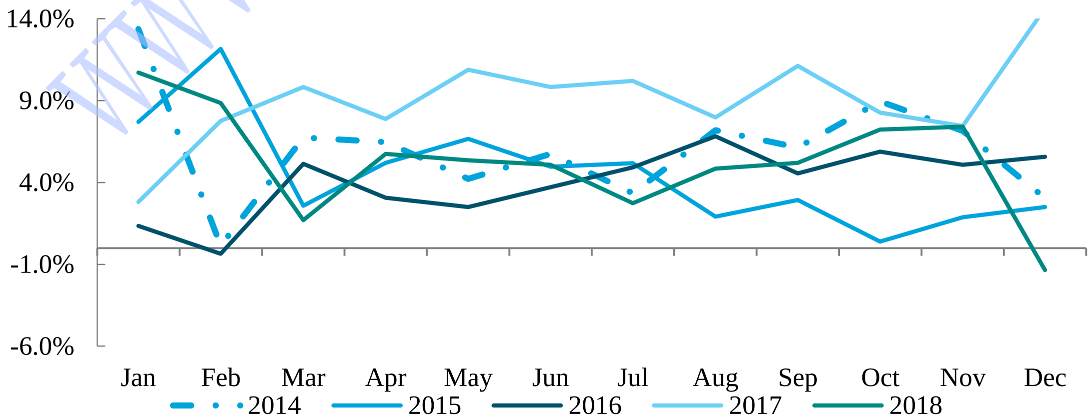


Note: * indicates projections.

Source: Drewry.

Figure 2-9 Container Throughput Growth Rate of Major Asian Ports in 2013-2018

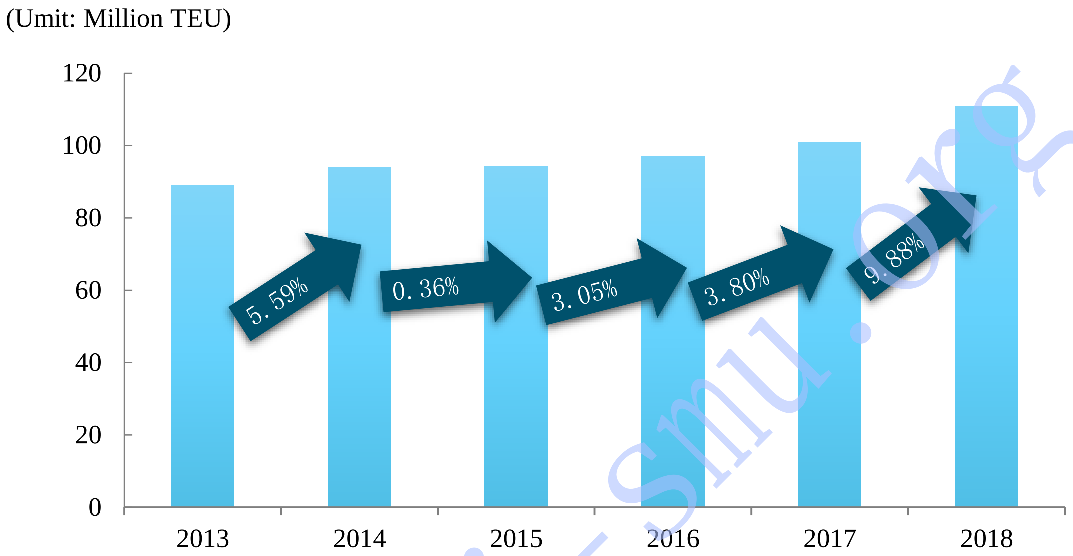
Container throughput growth of the ports in Mainland China dipped. In 2018, fluctuations in the global trade and the weak momentum of domestic demand led to slower growth in container throughput of China's ports. In particular, the growth of containers for foreign trade grew by mere 2.9%, with the container throughput of the year totaling 250 million TEUs, rising by 5.2% year-on-year. The growth signaled a significant fall from the 8.3% in the previous year. Due to new environmental policies, China's containers for domestic trade witnessed robust growth, at 9.2% year-on-year.



Source: Ministry of Transport of China.

Figure 2-10 Container Throughput Growth Rate of Major Ports in Mainland China in 2014-2018

Container throughput in Southeast Asia continued high growth. Ports in Southeast Asia presented robust growth in 2018. Specifically, the container throughput of the Port of Singapore rose by 8.7% year-on-year to 36.6 million TEUs. The Port of Kelang recorded a container throughput of 12.03 million TEUs, a growth rate of mere 0.5%, as most liner companies started to make the Port of Tanjung Pelepas and Port of Singapore their hub ports. Port of Tanjung Pelepas, thanks to its augmented investment in port infrastructure and the commissioning of its Free Trade Zone Logistics Distribution Center of the port, recorded a 6.4% year-on-year growth rate in its container throughput to 8.8 million TEUs.



Note: * indicates projections.

Source: Drewry.

Figure 2-11 Container Throughput and Growth Rate of Major Ports in Southeast Asia in 2013-2018

Top 20 container ports in Asia defended positions on port rankings. The top 20 container ports in Asia witnessed minor changes in their rankings in 2018 compared with that in 2017. Port of Singapore, Port of Busan, Qingdao Port and Guangzhou Port all maintained stable growth in throughput. The throughput of Hong Kong Port fell by 5.6% to 19.6 million TEUs, with the port's ranking dropping to seventh on the global container port ranking list.

Table 2-4 Container Throughput and Growth Rate of Asian Top 20 Ports in 2018

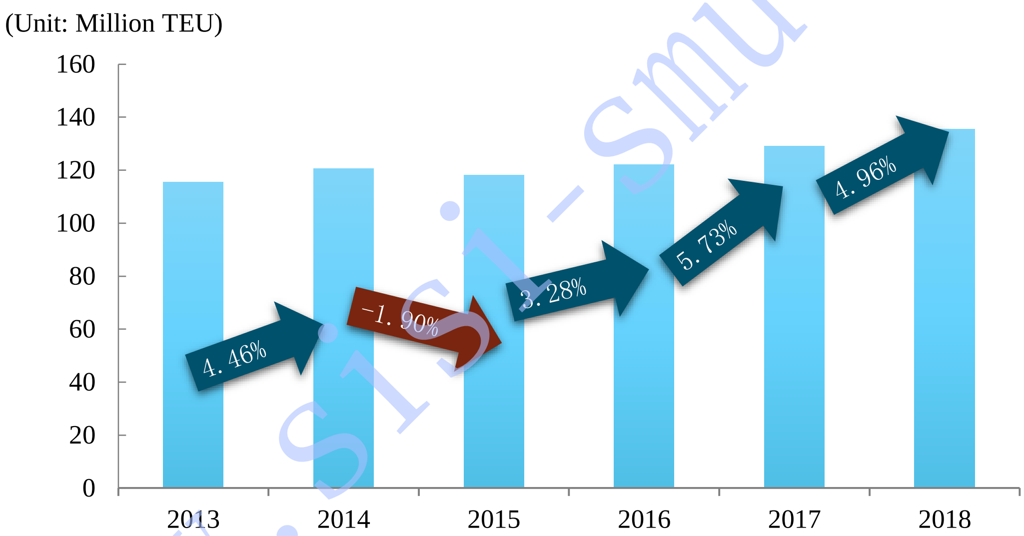
(Unit: 1,000 TEU)

Ranking	Trend	Port	2018	2017	YoY Growth Rate
1 (1)	→	Shanghai	42010	40230	4.42%
2 (2)	→	Singapore	36600	33670	8.70%
3 (4)	↑	Ningbo Zhoushan	26350	24640	6.94%
4 (3)	↓	Shenzhen	25740	25210	2.10%
5 (7)	↑	Guangzhou	21920	20370	7.61%
6 (6)	↑	Busan	21590	20470	5.48%
7 (5)	↓	Hong Kong	19590	20760	-5.61%
8 (8)	→	Qingdao	19320	18310	5.52%
9 (10)	↑	Tianjin	16000	15060	6.24%

10（9）	↓	Dubai	14950	15400	-2.90%
11（11）	→	Kelang*	12030	11980	0.46%
12（12）	→	Xiamen	10700	10380	3.08%
13（13）	→	Kaohsiung	10450	10270	1.75%
14（14）	→	Dalian	9770	9710	0.62%
15（15）	↑	Tanjung Palapas*	8790	8260	6.39%
16（16）	→	Lin Chaban	8070	7780	3.79%
17（17）	→	Yingkou	6450	6270	2.82%
18（18）	→	Suzhou	6360	5880	8.16 %
19（19）	→	Nehru*	5050	4830	4.59%
20（20）	→	Lianyungang*	4760	4710	1.14%

Source: Websites of various port authorities, sorted by SISI.

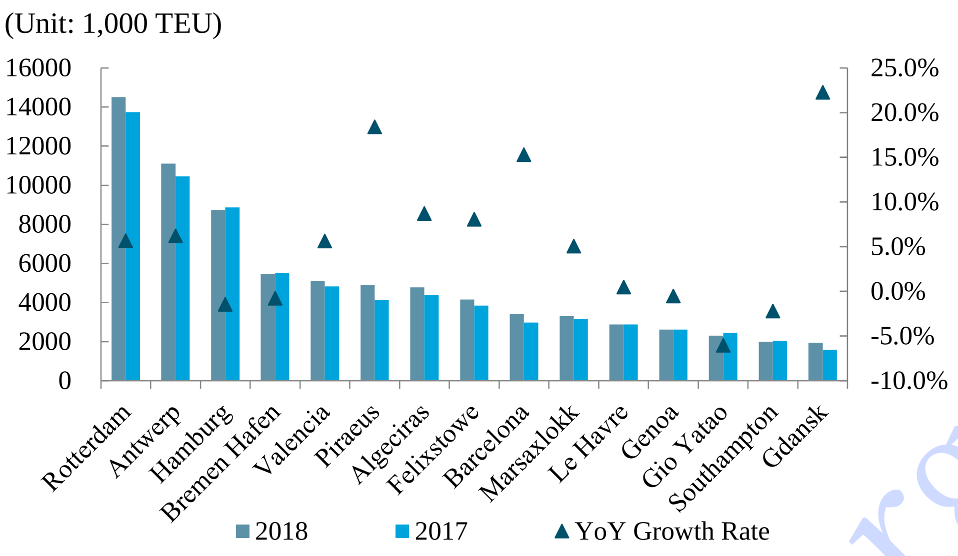
European ports enjoyed steady throughput growth. In 2018, Europe's economy was weak, but thanks to an increase in bilateral trade between China and the EU, Europe's container throughput rose by 5.0% year-on-year to 135 million TEUs.



Source: Drewry.

Figure 2-12 Container Throughput and Growth Rate of Major European Ports in 2013-2018

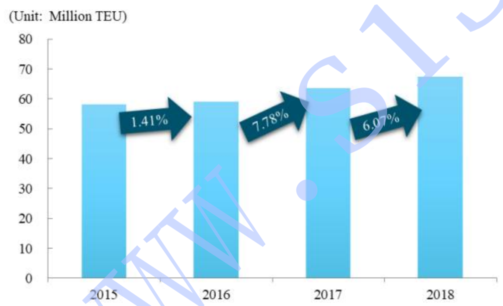
Specifically, Port of Rotterdam showed sound growth in container throughput, which jumped by 5.7% to 14.5 million TEUs, with significant increases in containers for imports and transshipments. Port of Antwerp's container volumes rose by 6.2% to 11.1 million TEUs, thanks to route adjustments made by shipping alliances. Port of Barcelona in Spain, Port of Piraeus in Greece and Port of Gdansk in Poland demonstrated robust growth.

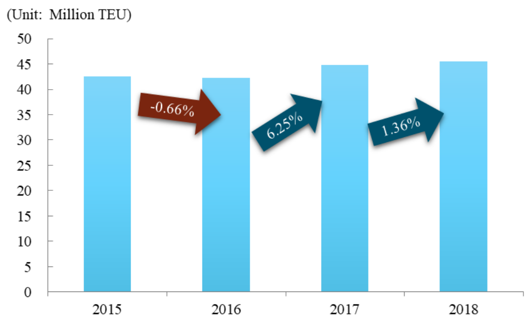


Source: Websites of various port authorities, sorted by SISI.

Figure 2-13 Container Throughput and Growth Rate of European Top 15 Ports in Europe

North American ports saw robust growth, while South American ports posted lackluster performance. The US enjoyed robust economic growth in 2018, with its container port recording sound growth figures overall. But the trade frictions and tariff quota disputes continued to simmer, and the trade performance of ports fell short of expectations. The container throughput of ports in the US rose by 6.1% to 67.6 million TEUs in 2018. Meanwhile, the US Fed's interest rate hike and other measures led to increased volatility in South American international financial market, as well as a gloomy economic outlook for the region. Against this background, the container throughput of ports in South America grew by mere 1.4% to 45.5 million TEUs.

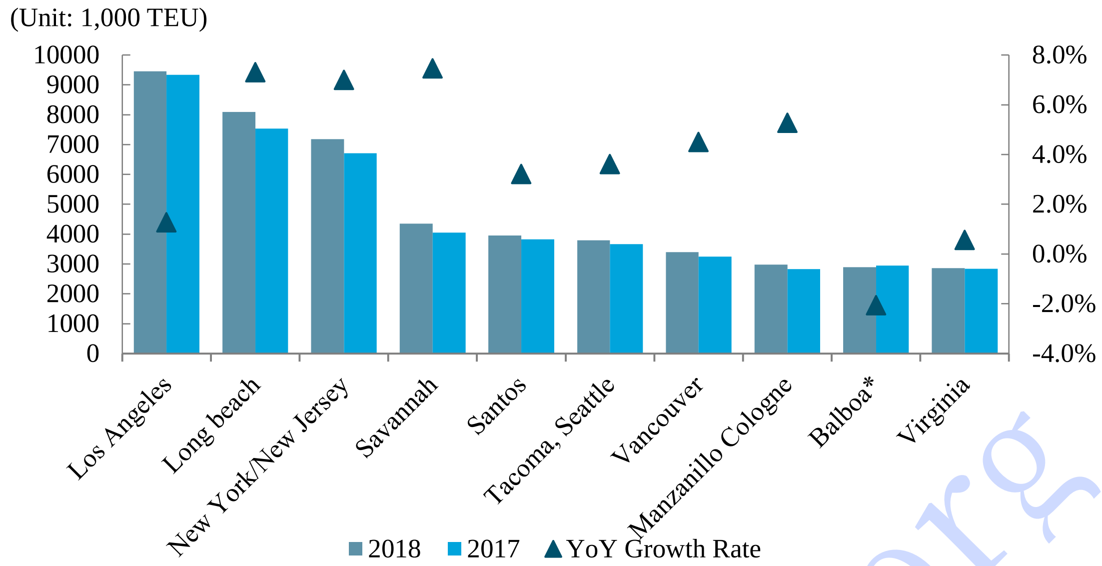




Note: * indicates projections.

Source: Drewry.

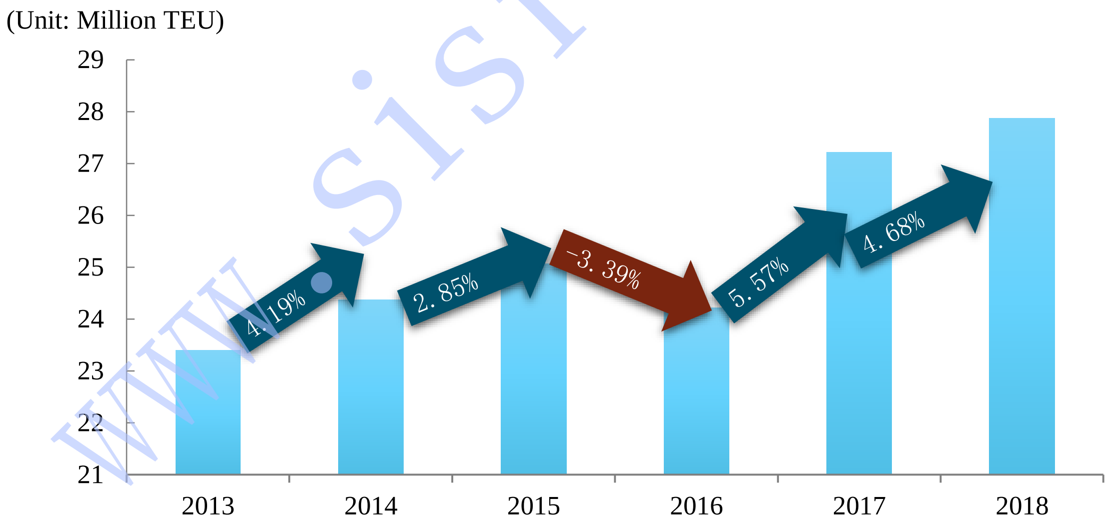
Figure 2-14 Container Throughput and Growth Rate of Major Ports in North America and Latin America in 2013-2017



Source: Websites of various port authorities, sorted by SISI.

Figure 2-15 Container Throughput and Growth Rate of American Top 10 Ports in the US.

African ports post moderate growth in container volumes. Africa's economy has been growing fast in recent years, with huge potential in the trade sector. In particular, with expanding infrastructure construction and consumer demand, its demand for container shipping has also been on the rise. In 2018, ports in Africa achieved a container throughput of 27.9 million TEUs over the year, a rise of 4.7% year-on-year.

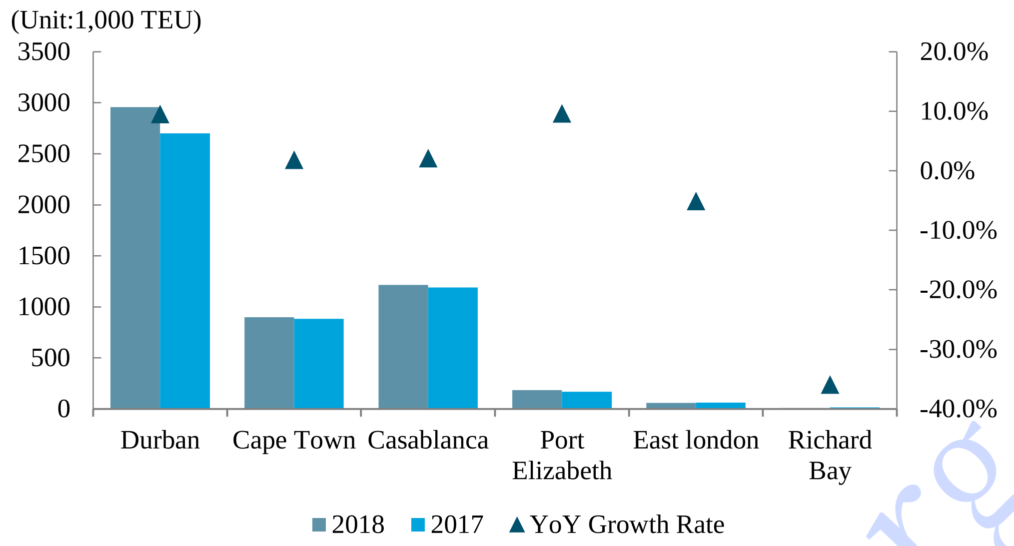


Note: * Forecast.

Source: Drewry.

Figure 2-16 Container Throughput and Growth Rate of Major Ports in Africa in 2013-2018

Specifically, the Port of Durban enjoyed a year-on-year rise of 9.5% in its container throughput which hit 3.0 million TEUs. The Richards Bay and the Port of East London suffered negative growth because of the shift of container shipping routes from the division and specialized development of ports. The Port of Casablanca and Port of Cape Town welcomed growth by small margins, namely by 2.1% and 1.8%, respectively.



Source: Websites of various port authorities, sorted by SISI.

Figure 2-17 Container Throughput and Growth Rate of Major Ports in Africa in 2017-2018

2.2.3 Rankings of global top 20 ports by container throughput

There was a general slowdown in container throughput growth among the global top 20 ports in 2018, as a result of the global trade environment uncertainty and economic depression. The container throughput of the top 20 ports totaled 350 million TEUs in 2018, a rise of 3.8% year-on-year, lower than the 5.6% of 2017. China had nine ports, with Guangzhou Port rising two places and Ningbo-Zhoushan Port and Tianjin Port each by one place. Ningbo-Zhoushan Port also replaced Shenzhen Port to become the world's third-largest container port. Apart from this, the ranking of Port of Tanjung Pelepas climbed, while that of Port of Dubai and Port of Hamburg declined. Hong Kong Port and Shenzhen Port also fell. Other ports maintained their positions on the list.

Table 2-5 Global Top 20 Ports by Container Throughput in 2018

(Unit: 1,000 TEU)

Ranking			Port	Container Throughput		YoY Growth Rate
2018	2017	Trend		2018	2017	
1	1	→	Shanghai	42010	40230	4.4%
2	2	→	Singapore	36600	33670	8.7%
3	4	↑	Ningbo Zhoushan	26350	24640	7.1%
4	3	↓	Shenzhen	25740	25210	2.1%
5	7	↑	Guangzhou	21920	20370	7.6%
6	6	→	Busan	21660	20490	5.5%
7	5	↓	Hong Kong	19600	20770	-5.6%
8	8	→	Qingdao	19320	18310	5.5%
9	10	↑	Tianjin	16000	15060	6.2%
10	9	↓	Dubai	14950	15400	-2.9%
11	11	→	Rotterdam	14510	13730	5.7%

12	12	→	Kelang*	12030	11980	0.4%
13	13	→	Antwerp	11100	10450	6.2%
14	14	→	Xiamen	10700	10380	3.1%
15	15	→	Kaohsiung	10450	10270	1.8%
16	16	→	Dalian	9770	9710	0.6%
17	17	→	Los Angeles	9460	9340	1.3%
18	19	↑	Tanjung Palapas*	8790	8260	6.4%
19	18	↓	Hamburg	8780	8800	-0.8%
20	20	→	Laem Chabang	7960	7780	2.3%

Source: Websites of various port authorities, sorted by SISI.

Special Topic I: Rankings of the Most Promising Container Ports in the World in 2018

The global economy enjoyed a mild recovery in 2018, though the trade growth slowed down. Container ports around the world maintained stable growth in production overall, but the growth rate was a little lower than the robust growth seen in the previous year. Among the top 20 container ports, Ningbo-Zhoushan Port, Port of Singapore, and Port of Antwerp recorded higher than 6% growth, while only the Hong Kong Port, Port of Dubai and Port of Hamburg suffered declines. In this chapter, we try to look at ports in various regions which may not rank among the top in terms of scale, but are nevertheless highly promising development-wise. Such ports are usually more prone to impacts of local economic development, or demonstrate prominent geographical advantages in specific periods or international landscapes.

Shanghai International Shipping Institute (SISI) has figured out the rankings of the most promising container ports in the world in 2017 based on three major indexes of "attracted cargo volume of the port", "attracted investment value of the port", "natural conditions (water depth and location) of the port" and other seven indexes, which can reflect the real values and development potentials of ports as much as possible and be used as a reference for industry insiders. The rankings of global top 20 potential container ports are as below:

Table 1 Global Top 20 Potential Container Ports in 2018

Ranking	Port	Country	Region	Score
1	Tangshan	China	East Asia	92.34
2	Sines	Portugal	Southern Europe	89.86
3	Fuzhou	China	East Asia	88.35
4	Incheon	South Korea	East Asia	87.24
5	Rotterdam	Netherlands	Nordic	86.69
6	Cai Mep	Vietnam	Southeast Asia	86.69
7	Zhuhai	China	East Asia	85.83
8	Chennai	India	South Asia	85.24
9	Laem Chabang	Thailand	Southeast Asia	84.76
10	Rizhao	China	East Asia	84.42
11	Tanjung Prik	Indonesia	Southeast Asia	84.33
12	Mundra	India	South Asia	82.87
13	Barcelona	Spain	Southern Europe	82.85
14	Piraeus	Greece	Southern Europe	82.16
15	Virginia	United States	North America	82.01
16	Ningbo Zhoushan	China	East Asia	81.98
17	Savannah	United States	North America	81.62
18	Le Havre	France	Western Europe	81.50
19	Yantai	China	East Asia	81.39
20	Gdansk	Poland	Central Europe	81.37

On the list of global top 20 potential container ports in 2018, 12 are in Asian ports, making Asia home to most of the promising ports in the world.

➢ **1. Southeast Asia is a new destination of industry shift, boosting its port development**

Emerging economies in Southeast Asia are enjoying rapid development and most of them are at the stage of rapid industrialization stage, creating a huge demand for materials for infrastructure construction. Leveraging the low production and manpower costs in Southeast Asia, global labor-intensive manufacturing sectors are increasingly shifting to Vietnam, Malaysia and other ASEAN areas. Foreign investment in those areas flourished and cargo trade grew fast. Benefiting from this, the economic growth of ASEAN in 2018 was generally higher than 7%, and ports there also welcomed new opportunities for development. On the list of the global top 20 potential container ports in 2018, Southeast Asia had three ports, namely the Cai Mep Port in Vietnam, the Port of Laem Chabang in Thailand and the Port of Tanjung Priok in Indonesia. The container throughput growth of Cai Mep Port in Vietnam averaged at 19.7% in the past two years, while that of Port of Tanjung Priok was 8.2%.

➢ **2. Some ports in China highly promising thanks to reinforced connections with hinterland**

With six ports on the list of global top 20 potential container ports in 2018, China continued to maintain its advantage in this aspect. Despite the rise in trade protectionism and the ongoing trade frictions with the US, China saw its economic growth remain overall stable. The country's foreign trade, in particular, enjoyed strong growth driven by the Belt and Road Initiative. Tangshan Port, Fuzhou Port and Ningbo-Zhoushan Port all ranked among the global top 20 promising ports. A major reason is that these ports have been vigorously developing their cargo collection, distribution and transportation systems in recent years, expanding their market shares in the hinterlands, which has secured their high growth of container throughput in recent years.

➢ **3. Panama Canal expanded to unleash the potential of ports in the US East Coast**

Port of Savannah is the fourth-largest port in the US and only next to the Port of New York-New Jersey container handling ports along the Atlantic coast. After the Panama Canal reopened for business in 2016 after expansion, various liner companies started to deploy shipping capacity to ports in the US East Coast. Port of Savannah is the first portal from Panama Canal to the US East Coast, enjoying a huge growth potential.

➢ **4. Ports around the Mediterranean Sea may embrace opportunities created by the "Belt and Road" Initiative**

Port of Sines is the largest container ports in Portugal, and a major outlet on the Atlantic coast of the Iberian Peninsula, ranking second on the list. Boosted by the Belt and Road Initiative, more and more Chinese enterprises are choosing to invest in Portugal, especially in the Port of Lisbon and Port of Sines. As per data, Portugal became the second-largest European destination of Chinese direct investment by value from 2010 to 2016. The cumulative investment ratio, weighted according to the economic scale, of China in Portugal stood at 3.66, only next to Finland. The industrial development has boosted the cargo volume growth in Portugal. Apart from this, the Port of Piraeus has gradually become the most important strategic hub in the east of Mediterranean Sea on the Maritime Silk Road.

2.3 Overview of Dry Bulk Throughput at Global Ports

In 2018, global dry bulk ports continued to post low growth in throughput, and seaborne volumes of all major dry bulks except coal registered slower growth. The seaborne volumes of the world's major and minor dry bulks rose by 2.4% to 5.2 billion tons. Port of Singapore's dry bulk throughput fell by 9.4%, the steepest decline among all major ports surveyed, due to port business transformation and environmental measures. In Australia, Port of Hedland saw dry bulk throughput grow at a rate of about 1.5 percentage points lower than that of the previous year, due to a slowdown in the growth of iron ore trade, while Port of Hay Point recovered from the impact of bad weather and posted a growth rate of 8.6% year-on-year. Port of Rotterdam saw dry bulk throughput fall by 3.2% to 77.6 million tons, due to the stagnant demand of the steel industry caused by blast furnace upgrades at steel mills, as well as the shift of the bulk grain business to Amsterdam. Brazilian ports' dry bulk throughput bucked the trend, though, as China increased soybean imports from Brazil and other countries amid stagnant imports from the US in the aftermath of trade frictions. The rising soybean exports enabled Brazilian ports to maintain a growth rate of 8.6% in dry bulk throughput despite the drop in iron ore export.

Table 2-6 Dry Bulk Cargo Throughput of Global Major Ports in 2018

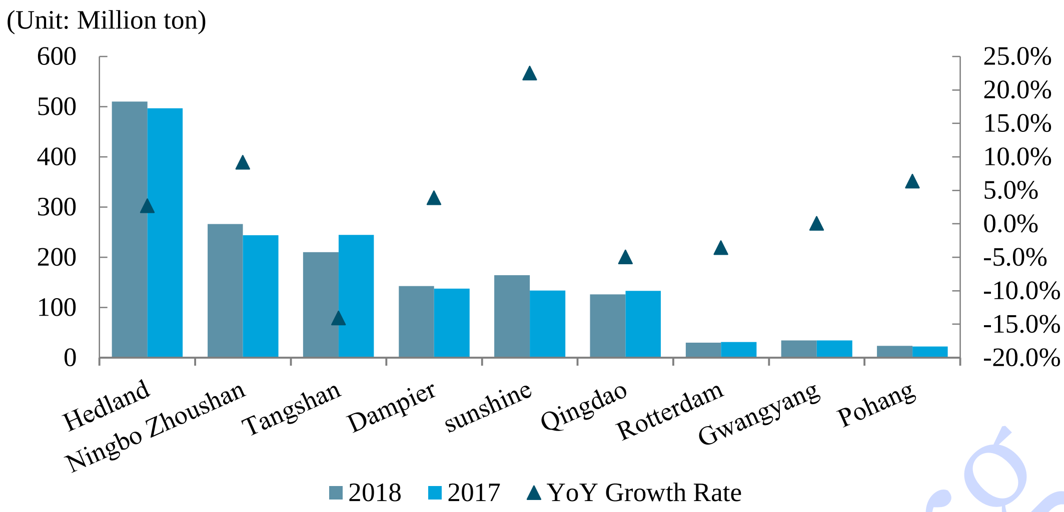
Port	2016	2017	2018					YoY Growth Rate 2017	YoY Growth Rate 2018
	(million tons)		Q1	Q2	Q3	Q4	Total		
Hedland	479	505	122	135	127	125	509	3.76%	2.34%
Qinhuangdao	152	222	58	57	53	56	223	45.94%	0.79%
Rotterdam	82	80	19	18	20	21	78	-2.59%	-3.19%
Singapore	19	19	4	4	5	4	17	-0.21%	-9.38%
Antwerp	13	12	3	3	3	4	13	-2.96%	-3.70%
Heinport	118	109	30	28	29	30	118	-7.15%	8.57%

Source: Websites of various port authorities, sorted by SISI.

2.3.1 Development of global iron ore ports

1. Major global iron ore ports suffered sluggish imports and exports

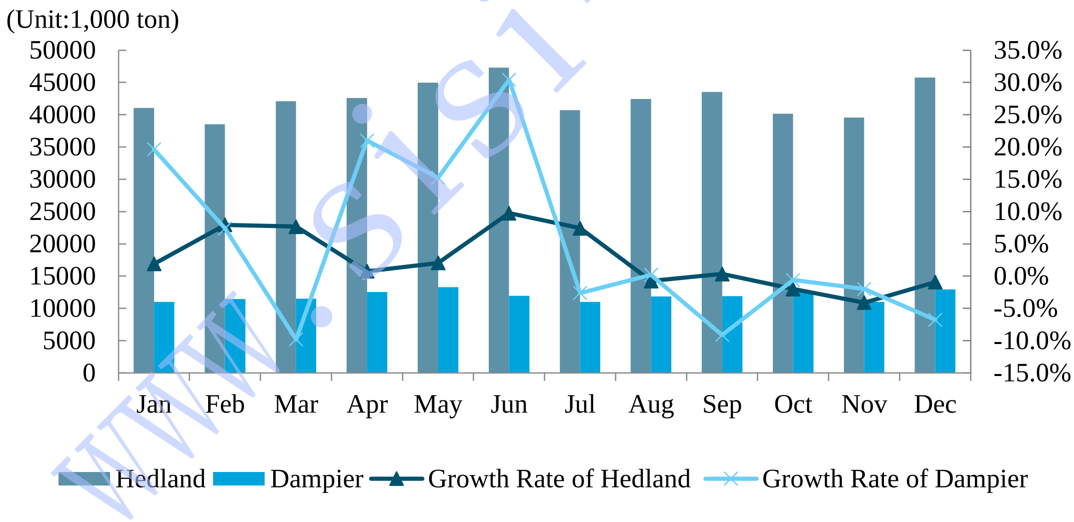
The iron ore trade market in 2018 was bleak with the iron ore seaborne volume increasing by mere 0.2% throughout the year. Among major iron ore handling ports, those in Australia, Brazil, Japan and South Korea enjoyed growth in iron ore throughput, while those in China suffered a slight drop, due to the changed iron ore demands in various regions.



Source: Websites of various port authorities, sorted by SISI.

Figure 2-18 Iron Ore Throughput and Growth Rate of Global Major Ports in 2017-2018

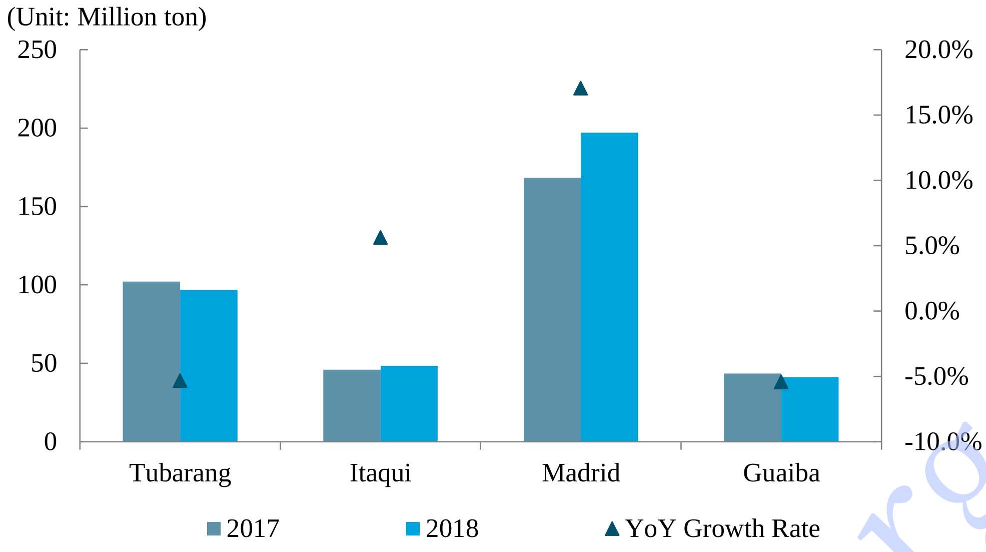
The iron ore throughput at Australian ports remained stable. Australia remained the largest iron ore exporter in the world in 2018. Although its iron ore exports to China declined in 2018, its iron ore exports still increased by 3.3% to 858 million tons in the year boosted by the growing exports to other regions. The iron ore throughputs of Port of Hedland and Dampier Port, two major iron ore exporting ports, rose by narrow margins, with the former by 2.7% year-on-year to 510 million tons, and the latter by 3.9% year-on-year to 143 million tons.



Source: The Official Website of Port Hedland Port Authority.

Figure 2-19 Iron Ore Throughput and Growth Rate of Port of Hedland and Port of Dampier in 2018

The iron ore throughput at Brazil ports increased slightly. In 2018, Brazil's economic growth slowly picked up. Iron ore export is one of its pillar industries and witnessed stable throughput growth in the year, by 2.9% to 407 million tons. The Brazilian dam break accident undermined the iron ore supply of Vale, but China canceled part of its iron ore imports from Australia and turned to Brazil, which secured the growth.



Source: Brazilian Port Authority official website.

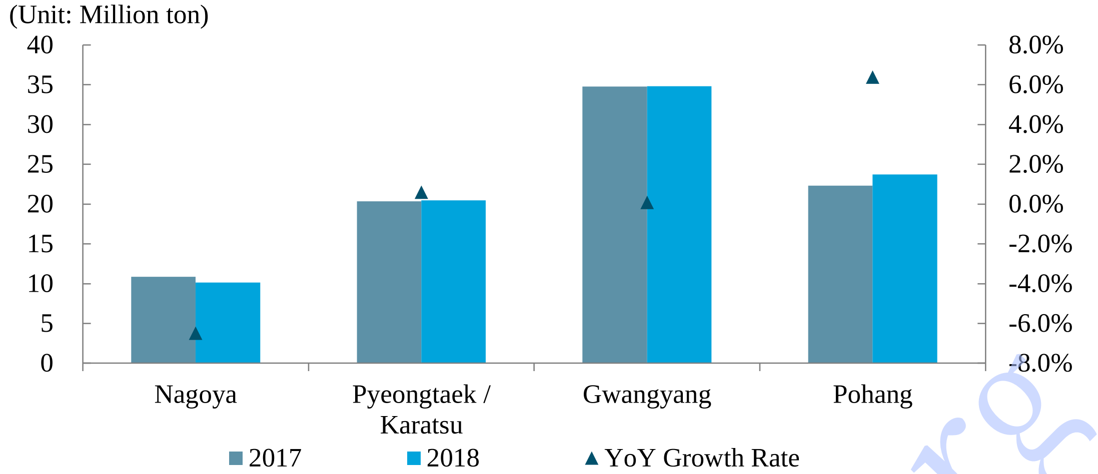
Figure 2-20 Iron Ore Throughput and Growth Rate of Major Ports in Brazil in 2018

China's iron ore throughput declined. In 2018, as environmental protection policies and supply-side reforms continued to advance, and iron ore stocks in ports remained high, China's iron ore import demand fell. Among major iron ore ports, Tangshan Port saw its iron ore throughput decline significantly. The construction of Rizhao International Iron Ore Distribution Center boosted the iron ore demand for Rizhao Port, with the iron ore throughput of the port surging by 22.5% year-on-year to 164 million tons. The bulk throughput of Qingdao Port fell by 4.9% year-on-year to 126 million tons. Boosted by the continuous progress of the major bulks trading center, Ningbo-Zhoushan Port registered 9.7% year-on-year growth of iron ore throughput to hit 266 million tons.

Source: China customs

Figure 2-21 China's Iron Ore Import Volume and Growth Rate in 2018

Iron ore imports of Japan and South Korea rose slightly. In 2018, the economic growth in Japan and South Korea fell short of expectations, with the manufacturing sector shrinking and the economic growth momentum losing pace. The iron ore imports of Japan fell by 0.8% year-on-year, while that of South Korea rose by 1.4% year-on-year.



Source: China National Customs Administration.

Figure 2-22 Iron Ore Import Volume and Growth Rates of Major Ports in Japan and South Korea in 2011-2018

2.3.2 Development of global coal ports

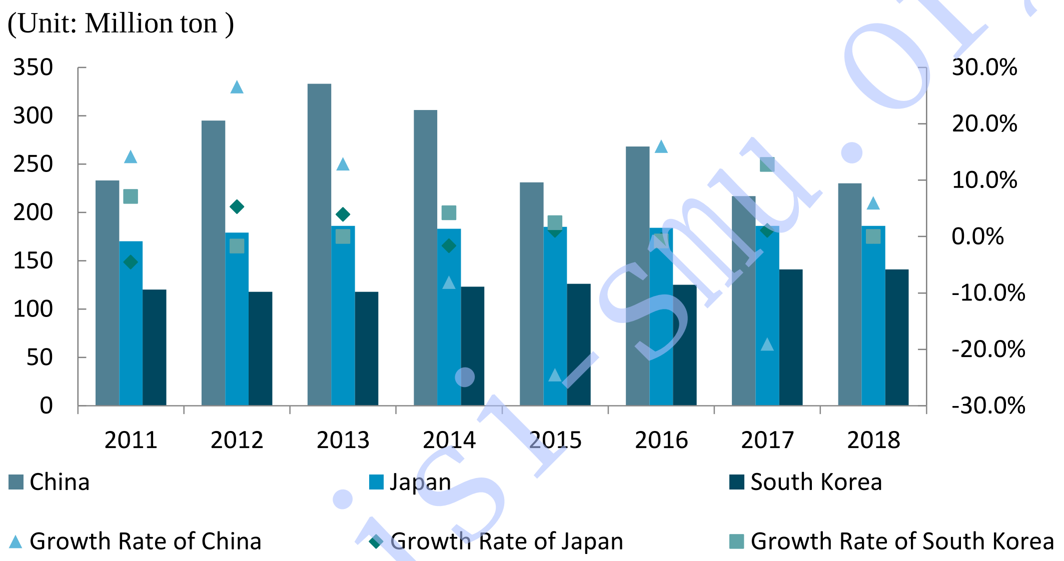
Major coal ports in the world suffered import and export trade recession in 2018, and global major coal ports showed slow growth.

Source: Websites of various port Authorities, sorted by SISI.

Figure 2-23 Coal Throughput of Global Major Ports in 2017-2018

Major coal ports in Mainland China saw differentiated throughput trends. Among major coal handling ports in China, the coal throughput of Qinhuangdao Port in China tumbled by 4.1% year-on-year as a result of the environmental protection policies. Tangshan Port saw its coal throughput rise by 45.9% year-on-year, primarily contributed by its Caofeidian Port Area which officially launched the international freight trains from Caofeidian Port to Ulan Bator, creating new points of growth for the port area. Besides, the resource integration of ports in Hebei province encouraged the transfer of cargoes such as coal to Caofeidian Port Area, which also formed a new driver for coal throughput growth at Tangshan Port. On the other hand, Tianjin Port was negatively affected by these factors, including the cargo category restructuring, the gradual transfer of coal and other bulks to Tangshan Port and Qinhuangdao Port among others, and the ban on vehicle-shipping of coal, with its coal throughput in 2018 dropping by 14.0% year-on-year. Huanghua Port maintained flat performance in throughput year-on-year.

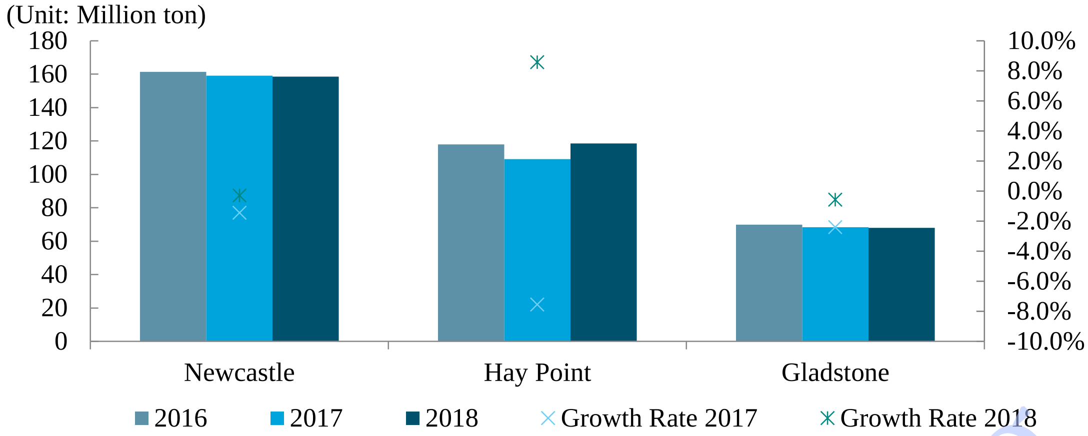
Imports growth of major coal ports in Japan and South Korea dipped. Amid the continued global abandonment of coal, multiple Japanese coal power enterprises and financial institutions such as the Dai-ichi Life Insurance Company Limited, Sumitomo Mitsui Financial Group and Marubeni Toa (Syouji) Corporation Limited withdrew from the coal industry, resulting in a decline of imported coal supply in Japan. The boom of clean energy in recent years has also curbed domestic coal demand in Japan. Japan's seaborne coal imports in 2018 stood at 186 million t. The coal imports of South Korea grew by 0.40% year-on-year due to the shrinking domestic manufacturing and alternative energy sources.



Source: China National Customs Administration, sorted by SISI.

Figure 2-24 China, Japan and South Korea Coal Import Volume in 2011-2018

Imports growth of major coal ports in Australia slowed down. The coal export business from Australia to China in 2018 was impacted by the political frictions between the two countries. However, due to the Australian government's strong support for coal exports and the increasing coal exports to India, ASEAN and the Middle East, Australia's coal exports continued to enjoy positive growth in 2018, by 3.0% year-on-year to 377 million tons. Among the three major coal exporting ports in Australia, Port of Hay Point recorded 8.6% of growth in coal throughput because of the vigorous growth of steam coal exports to India, while the coal throughputs of Port of Newcastle and Port of Gladstone dropped a little.



Source: China National Customs Administration, sorted by SISI.

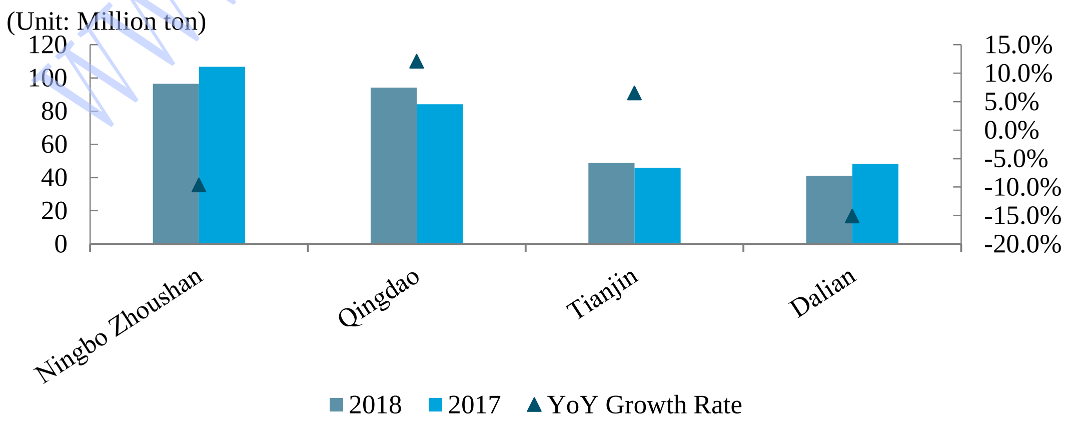
Figure 2-25 Coal Throughput and Growth Rate of Major Ports in Australia in 2016-2018

2.4 Overview of Liquid Bulks Throughput at Global Ports

The economic growth slowdown in most economies in 2018 resulted in widespread pessimism in the crude oil market. Both the Brent crude oil and WTI crude oil prices plunged by more than US$30. Besides, a stronger dollar also hampered the rebound of oil prices. As a result, the global crude oil seaborne volume grew slower in 2018.

2.4.1 Liquid bulk throughput at ports in Mainland China grows rapidly

China maintained its position as the world's largest oil importer in 2018, importing 461.9 million tons of crude oil, rising by 10.1% year-on-year. Among the ports in Mainland China, Qingdao Port continued to enjoy strong growth in crude oil throughput thanks to the rapid development of local oil refineries in Shandong province, which recorded 94.2 million tons of crude oil throughput in 2018, a rise of 12% year-on-year.

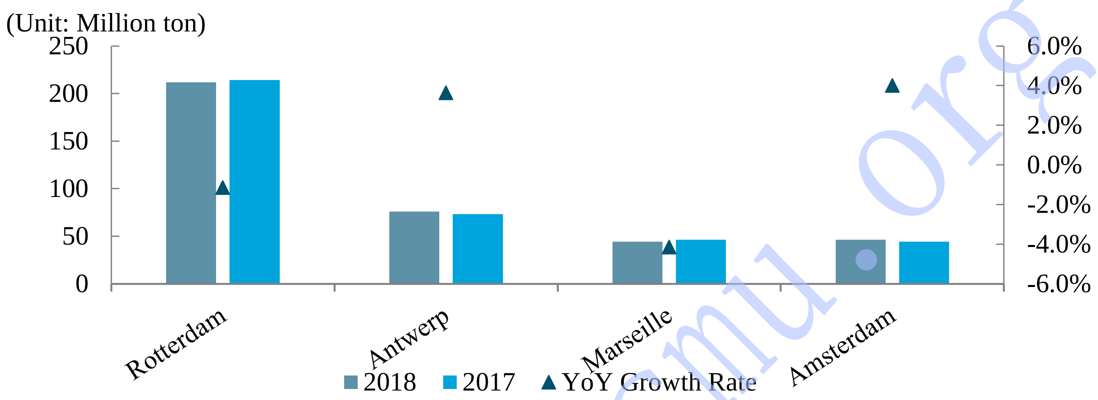


Source: Ministry of Transport of China.

Figure 2-26 Crude Oil Throughput of Major Ports in Mainland China

2.4.2 Liquid bulk throughput at ports in Europe slips

European economy fell short of expectations in 2018 in economic growth. The industrial sectors in Europe continued to face a downside pressure. The Port of Rotterdam, the largest port in the region, saw its crude oil throughput fall by 1.1% to 212 million tons, due to narrowing profits of the oil refineries in the port and the oil refining industry's transformation and upgrading. Port of Antwerp also saw its crude oil throughput dip, but its liquid bulk throughput in 2018 rose by 3.6% year-on-year to 75.8 million tons, due to the increases in the throughputs of liquid chemicals (up by 9.1%) and products derived from crude oil (up by 3.1%).

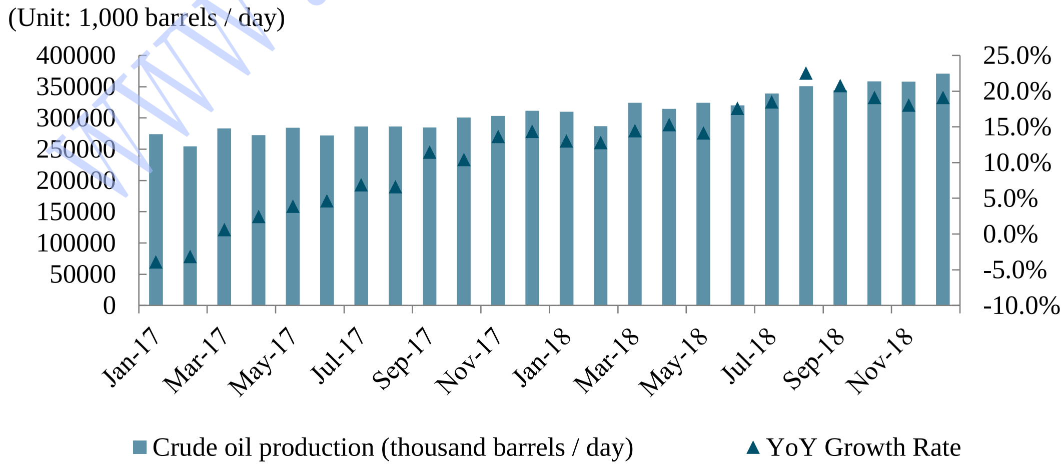


Source: Websites of various port authorities, sorted by SISI.

Figure 2-27 Liquid Bulk Cargo Throughput of Major Ports in Europe

2.4.3 Liquid bulk throughput at ports in Americas fluctuates

In 2018, the increased output of shale oil boosted the US' crude oil exports, making the US a pillar supplier in the global oil market. In Canada, another oil exporter, prices of heavy crude oil soared, leading to a fall in crude oil exports.



Source: US Energy Information Administration (EIA)

Figure 2-28 US Crude Oil Production in 2017-2018

III. Comments on Port Operation and Management in 2018

3.1 Development Trends of Port Logistics

In 2018, as the international trade underwent transformation, the logistics supply chain with port as the node gradually evolved. Ports formed a highly integrated supply chain network through joint planning and operation. For example, in North America, railway transport represented by the North American Landbridge is an important part of the port distribution and transportation systems, supporting the transport growth of trans-Pacific trade. In Western Europe, the barge system complements the shortcomings of inland road transport, with barge transshipment accounting for 30%-40% of the total container volume in the ports of Rotterdam and Antwerp.

Meanwhile, with the increasingly close connections between ports and enterprises, the launch of sea-railway intermodal transport and trunk-feeder route combined transport not only benefit service improvement to sharpen competitive edges, but also help cargo owners to cut down logistic costs and improve logistic efficiency, so as to expand market shares and enhance enterprise competitiveness. In this context, large freight forwarders such as DHL, Panalpina, and Kuehne & Nagel among other logistic service providers are also expanding multimodal transport services through port shipping. Various port, shipping and logistics companies are also engaging themselves in the development of multimodal transport systems, focusing on supply chain expansion and value chain enhancement so as to build a service system that fuses with modern logistics.

Source: Roland Berger Global Logistics Markets, sorted by SISI

Figure 0-1 Development Trends of Logistic Service Providers

3.1.1 Trends of sea-railway intermodal transport services

Sea-railway intermodal transport is a dominant organization pattern of international multimodal transport services. Sea-railway intermodal transport combines the advantages of seaborne shipping and railway transport such as a low cost, a high transport volume, and convenient connections, creating an obvious superiority for transport activities with a haul distance of 600 km or longer. According to the World Bank database, currently the global railways add up to around 1.05 million km[1]. The constant expansion of railway networks also promotes the connections between ports and their hinterland. For example, with the launch of the China-Europe trains, the multimodal transport system in Europe has been improved, increasing the connectivity between ports in the continent.

There are currently three major categories of sea-railway intermodal transport service providers. First, **shipping companies and port terminal operators that primarily offer marine shipping services**, such as CMA-CGM, Maersk, COSCO, China Merchants Port Holdings, DP World and PSA. Those shipping companies and global terminal operators improve their connectivity and convenience of inland transport through sea-railway intermodal transport services, so as to overcome the geographic restrictions by focusing on offering marine shipping services or running port services. Second, **railway transport enterprises that primarily offer railway transport services**, such as BNSF, Union Pacific, Deutsche Bahn in Germany, SNCF Logistics in France and China Railways Corporation. Such enterprises usually have advanced railway transport networks and intense rail train services. They build new stations and depots to connect to ports and offer sea-railway intermodal transport services to attract cargoes and increase their facility utilization and profits. Third, **third-party logistics enterprises and freight forwarders offering comprehensive logistic services**, such as Kerry Logistics and DHL. For these full-process logistic service providers, sea-railway intermodal transport is a way to achieve efficient and convenient door-to-door services.

Table 3-1 Major Suppliers of Rail-sea Intermodal Services

	Suppliers
Shipping companies and terminal operators	CMA CGM, Maersk, Cosco Shipping, PSA, DP World, etc.
Railway company	BNSF Railway， Canadian Pacific, CSX Transportation, Florida East Coast Railway, Union Pacific, etc.
Third party logistics enterprises and freight forwarders	Kerry Logistics Network, DHL, etc.

The sea-railway intermodal transport networks of shipping companies primarily serve their maritime hubs on trunk routes, concentrating in Asia, Europe and Latin America. Railway may find it hard to rival ship in terms of transport volume, but it excels in inland transport. Sea-railway intermodal transport can give cargo owners more flexibility options on the supply chain, helping shipping enterprises establish long-term competitive edges and improve their presence and initiative in industry competition. Currently, large shipping companies launch inland logistic services primarily in the form of setting up branches or dedicated departments, such as the CMA

[1] World Bank database: https://data.worldbank.org/indicator/IS.RRS.TOTL.KM?view=chart.

CGM Log under CMA-CGM and the Damco under Maersk. Shipping companies usually develop their railway networks around their hub ports.

Port terminal operators launch sea-railway intermodal transport services primarily in the form of **leasing railways and shareholding of railway stations across borders to take the management and operation rights over railway transport.** In such a mode, ports not only have to run traditional terminal businesses such as cargo handling and stockpiling, but also well connect up ship enterprises, railway transport undertakers and railway stations and depots. Cargo owners, on the contrary, only need to send their cargoes for import or export to a nearby hub depot. For example, the Contship under Eurogate launched the Hannibal multimodal transport solution where Contship undertakes part of the railway transport, and builds a railway transport passage that links the north and south of Europe and traverses the Alps. This solution fully leverages the advantages of Italy's ports on the coast of the Mediterranean Sea to increase train frequency and shorten the overall transport duration.

Source：Website of Eurogate.

Figure 0-2 Hannibal – European Gate Rail over the Alps

3.1.2 Trends of inland waterway shipping services

Inland waterway shipping, as an important part of the multimodal transport of ports, not only represents a cargo distribution and transportation mode between the hub ports and their vast hinterland, but also a direct connecting transport mode for small and medium-sized ships between the hub ports and their feeder ports. Compared with the sea-railway intermodal transport and sea-air intermodal transport in multimodal transport, the connection of inland waterway shipping to trunk route shipping is more dependent on ports. At present, the biggest inland water-going ship in the world is of more than 80,000 DWT. The largest general-purpose ship on Yangtze River trunk routes in China is of more than 30,000 DWT. The high shipping volume and adaptability to ultra-large cargoes make inland waterway shipping irreplaceable by other transport modes.

There are two categories of inland waterway shipping operators by organization pattern. First,

common barge carriers. They act like common carriers and specialize in a certain area or route, such as ZhongGu Logistics Corporation, PANASIA Shipping, X-PRESS FEEDERS and Unifeeder. Common barge carriers address feeder transport issues for cargo owners and ocean-going large ship enterprises through regular ship schedules and liners. Second, **carriers with self-owned barges**. They address feeder transport demands through self-owned barges, such as Maersk and CMA-CGM among other large shipping enterprises. Such carriers are usually also trunk route shipping companies or ocean-going shipping companies, or subordinate logistics departments of such companies. In addition to operating barges, they also offer full-process shipping services.

Table 3-2 Major Suppliers of Inland Water Transportation

Supplier	Distribution
Panasia	China-Japan routes, Taiwan routes, Yangtze River feeder routes, Pearl River routes, etc.
Unifeeder	Pan-European feeder and short-distance container shipping, covering Nordic, Western Europe, the Mediterranean and the Black Sea
X-Press Feeders	Independent public barge company, routes covering Asia, Middle East, Central America, Mediterranean and Europe

From inland waterway shipping operators, we can find that **most inland waterway shipping enterprises are local transport service providers.** As inland river transport belongs to waterway transport and involves national security, many countries have stated in their existing laws and regulations that only domestic waterway transport enterprises can offer such services, and inland waterway transport can only be handled by domestic or local waterway shipping service providers. For example, ZhongGu Logistics Corporation, PANASIA Shipping and other Chinese shipping enterprises are primarily responsible for the transport services along China's coasts and inland rivers. Unifeeder, a European enterprise, primarily serves offshore and feeder route shipping in Europe and the Mediterranean Sea areas.

Source：Website of Unifeeder

Figure 0-3 Feeder Network in Europe of Unifeeder

The logistics trends of ports in recent years showed that large shipping enterprises and port enterprises have actively engaged themselves into the expansion and extension of port logistics to the inland, integrating themselves into the supply chain system as a logistic node and eying the operation efficiency of cargo owner procurement, production, sales and other links to adopt open-ended transport development strategies.

As the logistic supply chain evolves, **port logistics will get rid of the traditional notion of "geographical distance" and stress "economical haul distance" and "efficient transport" ideas** to take transport charges, durations and other basics into comprehensive account for the purpose of reducing logistic costs. How to build and utilize a comprehensive cargo collection, distribution and transportation system and expand ports' economic hinterland and logistic service scope are of vital significance for port logistics development. Shipping enterprises and port enterprises, as important nodes in the logistic supply chain, also face a mounting need to transform to providing full-chain logistic services and flexible services during port logistics development. How we can timely and efficiently launch comprehensive logistic activities for multiple cargo types at a wider range and for varied periods to enable more diverse features based on user (cargo owners or carriers) needs, so as to eventually enhance the competitiveness of ports and enterprises as logistic service providers is vital.

3.2 Development Trends of Port Operation

3.2.1 New characteristics of port enterprise M&A

Port enterprises mergers and acquisitions usually come in one of the following two forms: first, **asset M&A**, that is to say, the buyout subject matters are tangible assets of a port, including terminals, container depots and handling machinery. This form of M&A can enhance the capacity of the acquiring party at short notice, expanding its share in maritime transport and waterway transport markets; second, **equity M&A**, that is to say, the buyout subject matters are stock equity of a port enterprise. The acquiring party of an equity M&A activity usually does not take part in the operation and management of the acquired enterprise, and the objective of the M&A is mostly of strategic resource integration, that is, integrate or extend the enterprise's value chain through M&A.

Port, as a capital-intensive industry, may more and more rely on capital-widening operations to materialize enterprise expansion and development. Multiple factors should be taken into account to complete an M&A activity, such as the M&A form, cost, and approval. In addition, M&A and reorganization is also a big challenge for many port enterprises.

Therefore, before making an M&A decision, port enterprises should well conduct feasibility analysis and assess the M&A risks based on their financial statuses, with the M&A cost and business planning fully considered, in addition to effective integration in architecture, businesses and cultures following the M&A to achieve the M&A objectives.

3.2.2 Port and shipping enterprises flock to M&A

With the logistic supply chain expanding in recent years, shipping enterprises and port terminal operators are also starting to seek joint operation apart from the M&A and reorganization in the port circle. Joint operations through M&A can not only reduce the direct capital export of terminal operators, but also facilitate resource sharing with partners for coordinated development. For example, the PSA International and ONE established a joint venture for joint operation of the Pasir Panjang Terminal in Singapore. COSCO Shipping Ports, China Merchants Port and AP Moller-Maersk, as subsidiaries to large shipping groups, enjoy support from their parent companies and fleet businesses. DP World follows a different way. It acquired Unifeeder to own the feeder transport business to secure connections for its trunk route customers and rapid and reliable feeder services, and ultimately improve the capacity and market competitiveness of its terminals.

Terminal operators' acquisitions of shipping companies may become a new trend. Maersk, CMA-CGM and COSCO Shipping among other large ship companies need berthing operations. They keep growing themselves through acquiring terminals and logistics companies while striving to extend to upstream and downstream of the industrial chain. Terminals with support from ship enterprises can not only guarantee prioritized ship arrivals at ports for quick handling, but also enable preferential prices for ship enterprises, forging close interactions between port and shipping activities. But for port enterprises, they have to consider the frequency of terminal usage by liner companies amid the evolving shipping alliances, and the connectivity between the terminals they operate. Only by having their own feeder operators or inland logistic service providers can port enterprises maximize their service scopes. Against this backdrop, port terminal operators represented by DP World started to pool transport resources through acquisitions or shareholding of shipping companies to secure business operations at terminals while offering more extensive and comprehensive logistic services for their customers, which can also create new sources of revenue and profit growth.

In the future, the boundaries between port enterprises and shipping companies will become more blurred, with cargo owners favoring full-process and customized logistic solutions and cross-shareholding becoming a common phenomenon among port and shipping enterprises. Port and shipping enterprise are two nodes on the supply chain, with cargo owners being their shared users. Port and shipping company M&A can improve the convenience and reliability of cargo transport while cutting down logistic costs of cargo owners and elevating competitiveness. The involvement of large international shipping enterprises in port development and vessel calls at related ports can not only drive up the cargo throughput, but also mitigate investment risks. Port enterprises investing in and purchasing shipping enterprises can also facilitate business diversity to some extent, improving enterprises' viability.

3.3 Development Trends of Port Management

3.3.1 Many countries roll out regulations to ease port congestion

As the world trade volume grows in recent years, port congestion has become more serious. Many ports in Asia, Europe and North America experienced terminal congestion, leading to delayed cargo deliveries. **Sudden congestion at ports** is primarily a result of workers' strikes, bad weather, congested inland traffic, a sudden change in the trade situation, etc., while **recurrent congestion at ports** is primarily due to the lack of port capacity, congested container depots at ports, disorderly logistic systems at ports, etc. For example, the Port of Los Angeles and Port of Long Beach in the US suffered sudden congestion due to the escalating Sino-US trade frictions, while ports in Nigeria experienced recurrent congestion of terminals because of the disorderly container depots.

Table 3-3 Major Port Congestions in 2018

Region	Port	Congestion
Asia	Chattogram Port in Bangladesh	A transport workers strike led to severe overstock of ships and cargoes at the Chattogram Port in Bangladesh and around 4,200 TEUs of containers were stuck in entry and exit.
	Shanghai Port in China	Shanghai Port was frequently hit by heavy fog and ships were unable to berth in time, leading to overstocked containers at terminals.
	Tan Cang-Cai Mep International Terminal (TCIT) and Cat Lai Port in Vietnam	China's ban on imported waste made the Tan Cang-Cai Mep International Terminal (TCIT) and Cat Lai Port flooded with imported waste, leading to congestion in the port areas.
	Port of Manila in the Philippines	The Philippine government announced move to weed out old and outdated trucks in stages, leading to a shortage in trucks. Warehouses were shut down and the too many empty containers made the Port of Manila suffer from severe congestion at terminals.
The Americas	Port of Los Angeles and Port of Long Beach	The rush of imports to the US to avoid the tariffs imposed on China by the US, the bad weather, and the shortage of truck drivers jointly contributed to the extreme congestion at ports along the West Coast of the US, including the Port of Los Angeles and Long Beach.
Europe	Port of Felixstowe in the United Kingdom	A problem occurred during the Terminal Operating System (TOS) update, hampering the terminal operations. The low efficiency led to a severe overstock of cargoes at the Port of Felixstowe and many container ships and cargoes were severely delayed.
	Port of Southampton in the United Kingdom	Too many empty containers, the shipping peak before the Christmas, and the poor ship operation and shipping capabilities all contributed to congestion at the Port of Southampton.
Africa	Port of Lagos in Nigeria	The road congestion caused by roadworks in the port area, a strike, as well as the slow customs clearance jointly led to the extreme congestion at the Port of Lagos. Many cargoes remained stuck for 30 days or even longer.

To cope with port congestion, some countries and their local port authorities rolled out policies in 2018. These policies included: promoting electronic devices, raising the container stockpiling charges, and opening container depots of shipping companies for use. For example, the Port of Montreal stipulated that all truck drivers serving the port should use electronic devices to receive notices about traffic information. The port also allowed truck drivers to take proper measures for the purpose of effective pickup or handling of containers to avoid further delays. All ports in Nigeria suspended port services for Maersk, COSCO Shipping, APS and Lansal for 10 days following the stipulations on container depots in the port area. Ports in the Philippines required shipping companies to open their container depots to warehouse empty containers to address the port congestion caused by too many empty containers.

From the policies issued, we can see that apart from improving port information exchange, price may become a means for a country or governing authority to tackle port congestion. Port congestion is usually caused by insufficient stockpiling capacity in the rear or insufficient cargo distribution and transportation capacities of the port. Ports primarily adopt a tiered stockpiling charge system for cargoes or increase overdue stockpiling charges among other storage charges for cargoes in port to encourage cargo owners and logistics enterprises to pick up their goods, so as to release the stockpiling capacity in the rear part of the port and improve the cargo turnaround rate. For example, the Caofeidian Port charges additional overdue storage fees to ease the coal demurrage. The Manila International Container Terminal in the Philippines shortened the allowed stay of containers at the port from 120 days to 90 days to reduce storage at the port.

However, when circumstances beyond the cargo owners' control occur, such as port strikes and bad weather, the additional costs from port congestion are always transferred to cargo owners. How to **balance port congestion solution and cargo owners' interests** is equally important. Cargo owners not only need to pay the overdue storage charges to the ports, but also bear the surcharges for ship companies for the prolonged sailing schedules and rising shipping costs because of the port congestion. Policymakers should consider how cargo owners' loss in port congestion can be avoided. For example, CMA-CGM charged additional US$400 for the congestion at the Port of Lagos. In view of this, the port authority in Nigeria launched a new container storage charging scheme targeting the congestion at the Port of Lagos, extending the rent-free period of cargo stockpiling at terminals from three days to 21 days, and the demurrage-free period of returning empty containers from five days to 15 days, to offset part of the economic loss of cargo owners and avoid cargo pickup peaks that may lead to another round of congestion at the port.

Ports, as a key node in seaborne trade, will constantly run into congestion and inefficiency problems. Apart from elevating port trafficability, how to improve ports' turnaround rates, avoid congestion or quickly channel through traffic at ports at the policy and regulation level while balancing the impacts of port congestion to cargo owners are of significance. Port authorities should never adopt a "one-size-fits-all" approach for solving port congestion. Instead, they should take the benefits of ports, cargo owners, logistic enterprises and social sectors into account, and base on the reality when designing and launching policies and regulations to plan and guide port production. Port enterprises should also actively communicate with authorities during operation and management in a timely manner to strike a balance among social sectors, ports and cargo owners to facilitate a better solution to port congestion.

3.3.2 EU bans port tax allowance

Port taxes are usually used for port facility development. As ports are mostly for public services, some countries and regions granted tax concessions to port enterprises. For example, the port authorities in the United Kingdom may also engage in cargo handling businesses in addition to terminal leasing, with the rentals for terminal facilities and cargo handling revenue directly handed over to port authorities for port development, with no taxes paid to the state. The revenues from other industries in ports in the United States are used for port development, with no taxes paid to the state nor local governments. Belgium waives the general corporate income taxes for some seaports and inland ports, such as Port of Antwerp, Port of Zeebrugge, Port of Brussels, Port of Charleroi, Port of Ghent, Port of Liège, Port of Namur and Port of Oostende. France also waives the corporate income taxes for most of its ports, including the 11 major seaports, Port of Paris

Authority and commercial ports.

Table 3-4 Purposes of Port Taxes in Different Countries

Country	Purpose
Germany	The tax rate of port taxes is determined according to the total expenditure of relevant governing authorities based on internal economic calculation results of corporates. Taxes are primarily used for port facility maintenance and usage.
United Kingdom	Port taxes are collected by port authorities and primarily used for ports and terminal facility development.
Portugal	Port taxes are used to maintain the infrastructure of the port and restructuring engineering for port development, with the fees of the seaport association.
United States	Port taxes are turned in to the Fed Funds managed by the port authorities and primarily used for maintenance of navigation channel data and navigating equipment.
France	Port taxes are collected by national customs and primarily used for port facility maintenance and port development.

Port facility development in the EU may not need replenishments in the form of tax. The EU has established multiple funds for port facility construction and development. ESI, IDIN and other funds have also been established to promote long-term investments in various aspects of ports. Against this backdrop, port tax concessions aim to cut the cost of port enterprises to foster competitive edges. According to the European Commission investigation, Belgium, France, and Spain launched tax reduction and exemption to subsidize customers in various forms, which distorted market competition. The European Commission has urged the three countries to abolish the tax concessions on ports.

Competition is an inherent feature of market players. Any profit-making economic entity will inevitably participate in competition. Competition can improve the product quality and service capabilities of enterprises to enhance their core competitiveness. However, port tax exemption aims to attract customers by reducing port charges, which is not conducive to the sustainable development of ports.

Special Topic II: Sore of Port Congestion in 2018

Due to bad weather, workers' strikes, Brexit, Sino-US trade frictions and other factors, global ports witnessed frequent congestion incidents in 2018. The port congestion led to longer ship schedules and higher transportation costs. Cargo owners, ship enterprises, port enterprises and other parties suffered serious losses, impairing port production and regional economic development.

I. Reasons for Port Congestions

From port congestions in 2018, we can work out some factors that lead to port congestion:

(1) Low service capability and efficiency of ports

Service capability and efficiency of ports are the biggest factors that lead to port congestion. Whether it is the congestion of the US ports caused by Sino-US trade frictions, or the congestion of ports in Southeast Asia and South Asia caused by the rapid growth of cargoes, the underlying problem is that the ports have exhausted their handling service capabilities. As pointed out in Special Topic I which analyzed the port infrastructure in the US, the trafficability of the US ports has been relatively strained. As highlighted in Chapter 8, which looks at the ship service duration at ports in the US using big data, a vessel usually has to stay for around three days at a US port, while the duration is only around one day at a port in Asia or other areas. The US ports have a wide gap to fill with other ports in terms of service efficiency and capability. In this context, the occurrence of any emergency will be the last straw for any port already underperforming in terms of service efficiency and capability, with the problems of port congestion immediately highlighted. A core problem for ports in Southeast Asia and South Asia is also the lack of service efficiency and capability. In particular, liners feature fixed-point and timed calls. Congestion in a port will implicate another port in the same region.

(2) Ports are not flexible enough to respond to emergencies

In the above cases, port congestion incidents share a feature - the impact of external emergencies, including policies, weather and workers' strikes. The ports lacked effective countermeasures to timely mitigate the impacts of these emergencies on the ports. Customers such as ship enterprises and cargo owners value the stability of the entire logistic chain for cargo transport more than the cargo transport speed. The so-called stability means that the expected services can be accomplished at the expected time and in the expected location. Port is an important link in the logistic chain. Previous cases show that ports lack the flexibility in responding to emergencies. Emergencies often have a greater impact on the stability of the logistic chain through congestion incidents, and the impact may even be amplified along the chain.

(3) Impacts from other links of port transportation systems

The port transportation is a large system, which includes the handling service system, the customs supervision service system, and the inland cargo collection, distribution and transportation system. Efficient services of a port are not just embodied in the loading and unloading operations. The efficiencies of the rear depot operations, customs services, and inland cargo collection, distribution and transportation all have an impact on port service efficiency. Based on the durations of above-mentioned port congestion cases in recent years, we can easily see that the congestion at the Port of

Rotterdam and the UK ports was not caused by problems in the loading and unloading processes, but in supporting services such as the customs system and the barge system.

II. Impacts from Port Congestions

(1) Impairing supply chain operations

Port congestion has its own nature - highly complicated transportation systems and relationships between market players, and a great number of transportation processes and participants. In the case of the Port of Rotterdam the container transport logistic chain of which requires the barge transshipment business, a full container maritime transport business involves the participation of six to seven players. The cargo owner has the maritime transport demand, the freight forwarder is responsible for handling the maritime transport business, the ship enterprise provides the maritime transport service which may also involve container supply, the coastal port in the destination is responsible for the loading and unloading operations, and the barge company carries out inland transshipment to transport the cargoes to the inland terminal. Finally, the cargoes are transported inland by railways or highways. Congestion at coastal terminals may impact other links in the supply chain, including liner transport, container trucks and trailers, barge transport, cargo collection, distribution and transportation by railways, cargo owner production and business and trade transactions. Impacts of port congestion on various market players along the supply chain are amplified level by level. International liner companies and cargo owners are the two ends of the chain, and the two most affected two by port congestion. Congestion often translates to a high demurrage. For cargo owners, in particular, demurrage is not the only manifestation of congestion cost, but congestion can incur economic losses in contracting and production processes.

(2) Congestion has a snowball effect

Container liner transport is different from other cargo transportation modes in that it features multiple points of calls. The congestion at a port may trigger a major change in the ship enterprise's shipping schedule, impacting follow-up calls at ports on the same route. To ease the impact of congestion at a port of call, ship enterprises may change their sailing schedules or re-assign a port of call, which is a sudden external factor for subsequent ports of calls that have the sailing schedules pre-planned. When a port is poor in responding to emergencies, congestion is also likely to occur. For example, the route adjustment from shipping alliances restructuring and the bad weather in 2017 led to congestion at Shanghai Port, and sequential congestion at neighboring ports such as Ningbo and Qingdao.

III. Suggestions on Solving Port Congestion

(1) Improvement of port flexibility in offering services

At present, more and more cargo owners and ship enterprises are asking for more flexible services at ports. Ports face a pressing need to improve their flexibility in offering services. Specifically, a vital facet of flexibility lies in the ability to respond to emergencies in a timely manner and provide helpful solutions. Emergency may not happen, but ports should formulate plans for different types of emergencies in advance. Some emergency plans even require close collaboration from surrounding ports and port-related systems.

(2) Appropriately advanced port capabilities

The development law states that whether to expand a port's capabilities should be determined based on the port's transport demand. But ports are often region-specific. According to the current internationally accepted landlord port mode, terminal operators that lease terminals are often less enthusiastic for expanding the terminal capacity. Instead, they are more willing to input effort in improving the financial performance with the existing terminal capacity. As the "landlord", the port authority needs to consider financial issues and resource waste from overcapacity among other issues, and they are also relatively cautious in investing in port construction. However, from the perspective of ensuring the stability of the port supply chain, port capabilities do need to stay moderately advanced. When there are sufficient support capabilities, a port can mobilize the support capabilities to alleviate the impact of the emergency. Of course, capabilities should be moderately advanced to achieve a balance between making economic benefits and addressing impacts from emergencies.

(3) Exploration of "smart port" development

With the boom in advanced and latest technologies, such as the Internet of Things, big data, and intelligent equipment, information technology has become increasingly mature, laying an important technical foundation for ports to move toward intelligent process. Building smart ports has become an important means to enhance the comprehensive competitiveness of ports. Compared with traditional ports, smart ports can free labor resources, and use advanced technologies such as the Internet of Things and big data to capture information on ships entering and leaving the port, cargoes and other information related to production and operations in real time. This will enable intelligent decision-making for optimal schemes, advanced projections and determination of emergencies and early formulation of contingency plans, and even overcome ports' incapability to operate in bad weather through intelligent technologies so as to improve port productivity.

(4) Improvement of cargo collection, distribution and transportation systems

Against the background of container ship upsizing and the increasing workload for handling a single ship, container handling operations at ports may become more concentrated, posing huge challenges to the cargo collection, distribution and transportation system of ports. The systems must enable faster flows of cargoes as a jam in any link will lead to port-wide congestion and low port operation efficiency. In addition, ports should vigorously enhance their multimodal transport system, and tune up the shares of waterway and railway container transport in cargo collection, distribution and transportation to ease the pressure on roads around the ports.

(5) Improvement of customs clearance environment at ports

The customs clearance environment at ports is also a link in the cargo operation process. During the peak period of ship clearance, the workload of relevant departments increases, which can easily lead to port congestion where ships have to queue up waiting for clearance. Improving the customs clearance environment and the supervision mode is also one of the important means to address port congestion.

IV. Comments on Global Terminal Operators in 2018

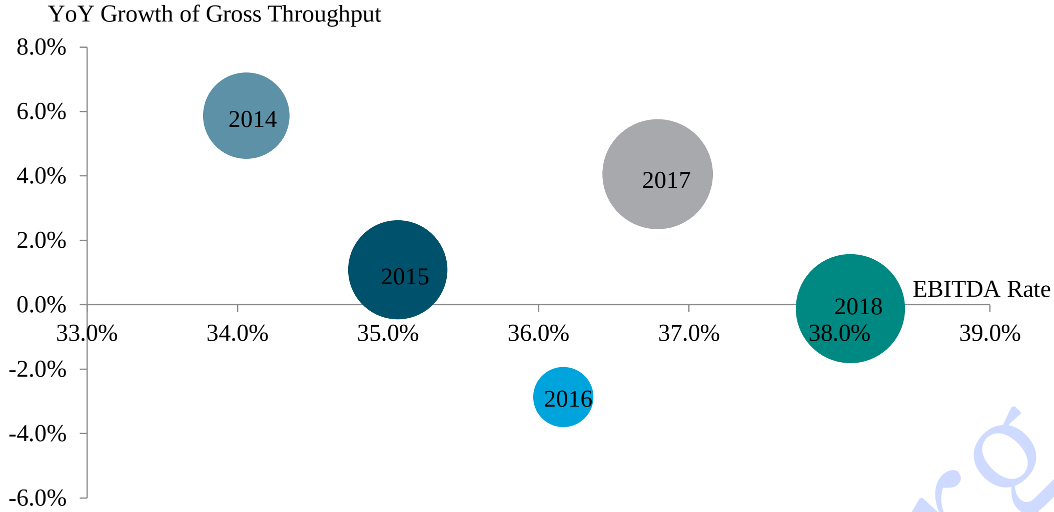
4.1 Overview of Global Terminal Operator Development

With a slowdown in the growth of global seaborne trade volumes in 2018, the world's major terminal operators also saw their growth drop slightly. On the one hand, major terminal operators engaged in expanding and upgrading terminals to accommodate larger ships and improve services by promoting diversity development strategies based on their terminal operation businesses. On the other hand, they also tended to seek new opportunities in the global supply chain, extend business scopes, expand inland services, and actively explore new technologies and blockchain, among others, in order to boost company earnings.

4.2 CK Hutchison's port business experiences a downturn

In 2018, CK Hutchison Holdings saw port and related services segments achieve a container throughput totaling 84.6 million TEUs, down by 0.12% year-on-year, and an EBITDA margin of 38.07%, up by 1.28% year-on-year. Overall, CK Hutchison's port and related services segments suffered a slight downturn in 2018, but operations continued to pick up.

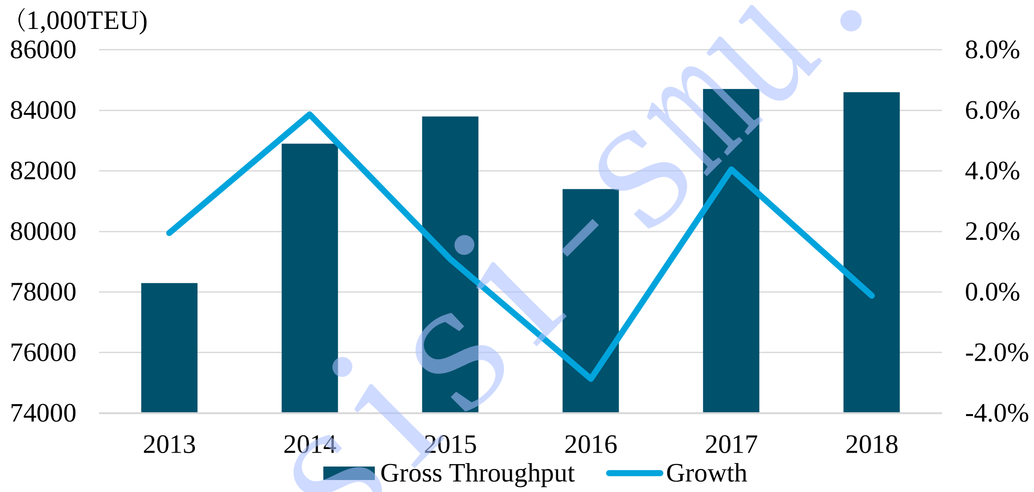
From the throughput and profits of port and related services segments of the company in the last five years, it can be seen that CK Hutchison, by virtue of its diverse terminal distribution and efficient terminal operations, maintained sound profitability, with the EBITDA rates of its port and related services segments growing year by year. However, due to the reduced cargoes for transshipment and intensified competition among homogeneous port operators in Asia since 2016, the container throughput of the company's ports and related services segments presented slow and fluctuant growth. On the one hand, CK Hutchison ports are dominated by Hong Kong Port and Shenzhen Yantian Port as home ports. Hong Kong Port lacks rear land resources and the rising ports in mainland China also grab some cargo flows from Hong Kong Port. On the other hand, the overseas segments of CK Hutchison were also challenged by COSCO Shipping Ports and China Merchants Port as the latter two were gaining pace for overseas expansion, and CK Hutchison suffered shrinking shares in overseas port market.



Note: The size of bubble represents the gross throughput.

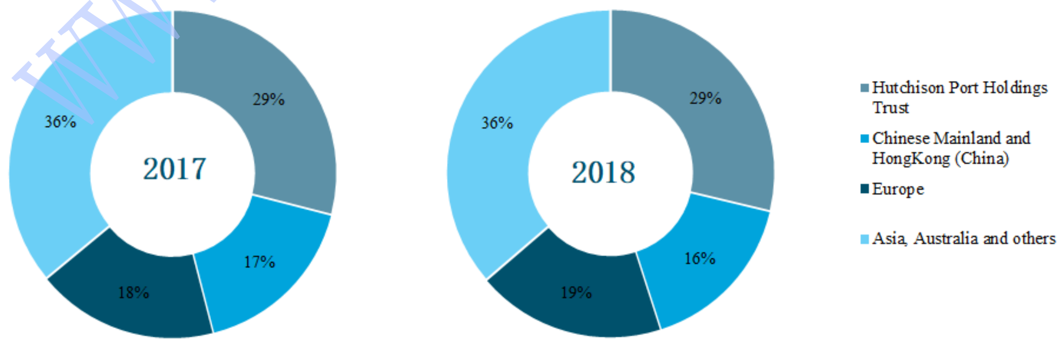
Source: Annual report of CK Hutchison Holdings Limited, sorted by SISI.

Figure 4-1 Gross Throughput and Profit Rate of CK Hutchison (Ports and Related Services) in 2014-2018



Source: Annual report of CK Hutchison Holdings Limited, sorted by SISI.

Figure 4-2 Gross Throughput of CK Hutchison (Ports and related services) in 2013-2018

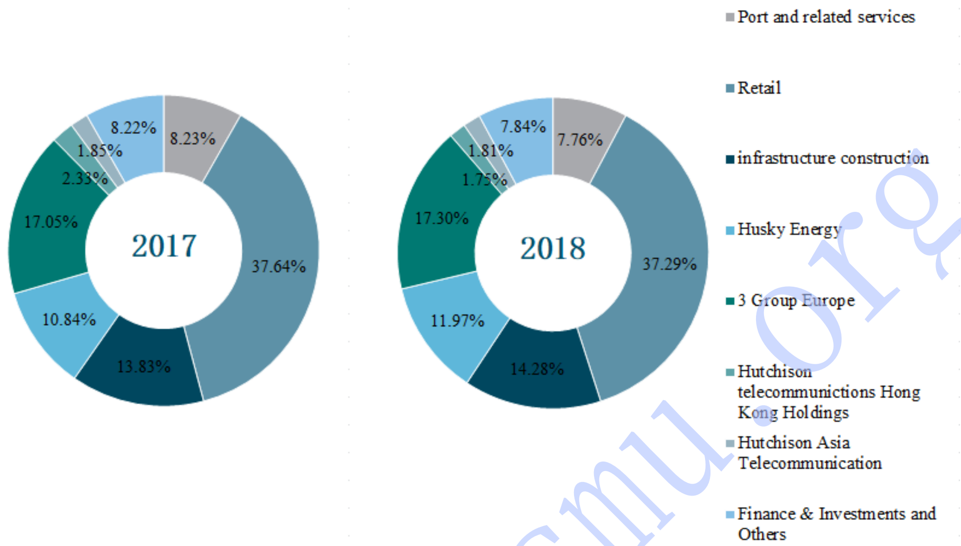


Note: "Asia, Australia and other regions" include Panama, Mexico and the Middle East.

Source: Annual report of CK Hutchison Holdings Limited, sorted by SISI.

Figure 4-3 Container Throughput of CK Hutchison (Ports and Related Services) by region in 2017- 2018

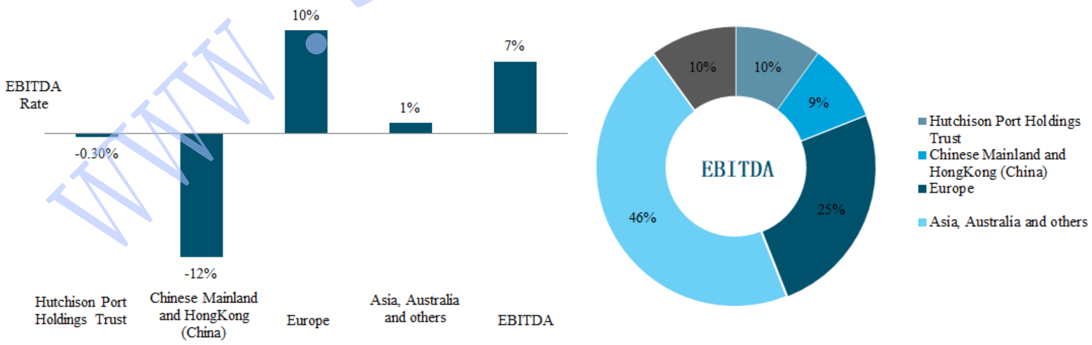
Profit-wise, Ports and Related Services of CK Hutchison recorded an operating revenue rise of 3.01% year-on-year to HK$35.18 billion, accounting for 7.76% of the company's gross operating revenue, due to the port business growth in Asia, the improving performance of Port of Rotterdam, and the benefits from selling the full equity of Shantou International Container Terminal. And Its Ports and Related Services EBITDA grew by 6.60% year-on-year to HK$13.39 billion, accounting for 11.79% of the company's total profit.



Source: CK Hutchison Holdings Limited, sorted by SISI.

Figure 4-4 Proportion of Operation Revenue of Each Business Segment of CK Hutchison in 2017- 2018

The continuous profit growth in the port and related service business segments was primarily a result of the large and stable customer base. All the 10 biggest customers of CK Hutchison are renowned larger shipping companies which contributed 77% throughput and 81% operating revenue of the port and related service business for the company. Specifically, CMA-CGM, COSCO Shipping, Evergreen Marine and Hapag-Lloyd contributed 48% throughput.



Source: CK Hutchison Holdings Limited, sorted by SISI.

Figure 4-5 YoY Growth Rate and Proportion of EBITDA in Ports and Related Service Sub-regions of CK Hutchison in 2018

In recent years, the company has pursued policies of "**expanding logistics, cautious investment and improving equipment**" to enhance its competitiveness in the Hong Kong market while seeking new opportunities in overseas markets.

In addition, the company has been dedicated to professional container operations, trying to improve its operational equipment to elevate port capabilities for handling large container ships in the world and highlight ultra-high operation efficiency in limited land areas.

In terms of port landscape, most of port assets of CK Hutchison are currently located in the Far East and Europe, along with some assets in the Middle East, Africa, Americas and Australia, totaling 288 terminals of 51 ports in 26 countries. Most of these ports are on trunk routes and hub ports, with CK Hutchison's investment in hub ports dominated by the shareholding form. From the terminal business investment in this year, we can see that the expansion of Port of Felixstowe in the United Kingdom aims to enhance the port's capability in handling large ships. The newly built Terminal D at Port of Laem Chabang in Thailand is also a deep-water terminal which will become a portal port for Thailand's trade activities. Besides, the CK Hutchison will sell a 70% stake of the Shantou International Container Terminal to a Singapore investor at the end of the year. In the big picture, most of the ports invested by CK Hutchison are full-fledged ones with a stable rate of return expectation, and the company's investment tends to supplement existing businesses and enhance port capabilities.

4.3 AP Moller-Maersk maintains stable operations

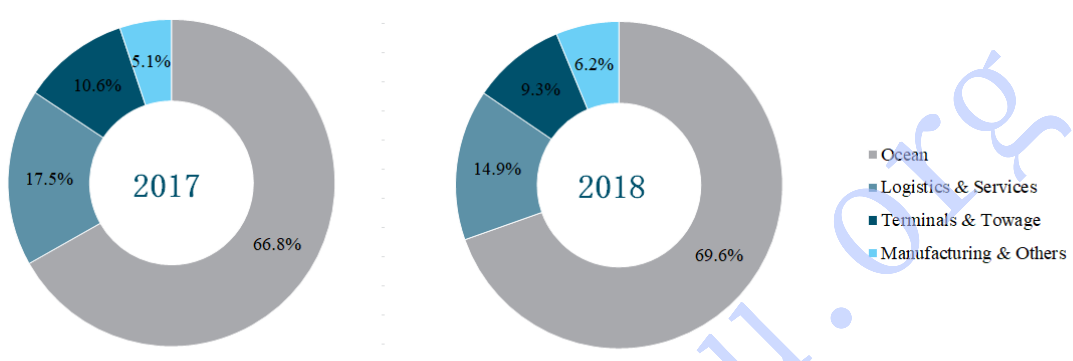
AP Moller-Maersk kept advancing its business transformation in 2018. The group stripped energy-related businesses and successfully integrated the sales, customer service, logistic products and logistics operation segments, serving its customers in a uniform brand.

Table 4-1 Revenue and Earnings before Interest, Tax, Depreciation and EBITDA Ratio of A.P. Moller-Maersk in 2018

	Revenue (million $)			EBITDA Rate		
	2017	2018	Growth Rate	2017	2018	Growth Rate
Ocean	22023	28366	28.80%	12.61%	10.60%	-2.01%
Logistics & Services	5772	6082	5.37%	2.41%	1.61%	-0.80%
Terminals & Towage	3481	3772	8.36%	18.36%	20.63%	2.27%
Terminals	2822	3080	10.71%	15.66%	18.41%	2.75%
Towage	659	692	5.01%	29.89%	30.49%	0.60%
Manufacturing & Others	1689	2547	50.80%	10.24%	2.32%	-7.93%
Unallocated activities, eliminations, etc.	-2020	-1748	-13.47%	9.70%	7.78%	-1.92%
Unallocated Activities, Eliminations, Etc.	30945	39019	26.09%	11.41%	9.75%	-1.66%

Source: 2018 annual report of Maersk Group, sorted by SISI.

Terminal and tug services, one of major business segments of Maersk Group, posted high profits and high growth. This segment's operating revenues in 2018 reached US$3.77 billion, accounting for 9.3% of the group's total and up by 8.4% year-on-year, while the EBITDA reached US$780 million, constituting 20.4% of the group's total and up by 21.8% year-on-year. The favorable performance of the terminal and tug services was creditable to the business volume growth from Maersk's maritime shipping segment and external customers, and the reduced cost per move. Compared with other business segments of the group, the terminal and tug services businesses, though taking up minor shares in the group's operating revenue, recorded as high as 21.8% of EBITDA growth, with the EBITDA rate standing at 20.6%, being the fastest-growing segment in terms of profit and the most profit-making segment.



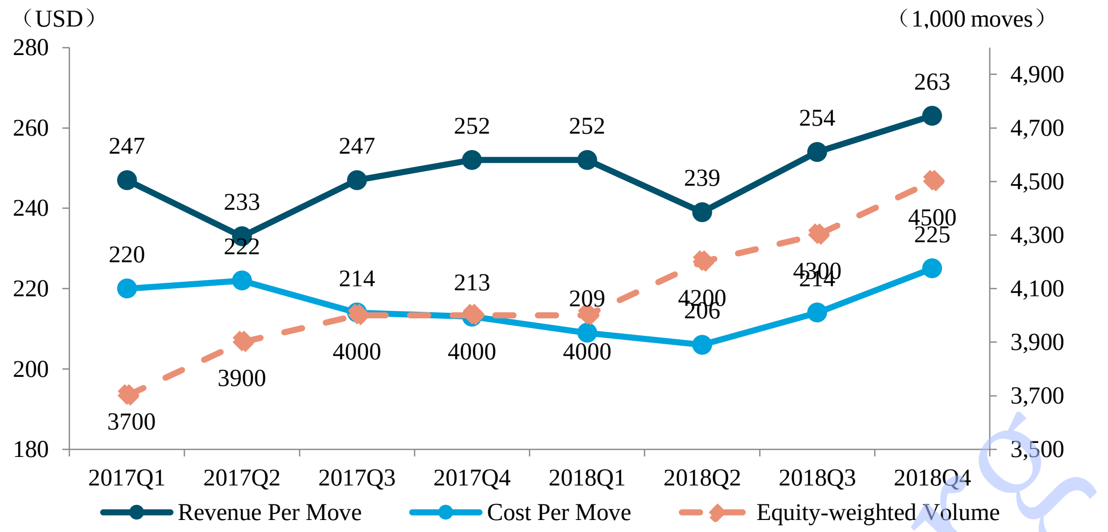
Source: 2018 annual report of Maersk Group, sorted by SISI.

Figure 4-6 Proportion of Revenue in Each Business Segment of Maersk Group in 2017-2018

In terms of terminal business, AP Moller-Maersk recorded an equity throughput of 17 million moves in 2018, an increase of 9.1% year-on-year. Apart from the European region, AP Moller-Maersk's business volumes in other regions all grew to some extent. Specifically, its equity throughput in the Americas hit 4.8 million moves, soaring by 29.9% year-on-year. Its equity throughput in Asia recorded 7.2 million moves driven by the container growth in South Asia, rising by 2.1% year-on-year. Although the equity throughput in Africa and the Middle East was the lowest, namely 2 million moves, the profit margin in these areas was as high as 45.2%, making the areas a potential focus of the group's future development.

Table 4-2 Terminal Sub-regional Equity-weighted Volume and EBITDA Rate of A. P. Moller-Maersk in 2018

	Equity-weighted Volume (million moves)			EBITDA Rate	
	2017	2018	Growth	2017	2018
Americas	3.7	4.8	29.9%	8.9%	13.5%
Europe, Russia and Baltics	2.9	3.0	2.7%	16.8%	15.8%
Asia	7.1	7.2	2.1%	20.3%	19.8%
Africa and Middle East	1.9	2.0	4.2%	43.6%	45.2%
Total	15.6	17.0	9.1%	15.79%	18.29%



Source: 2018 annual report of Maersk Group, sorted by SISI.

Figure 4-7 Equity-weighted Volume, Revenue Per Move and Cost Per Move of APM Terminals in 2017-2018

Maersk Group's sound business performance in terminal businesses was a result of its strategic transformation. In 2018, AP Moller-Maersk shifted its development strategy from **"invest in deep-water terminals and seize global share"** to **"extend business scope and expand inland services"**. These measures not only elevated the terminal operation efficiency and reduced the logistic cost, but also brought sound environmental benefits.

Currently, the global network of AP Moller-Maersk terminals covers 172 ports and inland facilities in a total of 57 countries in Africa, the Middle East, Asia, Europe, Latin America, North America, Russia and the Baltic Sea. In 2018, AP Moller-Maersk invested in building a new bulk terminal at the Port of Poti, the largest port in Georgia. Previously, Maersk invested in the port starting from 2011 to improve the port's facilities, and built a deep-water container terminal at the port at the end of 2015. The new bulk terminal will supplement the existing business portfolio of the Port of Poti.

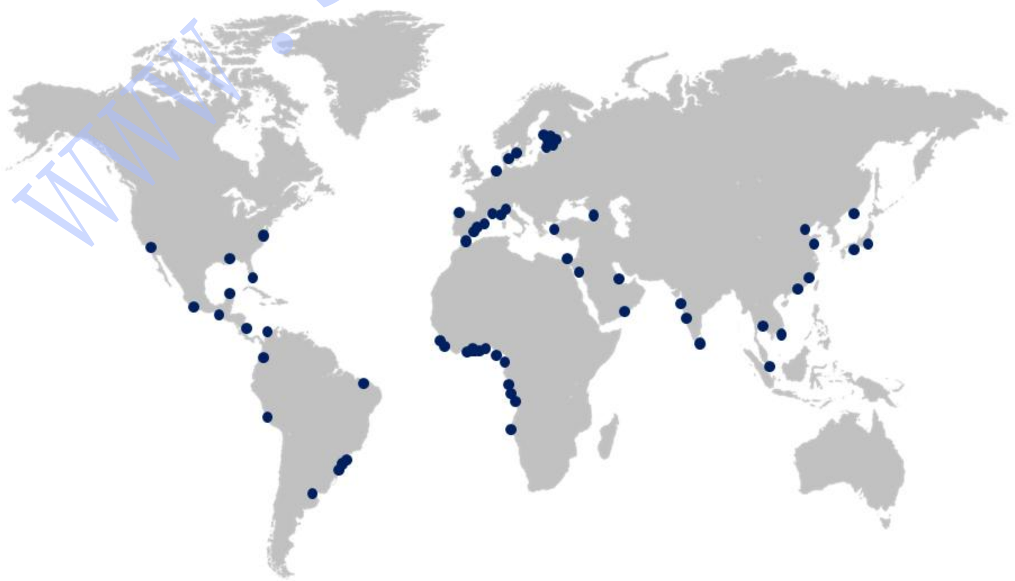
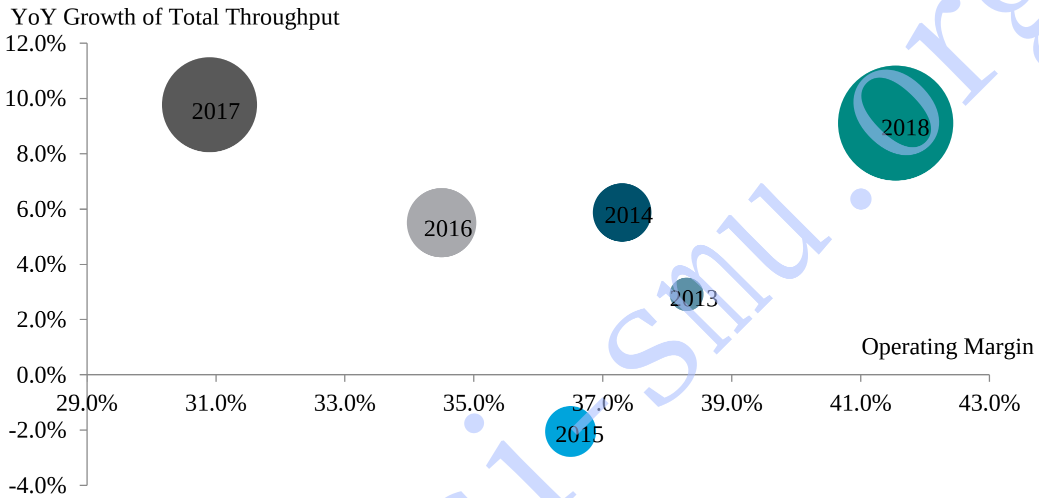


Figure 4-8 Asset Distribution of APM Terminals in 2018

4.4 PSA International continues the growth

In 2018, PSA International recorded a container throughput of 81 million TEUs, up by 9.11% year-on-year, with an operating margin of 41.54%, up by 10.64% year-on-year. On the whole, PSA International's port business kept growing in 2018.

In the past five years of development, the PSA International group has stayed customer-centered and kept launching innovations and reforms, posting sound operating revenues. Its business profit rate has been above 30% and surpassed 40% for the first time in 2018. Except the gross throughput plunge in 2015 due to sluggish trade growth, PSA International has enjoyed rising throughput for terminals both in and out of the country and the gross throughput also presented sound growth.

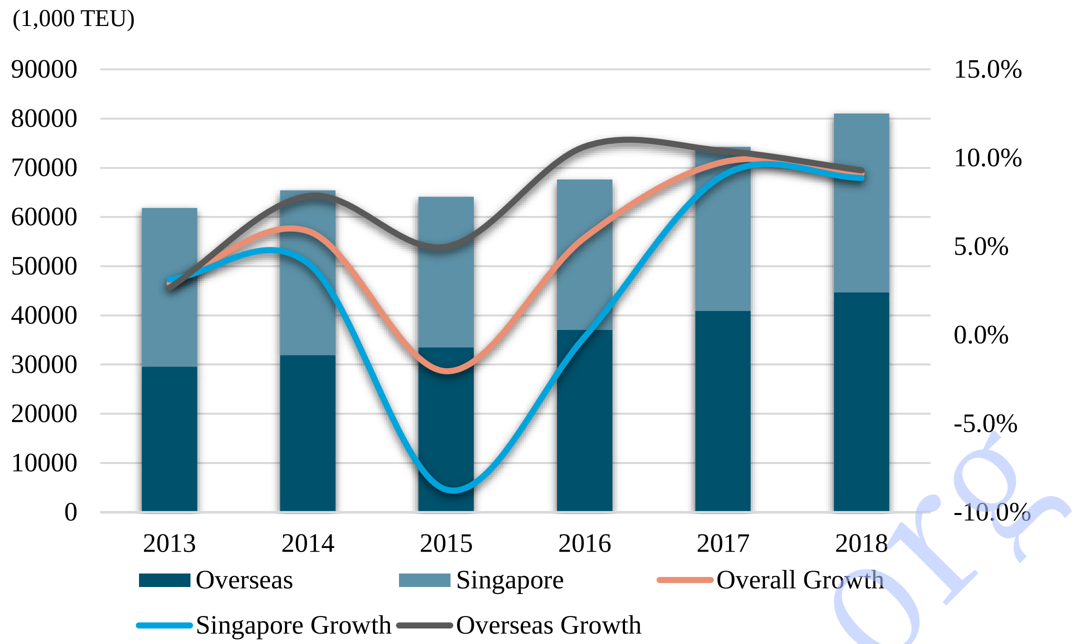


Note: The size of bubble represents the gross throughput.

Source: Annual report of PSA International, sorted by SISI.

Figure 4-9 Gross Throughput and Operating Margin of PSA International in 2013-2018

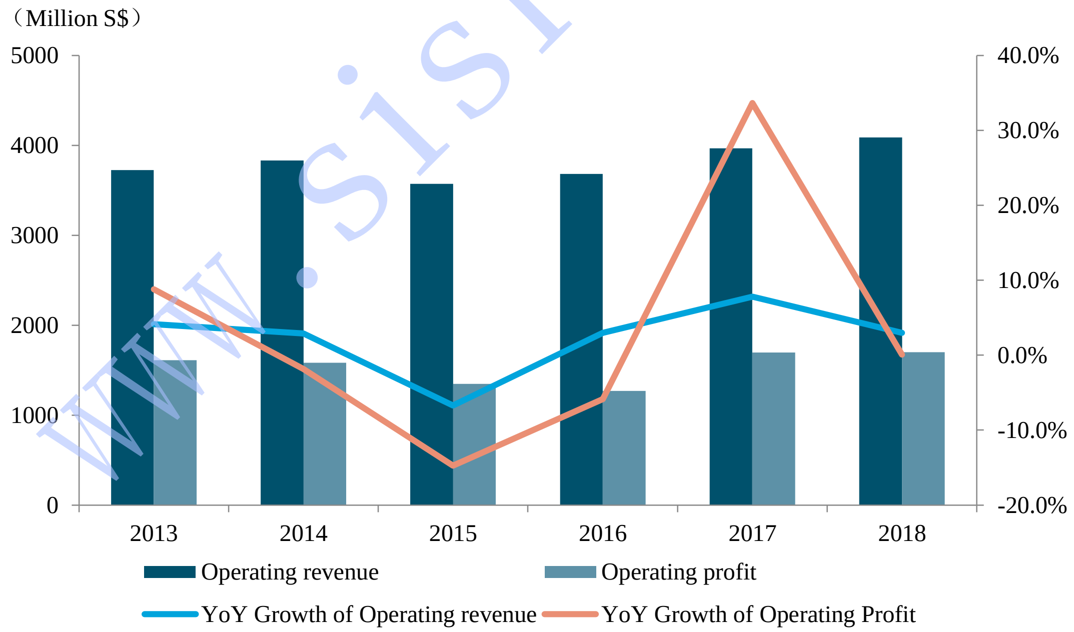
In terms of throughput figures, PSA International recorded an overseas throughput of 44.69 million TEUs in 2018, rising by 9.29% year-on-year. Boosted by the increased calls of vessels from the new alliance, the group's terminals in the country recorded a total container throughput of 36.31 million TEUs, rising by 8.88% year-on-year. In terms of the throughput variations of the group in the past five years, the throughput was generally on a rise, yet the throughput growth rates followed a "V-shaped" curve, leveling off following a steep fall in 2015 and then rising for three years.



Source: PSA International website, sorted by SISI.

Figure 4-10 Container Throughput and Growth in Each Region of PSA International in 2013-2018

Profit-wise, PSA International posted an operating revenue of S$4.09 billion in 2018, increasing by 2.97% year-on-year, thanks to its stable throughput growth. The revenue included S$1.7 billion of operating profit, running flat with the previous year. However, the increasing depreciation brought down the overall net profit by 2.27% to S$1.21 billion.



Source: PSA International website, sorted by SISI.

Figure 4-11 Operating Revenue and Profit of PSA International in 2013-2018

PSA International continued its development strategy from previous years in 2018, investing in terminals for global expansion and shifting to logistic supply chain development in active exploration of new technologies. In terminal investment, the group's subsidiary PSA Canada

Holdings acquired 60% equity in Ashcroft Terminal (AT), marking the group's march into the North America inland supply chain. This is conducive for the group to enhance its capabilities in multimodal transport and inland container depot (ICD) operations. In addition, the group entered joint operations with Ocean Network Express (ONE), a shipping enterprise, to establish a joint venture for investing in and operating the Pasir Panjang Terminal in Singapore, bringing new blood to the group's terminal business. In the logistic supply chain aspect, PSA International laid its strategic focus on building an Internet of Logistics (IOL) coupled with active explorations in new technologies and the blockchain fields. It worked with partners and related stakeholders in blockchain tests to strive to enhance its physical and digital connectivity and eventually improve its global supply chain efficiency.

Currently, PSA International's port network is mostly located in Southeast Asia, Northeast Asia, the Middle East, South Asia, Americas, Europe and the Mediterranean Sea. The group's invested assets form a network composed of more than 50 coastal, railway and inland terminals in 17 countries. The acquisition of 60% equity in Ashcroft Terminal (AT) by a subsidiary of PSA International in 2018 also offers new space for the group to march into the Canadian market and improve its global port network.

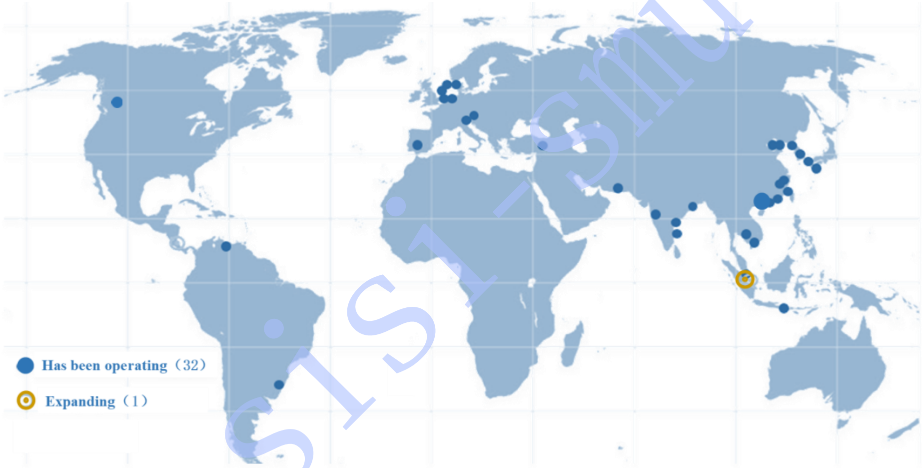
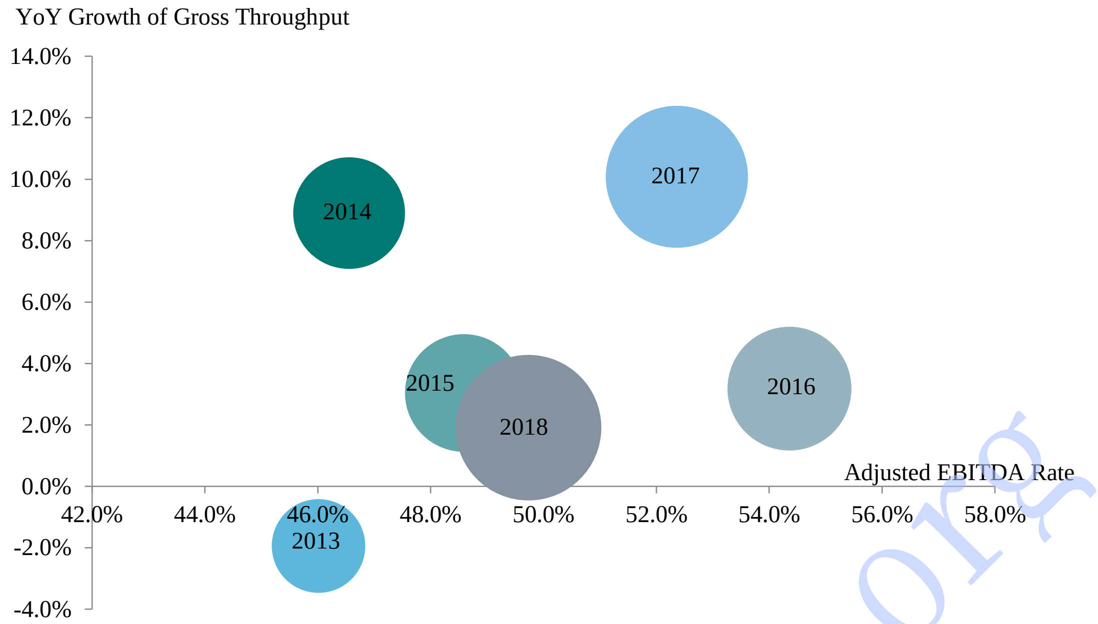


Figure 4-12 Port Asset Distribution of PSA International in 2018

4.5 DP World growth slows down

In 2018, DP World recorded a container throughput of 71.42 million TEUs, up by 1.91% year-on-year, a slump of 8.17 percentage points from that in the previous year. The group posted an adjusted EBITDA margin of 49.73%, down by 2.63% year-on-year. Overall, DP World's business growth suffered a slowdown in 2018.

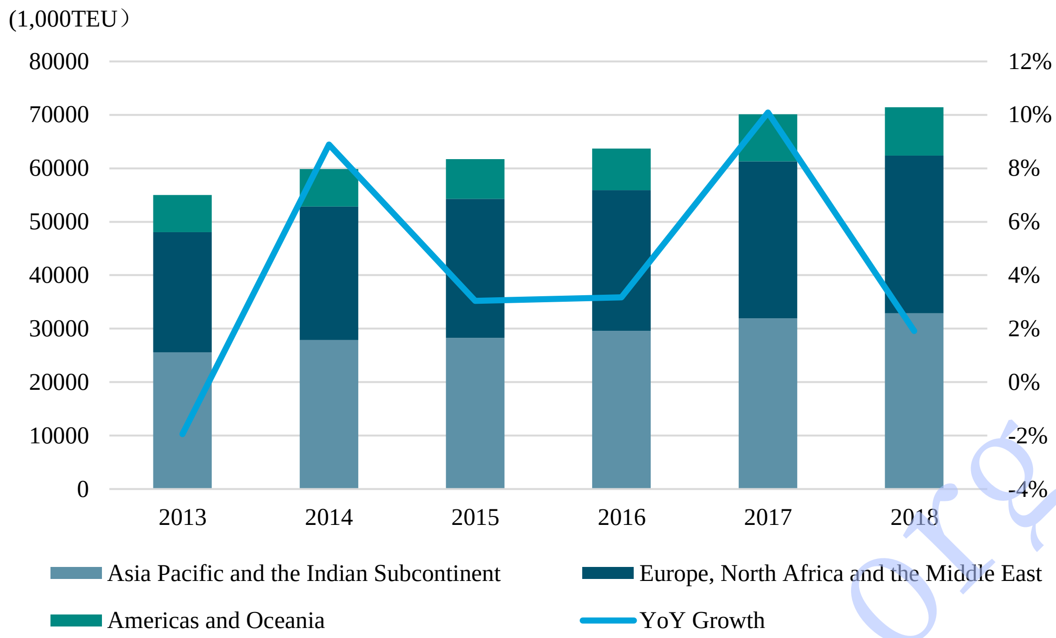


Note: The size of bubble represents the gross throughput.

Figure 4-13 Gross Throughput and Operating Margin of DP World in 2013-2018

DP World has maintained sound business performance in the past five years, with its EBITDA margin above 40% and its gross throughput on a rise. Although the group's throughput growth slowed down because of its share investment in the terminal at Port of Busan, South Korea, in 2017 which erased the direct incremental effect in 2018, and the trimming of its low-profit terminal businesses to boost profits, its gross throughput managed to sustain a growing momentum.

Region-wise, all the three business segments of DP World saw slower growth. Specifically, the operation of the expanded project of Port of Prince Rupert in Canada and the long-term partnership extension agreement with CMA-CGM boosted the group's businesses in the Americas and the Oceania, with the container throughput in these areas hitting 9.04 million TEUs, a rise of 2.75% year-on-year. Driven by the London Portal Terminal in the UK, the Yarimca Port in Turkey, the Port of Daker in Senegal and the Port of Sokhna in Egypt, the group's performance in Europe and North Africa remained strong. However, the group trimmed its low-profit businesses in the United Arab Emirates, resulting in depressed performance in the Middle East. The combined effect of the two resulted in a growth rate of mere 0.4% for the group's businesses in Europe, North Africa and the Middle East areas. The Asia-Pacific and Indian subcontinent, one of the pillar terminal segments of the group, recorded a container throughput of 32.9 million TEUs, a rise of 3.07% year-on-year, being the fastest-growing region. Specifically, the Asia-Pacific demonstrated the strongest growth in throughput.



Source: DP World website, sorted by SISI.

Figure 4-14 Gross Throughput of DP World in 2013-2018

Profit-wise, the revenue of DP World in 2018 recorded a surge of 19.8% to US$5.65 billion, partly from the newly acquired assets, such as the Drydocks, World and Dubai Maritime City (DMC), Cosmos Agencia Maritima, CWC and Santos Consolidated, partly from the 6.3% growth in container shipping revenue which helped the revenue of the period to grow by 4.2%. The group registered a profit of US$1.33 billion, an increase of 2.2% year-on-year, primarily attributable to the Doraleh Multipurpose Port (DMP) in Djibouti and Brazil's Port of Santos project, with the adjusted EBITDA standing at US$2.81 billion.

DP World renewed its commitment to tapping new opportunities in the global supply chain by diversifying investment portfolio to spread risks in 2018 as part of its effort of shifting development strategies so as to ensure profits. On the one hand, DP World shifted its investment gravity to inland logistic services. On the other hand, it started to strengthen strategic cooperation on the global scale with shipping enterprises. It first acquired a 100% stake in Unifeeder Group, the world's largest offshore operator on pan-European feeder routes, as a terminal operator. This move will bridge the company's terminals relying on the shipping businesses to ultimately enhance the group's terminal business volume and market competitiveness.

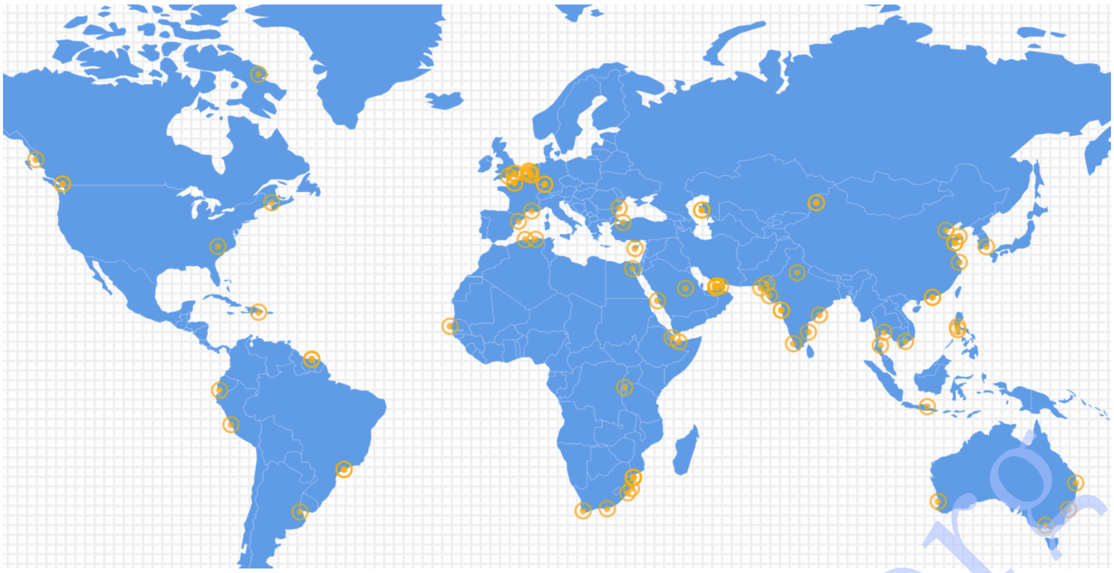
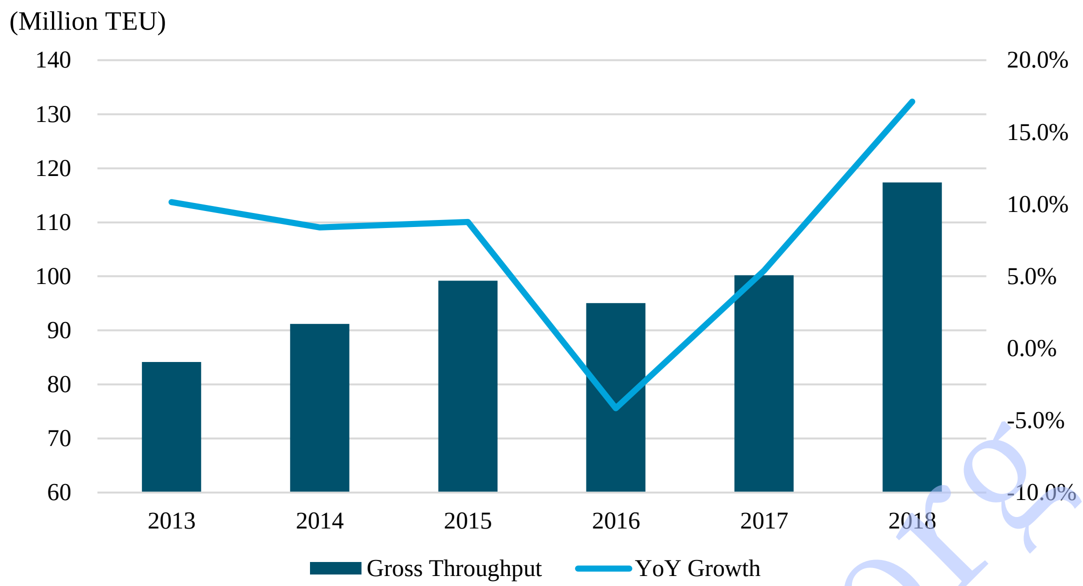


Figure 4-15 Port Asset Distribution of DP World in 2018

DP World currently operates 12 terminals in seven countries in the Asia-Pacific, and has investments in full-fledged deep-sea container terminals, multi-purpose terminals, five inland nodes and logistic parks in Europe and Russia, and launched large-scale expansion and developed new sites in the Middle East and Africa. It also owns a complete container terminal network in the Americas. In recent years, DP World has established an extensive logistic asset network in India, including six terminals, two bonded warehousing districts, five container freight stations (CFS), six cold chain facilities (logistics in winter), and three inland container depots (ICD)/private freight stations as well as highway and railway transport networks. The group's exploitaion in the Indian market will introduce a terminal business volume with an average annual growth rate of 8-10% to the group, and create a new growth momentum for the group's businesses in the Indian subcontinent.

4.6 COSCO Shipping Ports posts strong growth

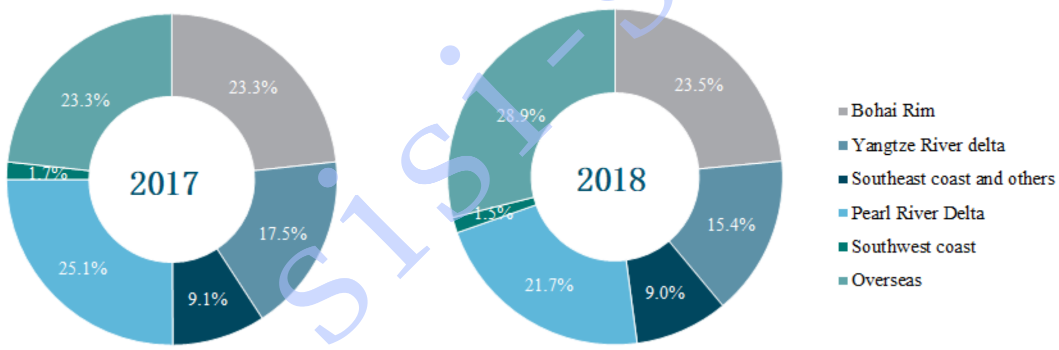
Backed by its parent company and the Ocean Alliance, COSCO Shipping Ports saw its container throughput total 117 million TEUs in 2018, soaring by 17.13% year-on-year, while the equity throughput of containers reached 37.06 million TEUs, up by 15.82% year-on-year.



Note: In 2016, COSCO Pacific Limited. and China Shipping Port Development Co. Ltd. were restructured and renamed to COSCO Shipping Ports Limited. The total throughput from 2013 to 2015 is the sum of the total throughput of COSCO Pacific Limited and China Shipping Port Development Co., Ltd.

Source: COSCO Shipping Ports Limited website, sorted by SISI.

Figure 4-16 Gross Throughput of COSCO Shipping Ports Limited in 2013-2018



Source: COSCO Shipping Ports Limited Website, sorted by SISI.

Figure 4-17 The Proportion of Equity Throughput of COSCO Shipping Ports Limited by Region in 2017-2018

Region-wise, the Bohai Rim region demonstrated the strongest growth, primarily from the inclusion of the full-year throughput of Qingdao Port International (the throughput data of only eight months was calculated in 2017), pushing up the local equity throughput by 16.82% year-on-year. The Nantong Tonghai Terminal in Jiangsu province went into operation at the end of June 2018, which boosted the throughput figure. As a result, the equity throughput of the Yangtze River Delta region rose by 1.92% year-on-year to 5.71 million TEUs, accounting for 15.4% of the company's total. The equity throughput of the southeastern coastal areas and other regions increased by 14.55% year-on-year to 3.34 million TEUs, primarily from the increased vessel calls from the Ocean Alliance in the year which boosted the throughput of Xiamen Ocean Gate Container Terminal. The Pearl River Delta and the southwest coastal areas were lackluster overall, with the equity throughput growth rates rising by mere 0.13% and 2.20%, respectively. Benefiting from the newly-acquired CSP Spain Group, the containers throughput of CSP Zeebrugge Terminal and support from the shipping alliance and its parent company, the company's overseas terminal business demonstrated the strongest growth, making the largest contribution to the total equity throughput. The segment recorded a year-on-year growth rate of as high as 43.66%, becoming a major driver of the company's business growth.

The year 2018 marks the second year after COSCO Shipping's restructuring. COSCO Shipping Ports Limited recorded excellent business performance, with enhancement in global terminal network and terminal operational capabilities in the year. In terms of profitability, COSCO Shipping Ports saw its revenue rise by 57.6% year-on-year to US$1 billion in 2018. The strong growth was primarily attributable to its acquisition of the CSP Spain Group in October 2017 and increased shareholding of CSP Zeebrugge Terminal in November 2017. The profit of CSP Zeebrugge Terminal was not included as a result of a special tax adjustment, and the company recorded a gross profit of US$379 million, a rise of 27% year-on-year. Specifically, the terminal holdings of the company were the main sources of the profit growth, with the Piraeus Terminal in Greece and the Xiamen Ocean Gate Container Terminal in China as the main contributors. The growth of non-controlling terminals was primarily from the surging throughput at Kumport Terminal in Turkey. In addition, the adjusted EBITDA of the company increased by 37.8% year-on-year to US$653 million.

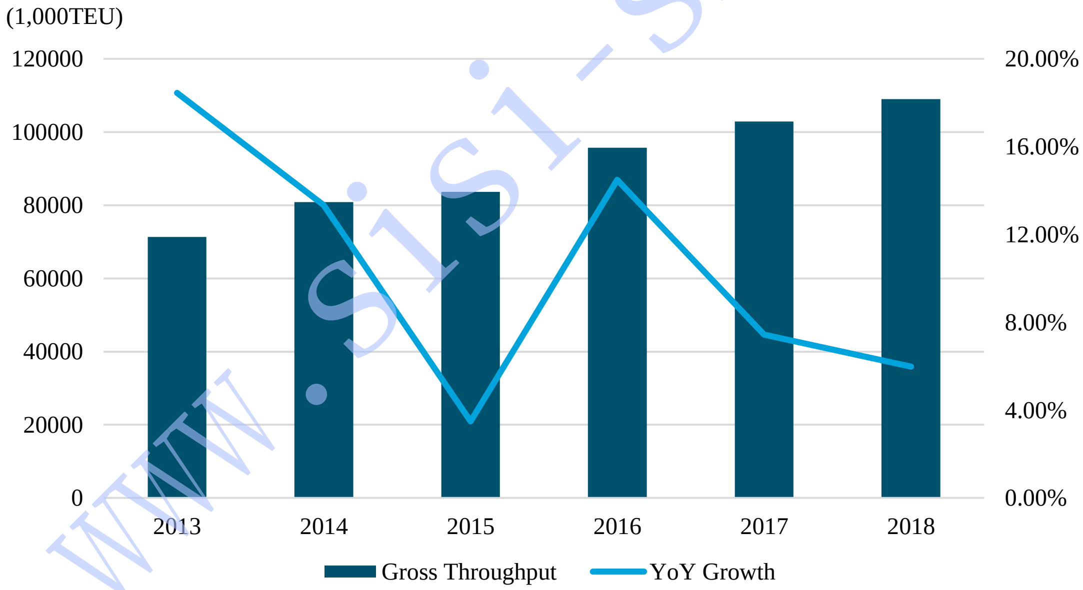
Since 2018, COSCO Shipping Ports has gradually shifted its development strategy from the **traditional endogenous growth to an innovative extensional growth mode, and from control of terminal resources to integrated allocation of port resources.**

At present, COSCO Shipping Ports' terminals are located in all the five major port groups in coastal China, Southeast Asia, the Middle East, Europe and the Mediterranean Sea. The company operates and manages 269 berths in 35 ports around the world, including 179 container berths. Since the restructuring in 2016, COSCO Shipping Ports has been dedicated to building a resultful controlling network around the globe that features linkage between cost, services and synergy. The company tends to invest in large full-fledged ports, and favors sizable proportion of shareholding of terminals for overseas expansion. In 2018, COSCO Shipping Ports acquired a 4.34% stake in Beibu Gulf Port to enhance its presence in southwest coastal areas in China, laying a foundation for the company's participation in port integration in Guangxi. It also signed an MOU with the PSA International on building two new berths at the COSCO-PSA Terminal (CPT) to boost the company's terminal network in Singapore. This move aims to build the COSCO-PSA Terminal (CPT) into a major container transshipment hub of the company in the Southeast Asia. In addition, COSCO Shipping Ports also announced in succession its strategic allying with the Zeebrugge Port Authority and CMA-CGM to elevate the synergy value.

Figure 4-18 Port Asset Distribution of COSCO Shipping Ports Limited in 2018

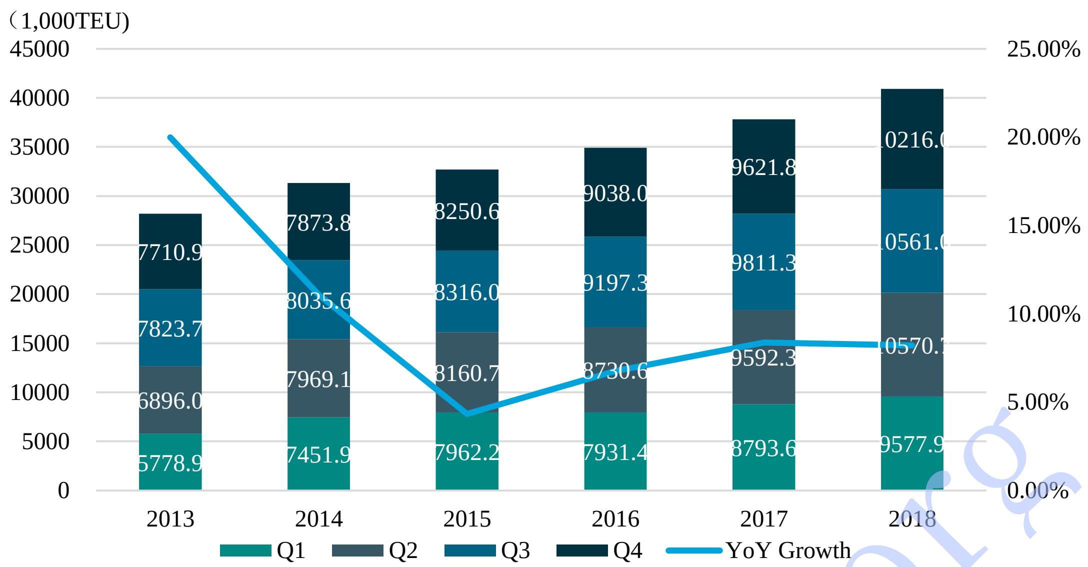
4.7 China Merchants Port Holdings enjoys steady growth

In 2018, China Merchants Port's container throughput totaled 109.06 million TEUs, up by 5.98% year-on-year, while its container equity throughput rose steadily by 8.21% year-on-year to 40.93 million TEUs. On the whole, China Merchants Port saw its business grow steadily guided by the development strategy of "internal integration and external expansion".



Source: China Merchants Port Holdings website, sorted by SISI.

Figure 4-19 Gross Throughput of China Merchants Port Holdings in 2013-2018



Source: China Merchants Port Holdings Website, sorted by SISI.

Figure 4-20 Quarterly Equity Throughput of China Merchants Port Holdings in 2013-2018

Region-wise, the six major business regions of China Merchants Port presented varied growth momentums in equity throughput. Specifically, its overseas business recorded a rise of 16.5% in overall equity throughput. Its southeast coastal region, boosted by the new investment in a 60% stake in Shantou Port Group Co., Ltd. last year, posted strong growth in equity throughput, namely at 92.6%.

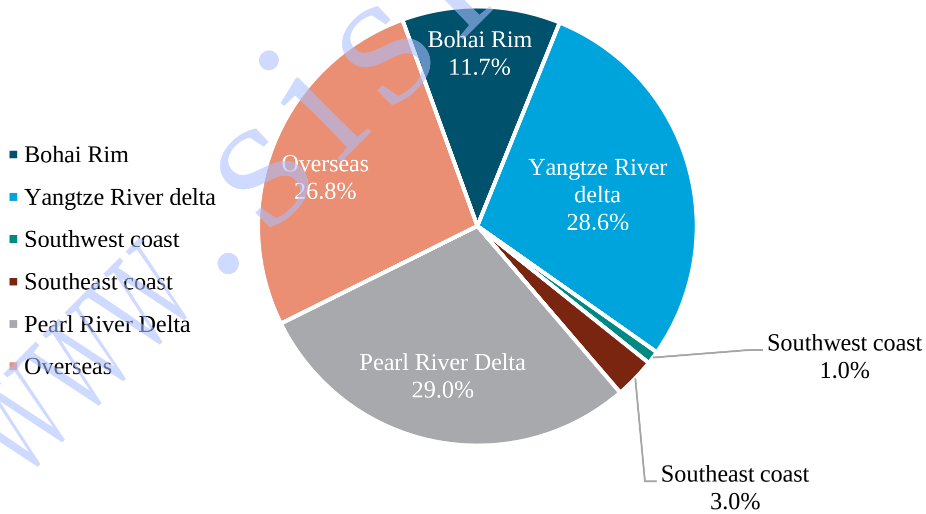


Figure 4-21 Proportion of Equity Throughput in Each Region of China Merchants Port Holdings in 2018

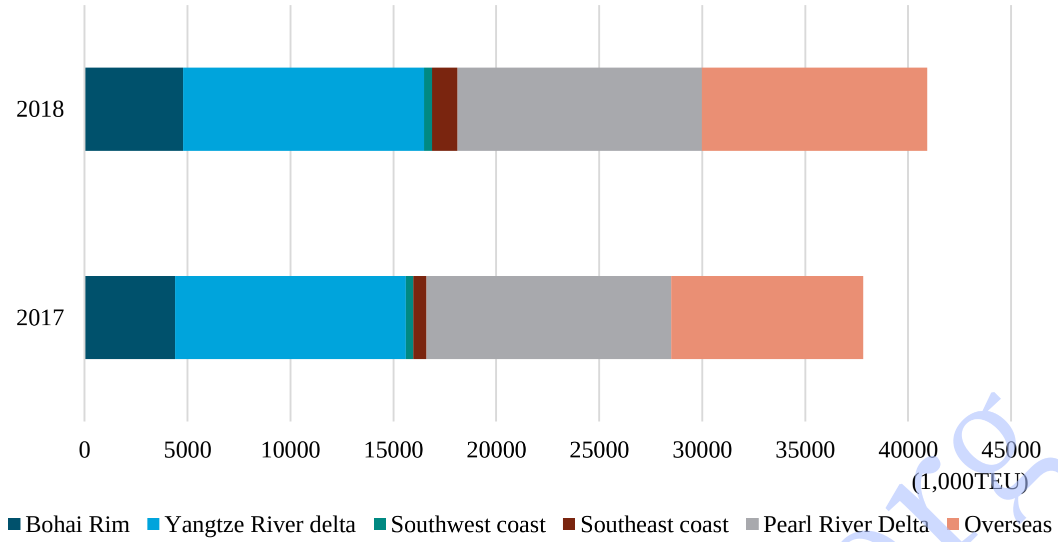


Figure 4-22 Regional Equity Throughput of China Merchants Port Holdings in 2018

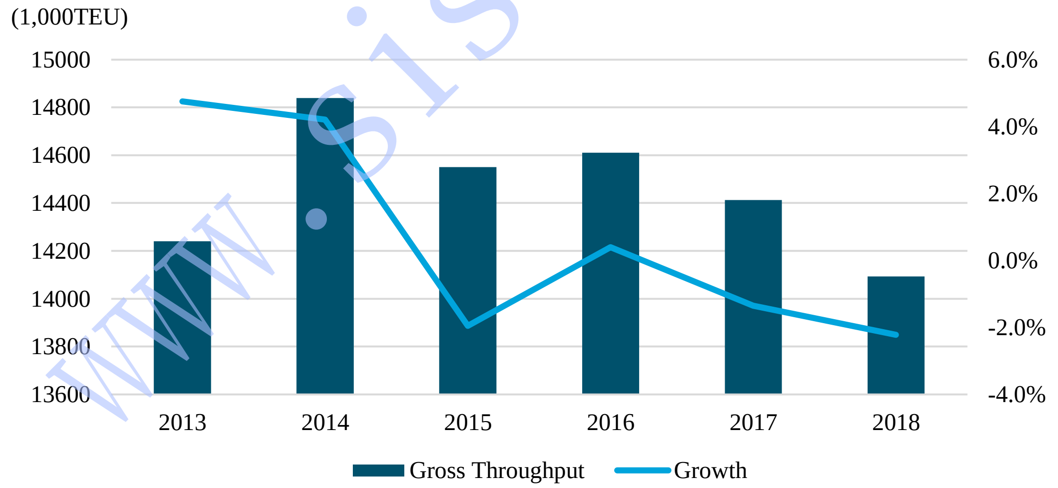
Profit-wise, China Merchants Port bagged HK$16.55 billion in the first half of 2018, down by 31.9% year-on-year. This was because, first, the company did not count the revenue of China International Marine Containers (Group) Ltd (CIMC) in the second half of the year after selling CIMC, and second, the revenue of its ports' core businesses increased by 10.0% year-on-year driven by its newly acquired projects and growing volume of business. The company's after-tax profits of ports reached HK$5.92 billion, up by 141.5% year-on-year.

In recent years, China Merchants Port has paid continuous attention to integration of existing port businesses in China and port-city synergy. By solving the horizontal competition with Shenzhen Chiwan Wharf Holdings Limited, the company managed to optimize its asset structures to reduce cost and enhance efficiency. On the other hand, it branched out and strengthened its global network. At present, China Merchants Port's domestic business landscape is vast, covering Dalian in North China, Zhanjiang in South China, and Tianjin Port, Qingdao Port, Shanghai Port, Ningbo Port, Zhangzhou Port, the western port area of Shenzhen Port and Hong Kong Port in the middle, presenting a well-equipped layout in China. China Merchants Port's overseas reach primarily follows the Belt and Road route, focusing on developing the hinterland economy in various regions, and conducting overall planning for the cities and countries home to its invested ports, highlighting a "port-industrial park-city" operational model relying on China Merchants Group's diversified industrial resources. In 2018, China Merchants Port further augmented its overseas port holding through acquisitions of Paranagua Port in Brazil and the Port of Newcastle in Australia, improving its overseas port network.

Figure 4-23 Port Asset Distribution of China Merchants Port Holdings in 2018

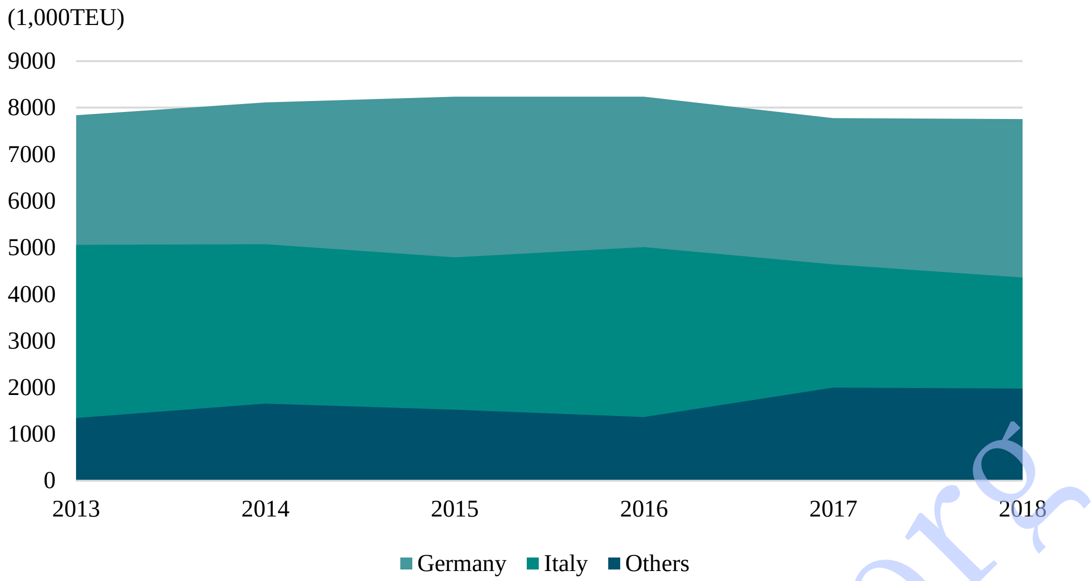
4.8 Eurogate's port business continues to dip

As the core business of Eurogate, terminals under the group posted 14.09 million TEUs in container throughput, with a growth rate 2.2 percentage points down from that of the previous year. Port throughput figures in recent years show that Eurogate has suffered throughput declines since 2016 due to overcapacity of European ports and the sluggish global trade. Both the container throughput and growth rate of Eurogate in 2018 hit six-year lows due to the tough situations in the container handling market in North Europe.



Source: Eurogate website, sorted by SISI.

Figure 4-24 Gross Throughput of Eurogate in 2013-2018



Source: Eurogate website, sorted by SISI.

Figure 4-25 Throughput of Eurogate by Region in 2013-2018

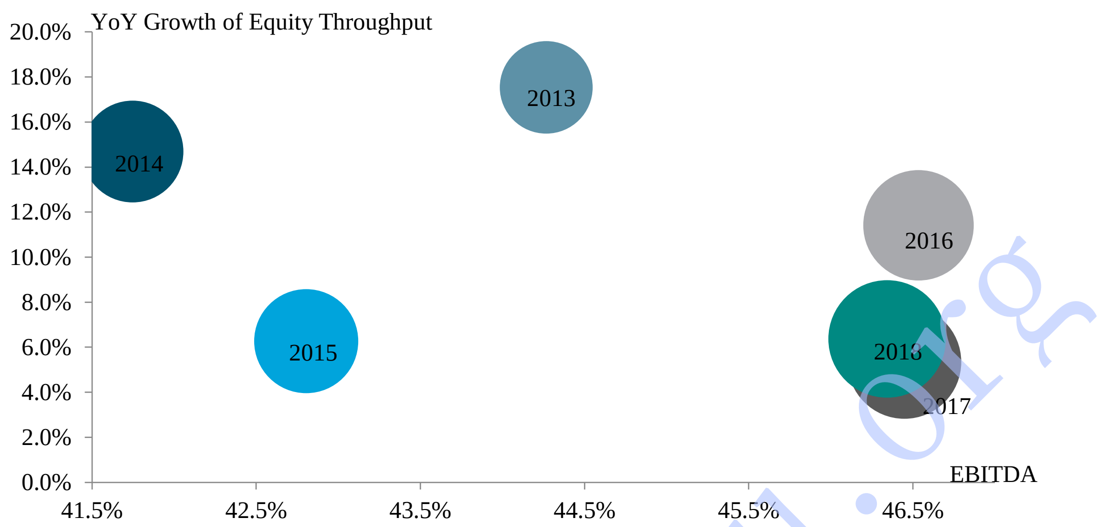
As the largest container terminal group in Europe, Eurogate is committed to building a terminal network that covers portal ports in Europe. Currently, Eurogate has an expanded network covering six countries, including Germany, Portugal, Italy and Belgium, and operates 12 terminals.

Figure 4-26 Port Asset Distribution of Eurogate in 2018

4.9 ICTSI records stable business performance

In 2018, International Container Terminal Services Inc (ICTSI) posted 9.74 million TEUs in container equity throughput, up by 6.37% year-on-year, sustaining positive growth for the ninth consecutive year. The company achieved an EBITDA margin of 46.34%, down slightly from that of the previous year. Overall, ICTSI maintained stable business performance.

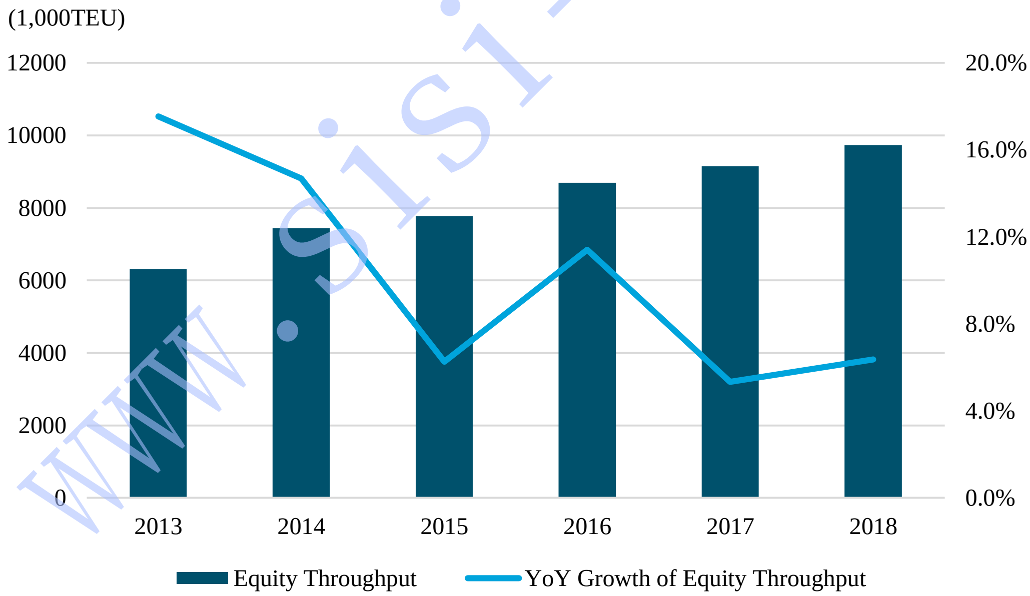
The company's operation figures in recent years show that ICTSI has enjoyed growing equity throughput year by year, with its EBITDA margins staying above 40%. Since 2016 in particular, despite the slower growth in equity throughput, the company has maintained higher than 45% of EBITDA margins, presenting a sound business momentum.



Note: The size of bubble represents the gross throughput.

Source: ICTSI website, sorted by SISI.

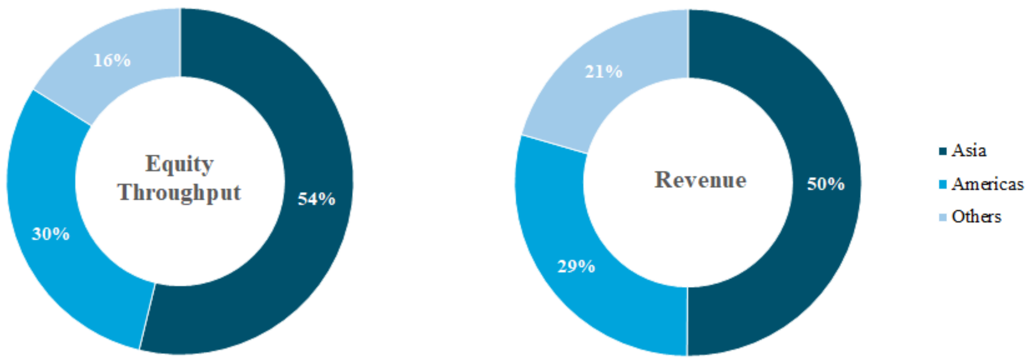
Figure 4-27 Equity Throughput and Operating Margin of ICTSI in 2013-2018



Source: ICTSI website, sorted by SISI.

Figure 4-28 Equity Throughout of ICTSI in 2013-2018

In terms of equity throughput, the Asia region completed an equity throughput of 5.24 million TEUs in 2018, rising by 8.75% year-on-year, being the fastest-growing business region and the biggest throughput contributor of ICTSI. The Americas completed an equity throughput of 2.94 million TEUs, rising by 2.79% year-on-year.



Source: ICTSI website, sorted by SISI.

Figure 4-29 Proportion of Equity Throughput and Revenue in Each Region of ICTSI in 2018

Profit-wise, ICTSI registered an operating revenue of US$1.39 billion in 2018, a rise of 11.36% year-on-year; its EBITDA hit US$642 million, a rise of 11.11%. The company's net profit grew by 20.27% year-on-year to US$250 million, and its gains per container also grew by 4.41% year-on-year to US$142. The stable business performance of the company was primarily a result of the growing revenues of non-container cargoes, warehousing and auxiliary services, the tariff adjustments and the contribution by new terminals.

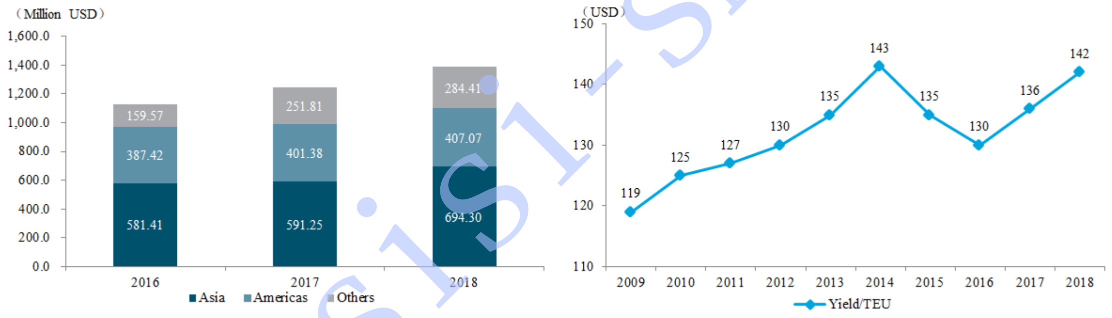


Figure 4-30 Revenue by Region and Earning/TEU of ICTSI in 2006-2018

Compared with other terminal operators, ICTSI positioned itself to focus on development, acquisition, and operation of public container terminals posting an annual throughput of 50,000 TEUs-1.5 million TEUs and a high potential for growth and profit-making. For this reason, ICTSI's operation strategies focus more on **terminal development and investment**.

At present, ICTSI has 20 container terminals around the world, operates and manages five container terminals in the Philippines, and its overseas reach covers Brazil, Poland, Madagascar, Japan, Indonesia, Syria, China, Ecuador, Colombia and Georgia.

Figure 4-31 Port Asset Distribution of ICTSI in 2018

V. Comments on Terminal Investment and Construction in 2018

With the promotion of the "Belt and Road" Initiative, the economies along the "21st Century Maritime Silk Road" have vigorously expanded their container terminals. Construction of dry bulk terminals remained generally stable, although the pace varied among regions. Meanwhile, as global environmental protection policies tightened, there was a boom in LNG terminal construction, as investments by China, the U.S. and other economies in LNG terminal construction rose significantly.

Figure 0-1 Distribution of Major Terminals Construction in 2018

5.1 Construction of Container Terminals

5.1.1 Asia

1. Southeast Asia saw booming investment in terminal construction

With the global manufacturing industry shifting to Southeast Asia and the "Belt and Road" Initiative advancing in depth, the investment in port construction in Southeast Asia keeps rising, and port construction projects keep getting launched one after another, improving production process at ports.

Specifically, the Tuas Port in Singapore progressed in 2018. With the smooth advancement of Phase I, Phase II included the design and construction of a 387-hectare reclamation project and a 9.1-km caisson wall, which will increase the port capacity by 21 million TEUs before the end of 2027. Although the business volume of the Port of Kelang has been declining due to the restructuring of shipping alliances, Port of Kelang will continue to build the No 10 to No 19 container terminals at Westport on Carey Island to further expand the port market. After the expansion, the handling capacity of the Kelang Westport terminals will double to 30 million TEUs. The Port of Tanjung Pelepas, benefiting from the restructuring of shipping alliances, enjoyed a robust rise in container throughput growth. It also strengthened the port infrastructure investment to ensure capacity availability. In February 2018, Port of Tanjung Pallapas upgraded its No. 5 and No. 6 berths and increased the berth draught from the current 16 meters to 18.5 meters through channel dredging to better receive large container ships.

Note: “ ” Under construction; “ ” Proposed construction; “ ” Completed

Figure 0-2 Overview of Container Terminal Construction in Southeast Asia

2. Ports in South Asia and West Asia enjoy steady progress

Various production indicators of ports in South Asia and West Asia keep growing. Although only a limited number of ports in these regions are listed in the top 50 container ports in the world, ports in South Asia and West Asia are preparing themselves by building and expanding ports. Specifically, India and Sri Lanka in South Asia, and the United Arab Emirates in West Asia among others accelerated their port development to improve port traffic ability and cargo collection, distribution and transportation conditions.

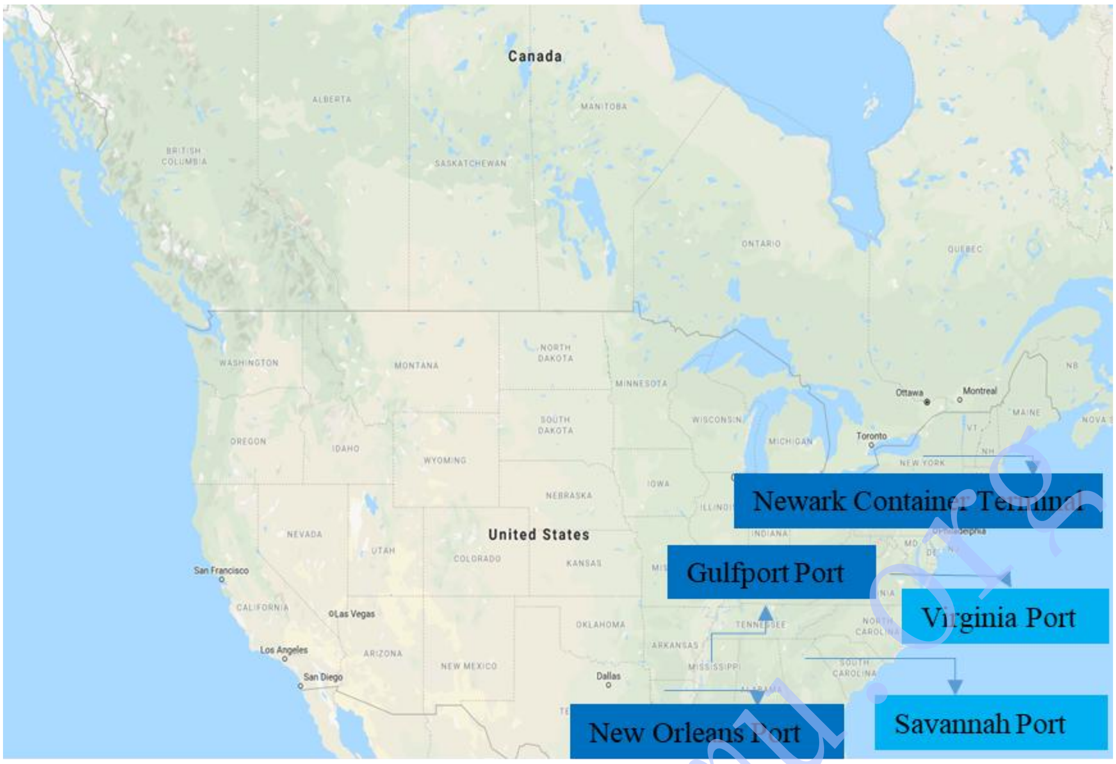
Note: “ ” Under construction; “ ” Proposed construction; “ ” Completed

Figure 0-3 Overview of Container Terminal Construction in South and West Asia

5.1.2 North America

In June 2018, the Panama Canal Authority announced that the maximum ship width allowed to pass was further increased to 51.25 meters. The increase in the navigable width will attract more cost-effective large container ships to North American ports. Therefore, port construction activities in North America were dominated by expansion to meet ship berthing demand brought by the Panama Canal expansion.

Specifically, the Port of Virginia in the United States began to push ahead the dredging project to set the passage to 55 feet deep, and expand the passage in the selected areas to allow two-way traffic of ultra-large container ships. Port Newark commenced the terminal expansion project, including the expansion and improvement of the terminal, construction and upgrading of new gate facilities, as well as deepening and expansion of berths. The expansion project plans to expand the terminal area by 17% to 309 acres and will enable the terminal to handle 2.3 million TEUs in the future. Port of Prince Rupert in western Canada will also launch its next-phase expansion plan, which will expand the port in the middle of 2019 to increase 1.6 million TEUs of handling capacity.



Note: “ ” Under construction; “ ” Proposed construction; “ ” Completed

Figure 0-4 Overview of North American Container Terminal Construction

5.1.3 Europe

At present, European ports face challenges such as handling large container ships and improving operation efficiency at ports. European container ports improve their operation capacity and efficiency primarily though expansion and automated terminal development.

1. Automated terminal development warms up

Development of automated terminals has undergone a process from the Europe Container Terminals (ECT) at Port of Rotterdam in the Netherlands and the CAT at Port of Hamburg in Germany, to the Phase IV of Yangshan Port at Shanghai Port in China, with the automated container terminal technologies increasingly improving and maturing and becoming a development direction for various ports. Specifically, the automated terminal at the Port of Rotterdam has seen rising throughput ever since its operation. In 2018, the cargo throughput of the port reached 469 million t. In addition, the Port of Malmoe in Copenhagen and the Port of Valencia in Spain also started to build automated terminals. With the advancement of automated terminals in Europe, European ports will handle a higher cargo volume in the future, which can also ease the port congestion from strikes and increasing demand for cargo shipping.

Note: "■" Under construction; "■" Proposed construction; "■" Completed

Figure 0-5 European Container Terminal Construction

2. Port expansion gains speed

European ports accelerated their port expansion pace in response to the demand for berthing large ships. Specifically, the expansion of Sweden's Gothenburg Port is progressing, in which the terminal land will increase by 220,000 square meters through marine reclamation. Port of Koper plans to expand its terminals to 98.5 meters long and 34.4 meters wide, enabling the port to handle 1.5 million TEUs a year. The terminal expansion project of the port also includes acquiring new supporting facilities including port facilities and handling vehicles. Overall, European ports will enjoy a large room of expansion boosted by its accessibility to funds.

5.1.4 Africa

Ports in Africa are still in development stage and a large part of the construction demand has yet to be tapped. Meanwhile, China is also actively involved in Africa's infrastructure construction under the "Belt and Road" Initiative, giving fresh impetus to port facilities development in Africa.

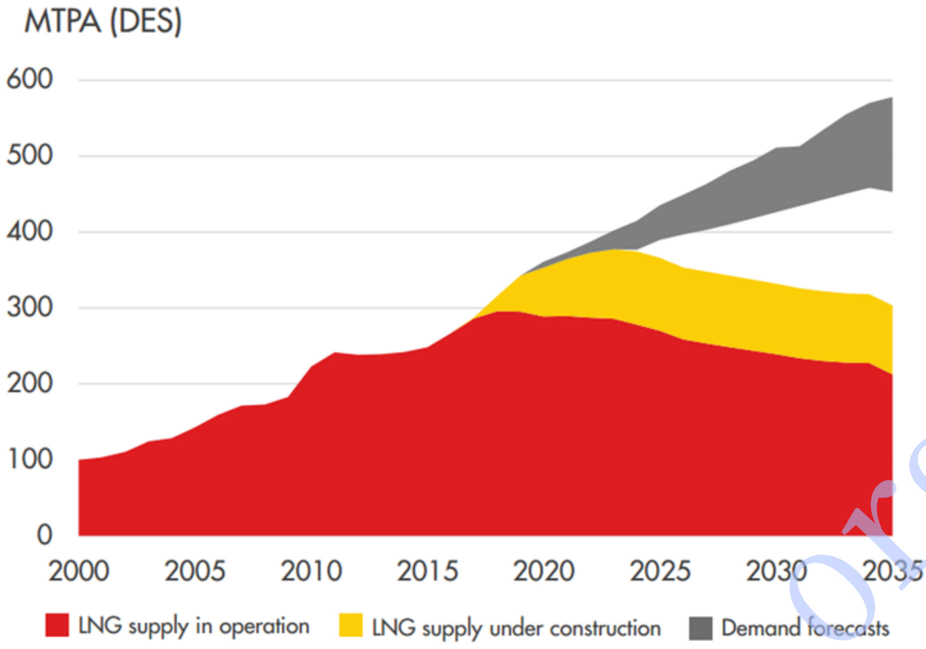
Port terminal construction in Africa advanced steadily in 2018. To boost the ocean economy through port investment, the government of South Africa plans to spend ZAR 2 billion updating existing facilities within the next five years, and another ZAR 13 billion to ZAR 15 billion building new terminal facilities. Meanwhile, the AP Moller-Maersk invested several billion US dollars in terminals in West Africa, and developed a multi-purpose port that cost US$1.5 billion with its partners. African ports are booming under the dual drives of local governments and terminal operators.

Note: “ ” Under construction; “ ” Proposed construction; “ ” Completed

Figure 0-6 Overview of the Construction of African Container Terminals

5.2 Construction of LNG Terminals

The new regulations on sulfur emissions in 2020 by the International Maritime Organization (IMO) will be enforced soon. In February 2018, IMO again made it clear that starting from January 1, 2020, all ship fuels should meet relevant regulations on sulfur content of no higher than 0.5%. The Asia-Pacific economies have taken active measures in response to the sulfur limit, and the construction of LNG terminals has entered a fast track.



Source: Royal Dutch /Shell Group of Companies

Figure 0-7 Global LNG Supply and Demand Forecast

5.2.1 LNG terminal construction in China rises

China's LNG imports skyrocketed in 2017 driven by the domestic demand, making China the world's largest LNG importer in place of South Korea. In 2018, China maintained its LNG imports surge. China's LNG terminal construction continued the momentum from 2017 and recorded high growth to meet China's strong demand for LNG. Major LNG receiving stations will conclude construction and enter operation in the near future, which will boost the production capacity to a large extent.

As per the Key Plan for LNG Terminal Distribution in the Bohai Rim Region issued by the Ministry of Transport of China in 2018, 16 LNG terminal berths will be built in five major ports around the Bohai Sea in China. Specifically, Dalian Port has already built one berth in the Nianyuwan Port Area, and one berth is in the planning stage. Caofeidian Port Area of Tangshan Port has completed one berth and three are planned. Dagang Port Area of Tianjin Port has built one berth and two are planned. Dongjiakou Port Area of Qingdao Port has built one berth and one is planned. The West Port Area of Yantai Port has two berths planned, and the Longkou Port Area of Yantai Port has two berths planned. Besides the Bohai Rim area, LNG construction projects led by energy companies such as China National Petroleum Corporation and China National Offshore Oil Corporation can also be found in ports such as Zhangzhou in Fujian, Ningbo in Zhejiang, Dachan Bay in Shenzhen, Rudong in Jiangsu and Qidong in Jiangsu, and are expected to be put into operation between 2020 and 2022. According to the current progress and plans, it is expected that China's LNG receiving capacity may reach 82.7 million tons per year by the end of 2020, and the utilization rate could rise to 97% to make up the gap between China's natural gas supply and demand.

5.2.2 U.S. expected to become LNG export center

North America is home to a large amount of low-priced natural gas reserves, making the area well positioned to develop LNG refueling business. With the Sulfur Limit Order approaching in 2020, LNG has been gaining increasing attention as a ship fuel, and the U.S. investment in LNG refueling facilities has also increased significantly. Specifically, the Port of Jacksonville, the Port of Fourchon and the Port of Tacoma have all started to build LNG terminals. Cove Point on the East Coast of the United States was completed and put into production in April 2018. At present, LNG exports at the terminal have become a normal part of the operation, signaling that the United States is turning into a major exporter of global LNG at a faster speed and will challenge Australia and Qatar's global LNG export dominance in the next five years. In addition, the United States will build three new LNG terminals along the coast of the Gulf of Mexico to further enhance the its LNG export capacity.

5.2.3 FLNG embraces a construction boom

FLNG, or Floating Liquid Natural Gas, is an offshore floating production platform integrating natural gas exploitation, LNG storage and handling. The world's second and third FLNG production facilities were put to use in 2018. In addition, there are four FLNG production projects at design and development, preliminary preparation and other stages in the world. Despite the exuberant demand for FLNG construction, such projects usually cost high and require multiple rounds of negotiations and financing between the energy providers and FLNG constructors, creating big uncertainties in future FLNG development.

5.3 Construction of Coal Terminals

The global coal terminal construction remained stable overall in 2018, though the pace varied among regions. Coal terminals in Australia were in oversupply, freezing the investment in construction. China's coal terminals presented variations between the south and the north. India's coal ports were in a construction boom, and multiple ports were in expansion to support the rapid growth. Coal terminals in Africa were under steady progress.

Figure 0-8 Global Bulk Cargo Terminal Distribution

5.3.1. Construction of coal terminals in China differs between the south and the north

The shipping pattern of departure ports of coal in northern China may undergo a dramatic change. There is an increasing expectation for the functional transformation of Qinhuangdao Port which may exit the coal shipping market within 20 years. The majority of thermal coal shipping volume in the Bohai Rim ports will be further transferred to ports such as Caofeidian Port. At present, Phase III of coal terminal of Caofeidian Port in China has entered trial operation, and Phase IV of Shenhua Coal Terminal of Huanghua Port and Phase II of Shenhua Coal Terminal of Tianjin Port have been approved and will begin construction. Due to the reduced demand from coal-fired power plants, the construction of coastal coal-unloading ports has declined. The Tsuen Wan Coal Terminal in Huizhou was put into operation and completed the cargo-evacuating railway construction. The alteration work of berths No. 1 to No. 3 of Fuzhou Port was also officially approved by the Ministry of Transport of China, with plans to build two 300,000-ton large-scale bulk cargo terminals to adapt to the major bulks shipping demand for coal and ores in Fujian and surrounding areas and the ship upsizing trend, so as to effectively promote the construction and improvement of the cargo collection, distribution and transportation system at ports.

5.3.2. Construction investment of bulk terminals in Australia stalls

Coal export is an important source of income for Australia, so the Australian government has always given high priority to building coal terminals to export coal resources. However, as the coal demand growth levels off, coal terminals in Australia face oversupply, leaving a large number of new coal terminals and expansion projects in abeyance, and some terminals in operation under utilized. Since

2012, Abbot Point T2 and Dudgeon Point coal terminals have been canceled, and Abbot Point T1 is operating at less than 50% capacity, a serious financial crisis for the terminal.

5.3.3 Expansion of coal terminals in India speeds up

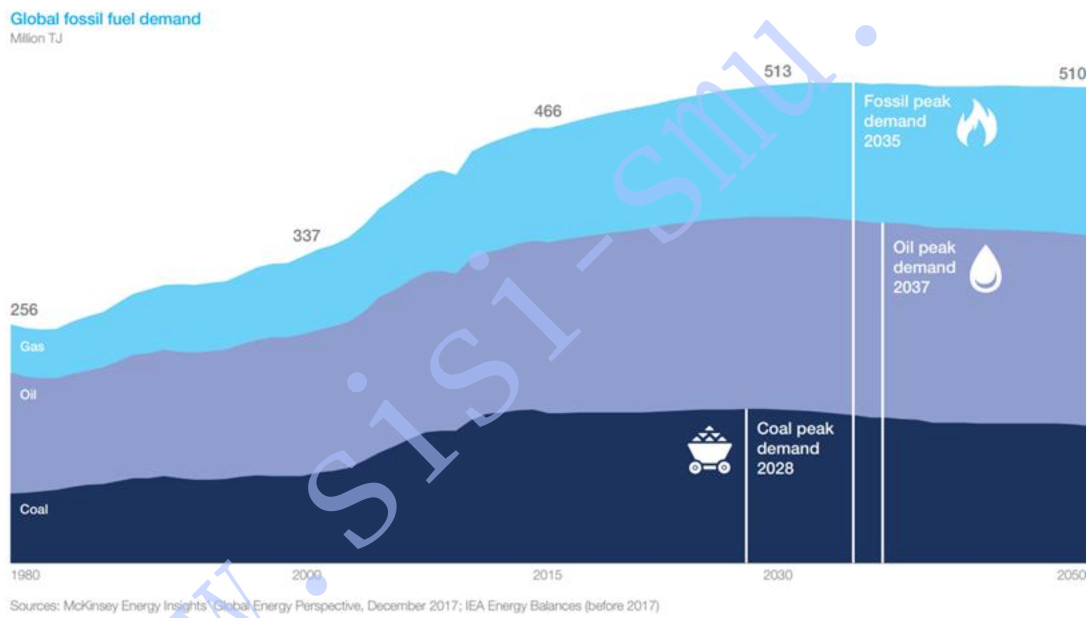
Although the Indian government is making louder calls for developing renewable energy sources, the rapid rise in power demand sustained coal-fired power's status as the best option in the short run. The short supply of coal spurred imports, creating a huge pressure on the coal supply chain. Multiple ports in India are planning expansion. The Port of Paradip plans to build two new coal terminals to elevate the port's coal throughput capacity by 40 million tons by 2020. The Port of Ennore is in a large-scale expansion, including building two new coal terminals and rebuilding one iron ore terminal. It is expected that the port will have its throughput increased by 24 million tons by 2020. The Dhamra Port and Tuticorin Port on India's east coast and the Port of Mangalore on its west coast are near completion and will enter operation in the near future.

5.3.4 Port terminal development in Africa advances steadily

South Africa is an important coal exporter in the world. Its government places high attention to its coal port development. As the Richards Bay coal terminal completed its equipment updating, and the coal terminals at Port of Ngqura and Port of Beira readied for operation in 2020, coal terminals in South Africa will basically meet the shipping demand. Meanwhile, with the coal demand growing in Africa, South Africa government projected that coal exports in the future will stay stable overall with no large-scale coal terminal construction planned in the short term.

Special Topic III: Coal Terminals Begin to Transform and Upgrade

Since the industrial revolution, coal has been widely used in transportation, thermal power generation and coal chemical industries. It once experienced explosive growth caused by the boom in industrial construction in Europe, the United States and China, and plays a very important role in social development. Due to the uneven distribution of coal production and demand, trade and transportation needs of coal naturally emerge. This also promoted the construction and development of coal terminals. Coal terminals are important links in the global coal transportation network. The highly professional equipment at coal terminals, though greatly enhancing the efficiency, has revealed their vulnerability in market changes. With the overall slowdown in coal demand growth, coal terminals in various regions will be impacted to varied degrees. How to grasp the market changes and actively respond by transformation and upgrading has become a concern for coal terminal operators.



Sources: McKinsey EnergyInsight. Global Energy Perspective 2018

Figure 1 Global Fossil Fuel Demand Forecast (2050)

I. Coal market steps into a slow and structurally declining stage

Coal is the world's most abundant fossil energy source and one of the most important basic energy sources in the world. Its status is difficult to replace in a short time. However, as a carbon-intensive energy source, coal has been the core of energy and climate policy debates for its use. The widespread use of coal generates greenhouse gases such as dust and carbon dioxide and has seriously polluted the environment, being an important cause of the global climate change. Therefore, the coal market is vulnerable to turmoil caused by environmental protection policies in various countries. In particular, the policy orientation in China and India will determine the trends of the coal market.

According to the *Coal 2018 - Analysis and Forecasts to 2023* report released by the International Energy Agency (IEA), global coal demand will grow again in 2018 as global economic growth increases industrial output and power consumption. Two consecutive years of positive growth is envisaged, but the strong growth in India and Southeast Asia may be offset by the declines in Europe and North America, so global coal demand is expected to remain stable over the next five years. Meanwhile, in view of the de-capacity of coal campaigns in the global power industry and the ultra-expected development of new energy technologies and policies, growth stagnation of overall coal demand is visible, the future coal demand may decline to some extent, and the proportion of coal in the energy structure may keep shrinking.

II. Distribution and supply-demand features of coal terminals

Coal is usually traded and transported on a global scale due to the imbalanced distribution of coal resources and different energy needs for construction and development among countries. Such a transport demand is primarily met by marine shipping, and features high directionality and concentration. As an important part in the global coal transporting network, coal handling terminals are primarily located in China, Australia, India, South Africa, Indonesia and other major coal import and export areas, reflecting the coal transport features. According to coal trade flows and handling equipment, coal terminals can be divided into coal exporting terminals and coal handling terminals.

Table 1 Distribution of World's Major Coal Exporting Ports/Terminals

Region/Country	Major Port/Terminal
Australia	Newcastle, Hay Point, Gladstone
Indonesia	Tanjung Bara Coal Terminal, Balikpapan Coal Terminal, Tarahan Coal Port
North of China	Qinhuangdao, Tangshan, Tianjin, Huanghua port
South of Africa	South Africa: Richards Bay Coal Terminal, Port of East London Mozambique: Nacala port, Beira port
Colombia	Puerto Drummond coal port, Puerto Bolivar coal export terminal
The United States	Norfolk, Baltimore, New Orleans

Table 2 Distribution of World's Major Coal Importing Ports/Terminals

Region/Country	Major Port/Terminal
Europe	Rotterdam, Antwerp, Hamburg
China	Fangcheng, Guangzhou, Xiamen, Ningbo - Zhoushan, Zhangjiagang, Rizhao, Jingtang
India	Mundra Port, Krishnapatnam Port, Kandla port, Paradip Port
Japan	Onahama Port, Port of UBE and Tokuyama-Kudamatsu
South Korea	KwangYang, Pohang, Inchon

Coal exporting terminals are primarily concentrated in Australia, southern Africa, North China, Indonesia, Columbia and other areas with abundant coal resources. The concentration of coal resources and the economies of scale of export shipments, coal exporting terminals are concentrated and usually large in size.

Coal handling terminals echo coal demands, and are smaller and extensively distributed around the world such as Europe, China, India, Japan, South Korea and other areas with active demand. With the continued de-capacity of coal in the global coal-fired power industry, coal handling terminals in areas such as Western Europe have gradually faded away.

VI. Comments on Port Technology and Information in 2018

The port technology and information development in 2018 was characterized by automation, digitization, electrification and platformization, pushing the transformation and upgrading of production and operation of port and shipping enterprises. The world today is in a period of transition from the industrial economy to the digital economy. Technology and information have become the new elements and new engines driving economic and social development. Transboundary development and integration are becoming the new normal of various industries. With the accelerated changes in technological innovation, customer demand and external environments, digital technologies and the real economy in the port field will become more and more closely tied. The transboundary port and shipping landscape with port enterprises developing full-chain logistic services and shipping enterprises expanding financial reaches against the trend will drive fundamental changes in the production and operation activities of the port and shipping sector.

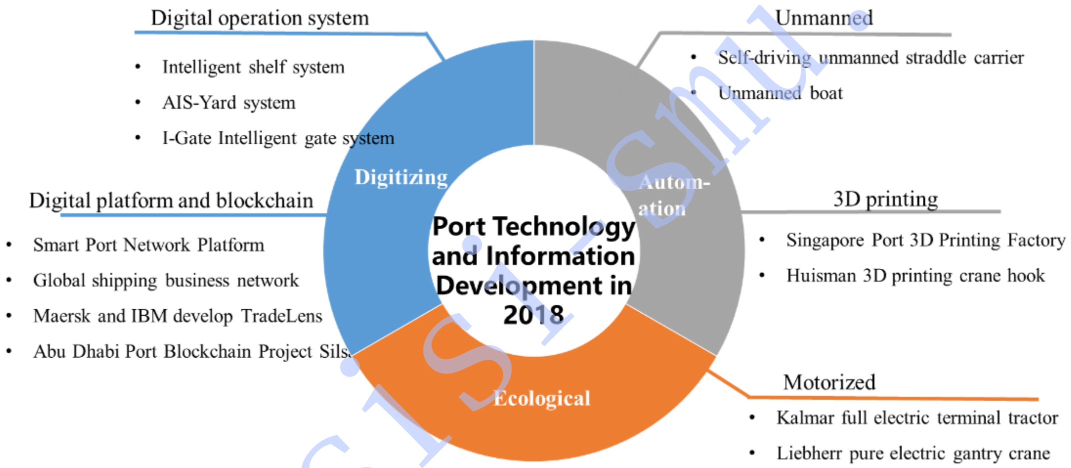
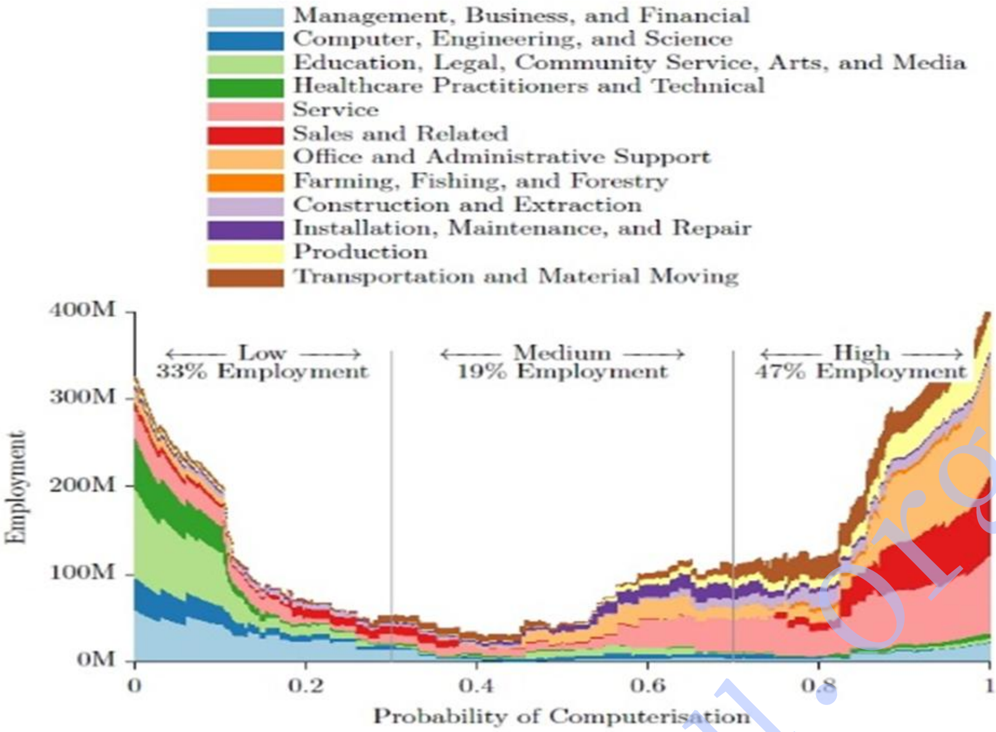


Figure 6-1 Port Technology and Information Development in 2018

6.1 Digitalization and Automation of Port Production

Currently the science and technology advancement has laid a foundation for port digitalization and automation, and is changing all aspects of human production and life. During the transformation of port production toward digitalization and automation, the strategic focus of ports has shifted from controlling resources to carefully managing resources, from optimizing internal processes to digitizing production management systems and unmanned operations of port machinery. Port and shipping enterprises have embarked a new era of port and shipping production modes through digital and automation technologies.



Source: American Labor Organization, McKinsey.

Figure 6-2 Possibility of Digitizing Employment in the Transportation and Warehousing Industry

6.1.1 Digitalization of port production

The digital and intelligent transformation of port production and operation systems can streamline the production and operation processes and achieve electronic, paperless and networked port and logistic services and automated mechanical operations. With the constant evolution of new technologies such as artificial intelligence, ports will provide convenient and refined services featuring multi-layer coverage and diversity with data resources as the core, to enable unified and efficient utilization of port resources in a more cost-effective manner. This enables the establishment of more reliable and complete infrastructure and operational networks to offer integrated intelligent transportation services that are efficient and agile.

Due to the scarcity and non-renewable nature of port resources, port enterprises will pay more attention to the output capacity of unit land area. However, port land has been used in an extensive manner for a long time, and terminal depots have been expanded without limit. The throughput per 100 meters of shoreline fails to rise significantly with the advancement of port technologies. With limited space resources, how to use information technologies to achieve intensive operations at ports is of great importance for port enterprises to achieve effective use of resources. In 2018, port storage exhibited a space-for-area trend. The port storage system shifted from the primitive planar storage to multi-dimensional storage. Port storage operations also became highly automated and unattended empowered by information technologies.

Amid the increasing scarcity of port resources, port storage, apart from transforming from planar to multi-dimensional storage, also witnessed optimizing transfer links in storage and logistics, easing the cargo storage duration pressure on ports. For example, the one-stop logistics service center launched by Singapore's transportation management service logistics provider, GoSun Holdings, not only enables stacking of 15 containers through a unique design of rooftop container transfer station, but also integrates the rear warehouse of the port with the transfer station. This helps shorten the transportation cycle and waiting time of containers, and facilitates seamless collaborative operations of the rear logistic operations.

Figure 6-3 High-density Racking System

6.1.2 Automation of port machinery

With the development of emerging technologies such as big data, cloud computing, virtual reality and artificial intelligence, unmanned vehicles, unmanned ships, and drones have gradually gained attention. Compared with traditional equipment, unmanned transporting equipment can conduct autonomous navigation through precise and fast information systems, and make emergency responses given sufficient intelligence to fundamentally reduce the impact of human factors on transportation safety. This can reduce the labor intensity of workers and cut down the operating costs of enterprises.

The most important impact from automation is the change in job content. Unmanned transporting equipment needs to realize remote real-time data transmission and transporting equipment transformation and replacement, but the high networking and equipment costs are hard to bear for port enterprises. All-round unmanned operations of ports still face the question of cost. It is crucial for port enterprises to well coordinate the relationship between personnel and machines. According to the World Economic Forum and the Accenture analysis report, the unemployment caused by smart technologies will be less than the projected figures by many studies. In the shipping field, 16% of jobs may be replaced by AI. But at the same time, the wave of AI technologies will also produce more job opportunities. Therefore, even if the port automation process continues, the labor demand in certain links of the value chain and in certain regions will continue to rise.

6.2 Information Interconnectivity on Port Supply Chains

With the rapid business growth and improvements in infrastructure for smart ports, the transformation and upgrading of ports should start from management and business process collaboration as well as data integration. With digitalized platforms as the center, business nodes involved in port businesses, such as customs, maritime affairs, shipping enterprises, and financial service departments, should be integrated to achieve information connectivity of the port supply chain. In this way, various market players can enjoy full information communications and sharing and fully utilize their own data to discover new business modes and offer better logistic services for customers.

For port enterprises both at home and abroad, advanced port handling equipment is not a hard nut to crack any more. How to combine the advanced front-end port operation systems with the back-end flows of people, capital and logistics is a prevailing problem. Port and shipping enterprises are asset-intensive and information-intensive. How to mine effective information from existing data and make data visualized and chain-based are of great significance to the operational decision-making of port and shipping enterprises.

6.2.1 Digitalization of information platforms

Ports connect up the world geographically, and connect up the basic industries, the manufacturing sector, and commercial networks. To facilitate transformation and upgrading, ports have established or updated their logistics service information platforms through information technologies and kept expanding their logistics functions. The platform services are rapidly moving toward integration, diversification and digitization.

At present, the establishment of port information platforms is mostly about regional logistic data exchanges centered around "logistics information and interconnected information system". Main undertakers of the establishment include port enterprises and third-party platforms.

Table 6-1 Information Platforms of Major Ports

Port	Platform and Major Functions
Port of Rotterdam	Portbase: primarily used for information notification and declaration of ship arrivals, cargoes for import and export, and hinterland transportation.
Port of Hamburg	SmartPort: primarily used for information notification and declaration of ship berthing and operations, and multimodal transport information that covers waterway shipping, land transport, air transport, railway transport and terminal processing.
Port of Singapore	PortNet: primarily for ordering port services, collecting ship information, offering real-time data on port and logistic services and cargo deliveries.
Yangshan Port in Shanghai	Comprehensive information service network (yangshanterminal.com): primarily for real-time inquiries of port information, production information, port services and company-related applications.

Ningbo-Zhoushan Port	Eporthub.com: primarily offering single windows, EDI, logistics transactions, public information inquiries, cargo and ship insurance services, etc.
Dalian Port	LineMate: primarily for matching the supply-demand information of cargo owners, ships and freight forwarders and offering real-time inquiries of ship, cargo and port information.
Yantian Port in Shenzhen	Yesinfo.com.cn: primarily offering inquiries of ship, port and other public information, customs clearance services and customs declaration value-added services

From the overall developments of information platforms of port and shipping enterprises, it can be found that in the current stage, digital platforms of ports are still either internal platforms or public service platforms. In the future, with the enhancement of third- and fourth-party cloud computing solutions in combination with data services, the port industry may further integrate the market fragments in the port and shipping industry to better obtain information in the port and shipping industry chain, thereby facilitating establishment of platforms to enhance the digital level of the port and shipping enterprises on the whole.

6.2.2 Ongoing debates on blockchain hosts

Port, as a key node on the global trade chain, requires multiple parties to file paper documents, such as bills of lading and customs clearance papers. Blockchain has emerged as a technology that shows promise in creating new opportunities for the port and shipping industry. The application of blockchain in the shipping industry is twofold: one, to use cryptocurrency of the blockchain to evade regulation so as to transact with countries or regions under trade or financial sanctions and restrictions, such as the 300cubits booking deposit module, and payments in cryptocurrency for shipping deals with Russia, Ukraine, and Venezuela; two, to utilize blockchain to facilitate trade and product tracing, such as Maersk's Tradelens and Abu Dhabi Port's Silsal.

In view of heated trials with blockchain application among port and shipping enterprises, there are quite a few issues to be addressed, as port and shipping is a conventional industry involving multiple stakeholders.

First, debates on blockchain hosts. Blockchain is built around "trust", as the technology seeks to build an eco-system trusted by all participants. It is a platform that alleviates the reliance on a single, centralized authority, and yet builds a trusted environment through consensus reached by all participants. It is the core value of the technology, but is also holding back its wider application. Blockchain in the port and shipping industry is typically initiated and hosted by one company, such as Maersk, COSCO Shipping, or a leading global terminal operator. It is therefore hard to for the blockchain to maintain neutrality and accept the company's rivals. Take TradeLens for example. As Maersk and IBM hold its 100% intellectual property, Maersk's rivals such as Hapag-Lloyd and CMA-CGM refused to join the platform. So it is hard to realize full coverage of all participants along the supply chain by the platform. On the part of blockchain host, it needs integration and approval of all relevant parties in the logistics process. It is only feasible to realize practical application of the blockchain technology when shipping giants (such as Maersk, COSCO Shipping, CMA-CGM, PIL, and Hapag-Lloyd) and global key operators no longer have absolute control over a blockchain, the smaller firms and operators can join the chain on an equal and independent footing, and the industry can make collective decisions over industrial solutions.

Second, blockchain application tends to be on a case-by-case basis rather than a complete chain. Each transaction in the port and shipping industry contains a large amount of information and involves multiple parties. Each party, located in a certain position on the chain, has its own data exchange format and standards, causing problems such as complex data formats and information leakage. Application of blockchain requires recording of complete transaction data, which might contain redundant data and amplify information system costs on relevant parties. In practical operation, blockchain organizations are yet to establish widely accepted industrial standards and technical protocols. For this reason, the current application of blockchain is dispersed and restricted. As cross-border trade is subject to regulation of relevant jurisdictions, current application of blockchain is limited to tracing ships or containers by a few shipping enterprises. Tracing of end-to-end process, including product purchase, processing, inventory, sales, and delivery, are undergoing trials. As blockchain is penetrating all types of businesses, We need collective contribution from companies and firms to realize data circulation along a complete blockchain, and the establishment of universal information standards, in order to promote interconnectivity of information throughout the port and shipping industry.

6.3 Port Reactions to Unmanned Ships

As the shipping industry is currently undergoing restructuring and de-capacity, there is a strong demand among shipowners for "smart, green, safe, and efficient" ships. Unmanned ships, when meeting the market's increasing desire for lower costs, will lead the overall industrial upgrading on infrastructure, management, and collaboration. The future of shipping is in unmanned ships, which will be a game changer in ship design and operation.

6.3.1 Application of unmanned ships faces challenges

Unmanned ships have clear advantages over conventional ships. Compared to conventional ones, unmanned ships are free from reliance on crew members, and capable of conducting shipping tasks independently, which helps lower staffing costs and maritime accidents arising from manual oversights and mistakes. As they are powered by electricity, unmanned ships have lower fuel costs, and therefore are greener. Moreover, unmanned ships have much higher deadweight carriage capacity, because all crew-related space and facilities in conventional ships, such as deck room, accommodation room, ventilation equipment, and heating equipment, can be converted to carry cargoes in unmanned ships.

However, considering restraints of cost-effectiveness, information transmission security, powering system stability, and incomplete maritime regulations, it will take more time for unmanned ships to realize large-scale application, to accommodate existing conventional ships, and eventually to replace them. From the perspective of cost-effectiveness, unmanned ships, on the one hand, save costs on crew-related facilities, but on the other hand, require higher initial and operation costs. For example, unmanned ships have higher requirements on reliability and security of propulsion system, which in turn impose higher initial costs; they also require new port shores, which is human-intensive and capital-intensive. On key technologies, unmanned ships are challenged on powering system and emergency system. For example, how to provide effective and sustained power under an emergency mode remains a technical challenge. Regarding laws and regulations, the authorization of right of navigation and right of way for unmanned ships remains unclear. The developers and lawmakers should determine how unmanned ships can meet requirements under International Regulations for Preventing Collisions at Sea (COLREG), and how they can auto-recognize other ships and avoid collisions.

6.3.2 Unmanned ships could be a game changer

Looking back on technical advances in recent years, largely driven by industrial development and national policies, it's clear that artificial intelligence has been at the center of a new round of technical reform. It is only a matter of time for unmanned ships to be used widely by shipping companies. Driven by this potential game changer, the existing shipping mode, maritime laws and regulations, operational management, rules and standards, and port business will all be overhauled.

On the shipping mode, unmanned ships will fuel the growth of emerging shipping business, such as ship-shore integrated communication, cargo regulation control, online freight services, while data collected on remote and automatic operations will create new market and business opportunities. Unmanned ships are remotely controlled and operated via information transmission, so risk control focus has shifted to cybersecurity. In the meantime, technological advancement on unmanned ships will accelerate port and maritime information clustering, such as highly integrated logistics information, smart maritime regulation, and smart route information.

On the laws and regulations, the ongoing trend of unmanned ships will give impetus to maritime laws and regulations amendments, including requirements on structure, life-saving facilities, fire-fighting crew, signaling and reporting to police under the International Convention for the Safety of Life at Sea (SOLAS); requirements on lookout sailing decision-making, light signal interactions, and certain rules involving crew members under the COLREG; and crew definition and requirements, safe manning requirements under the Minimum Safe Manning Requirements.

On the operational management, higher requirements on reliability of shipping system onboard unmanned ships should be met, as there will be no crew members to be held accountable. A facility soundness management system should be established as well. Considering the high integration of systems onboard and their interconnectivity and synergization with shore-based networks, the regulation approach on unmanned ships by flag states, port states, customs, and border defense authorities will utilize automatic information collection and transform to remote enforcement from the current approach by boarding the ships.

On the standardization, in line with features of unmanned ships, standards on technicality, safety, management, inspection and appraisal, are not yet established. These include, for example, safe sailing standards and environment protection standards for unmanned ships, and safety prevention and control standards of information systems onboard.

On the part of ports, corresponding infrastructures for unmanned shipping should be added to ports and routes, along with changes to management mechanisms. For example, ports can grant onshore operators Pilotage Exemption Certificates (PECs), or enable information exchange and match among the port systems and onshore operators to realize automatic berthing of unmanned ships. As the unmanned shipping technology develops, we should lift restrictions on port and route operations and pilotage, and enhance the port information platforms. Ports may try to develop self-owned unmanned ships which are safer, faster, and more cost-effective, and add them to their regional port fleets (such as tugboats, pilot boats and ferryboats), as part of the solution for better predictability and controls over ship activities and reliable port response.

VII. Comments on Green Port Development in 2018

7.1 Green Port Development Mode and Concept

According to the MEPC286 (71) Resolution by the IMO's Marine Environment Protection Committee, from January 1st, 2020, ships should use ship fuel with no more than 0.5% sulfur content when voyaging in emission control areas (ECAs) (already implemented), and use ship fuel of no more than 0.1% sulfur content when voyaging outside of the ECAs.

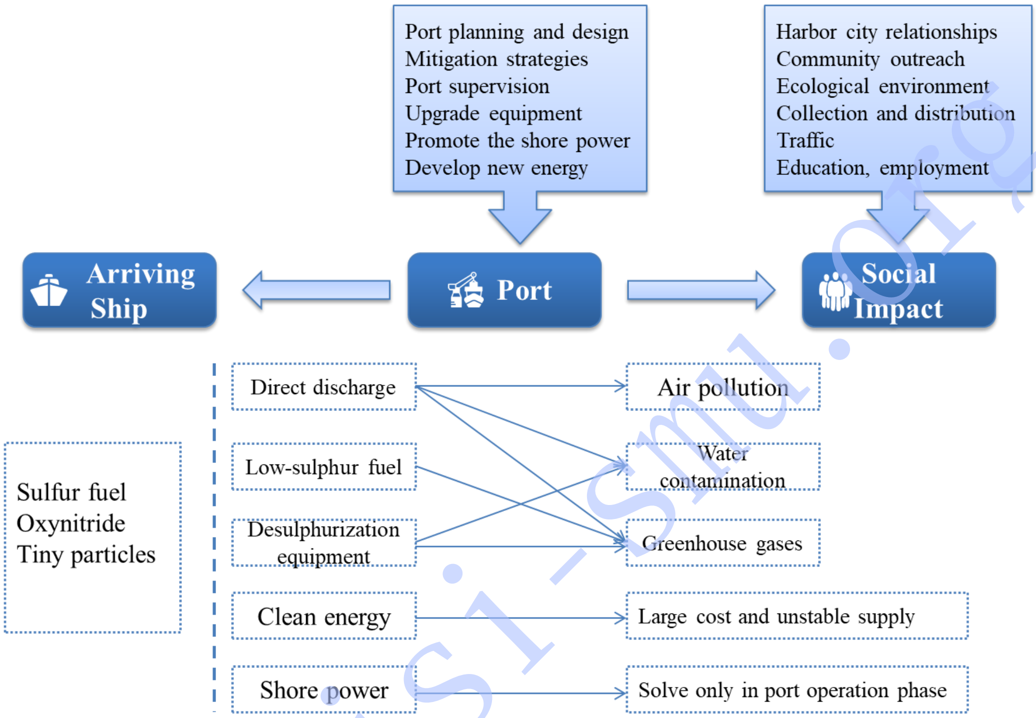


Figure 7-1 Ports, Ships, Regional Emission Reduction Systems

Ports themselves generate intermediary demands for green development, including equipment upgrading, such as "oil-to-gas" and "oil-to-electricity" renovation, emission reduction controls, and production process optimization to reduce energy consumption in production. However, for ports, green development goals should not be restricted to fuel oil sulfur content reduction. The UN Katowice Climate Change Conference, closed in December 2018, finalized the implementation procedures of Paris Agreement, and reiterated the global commitment to keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels; IMO's MEPC 72, also held in 2018, clarified an "initial IMO strategy" on port and shipping industry emission reduction, and an emission reduction target to reduce CO2 emissions per transport work by at least 40% by 2030 compared to 2008. Diesel particles, nitrogen oxides and other pollutants were covered as well. In response, Port of Los Angeles and Port of Long Beach further amended Clean Air Action Plan (CAAP) and upgraded control strategy on pollutant sources.

The industry downstream has some sectors radiated by ports. Protective and optimizing measures on port operation and urban environment include adopting better cargo collection, distribution and transportation systems to endorse water-water transfer and sea-railway intermodal transport at lower energy consumption needs, using peak-load shifting to release transport pressure on urban road systems, utilizing the Internet of Things to optimize road transport route efficiency, providing subsidy for high-polluting truck upgrading, integrating intensive production in port areas to make room for tourism development, and restoring port ecology through plantation and fish restock. Among the measures taken, the most noticeable is that in 2018, the BMVI, the German transport authority, launched a subsidy for environment-friendly trucks powered by cells or fuel cells, in order to promote emission reduction in German ports. Port of Los Angeles and Port of Long Beach planned to implement a freight rate on regular trucks and waive the PDTR registration fee of environment-friendly ones, as part of effort to realize the target of zero emission by container trucks by 2035. New Zealand's Port of Auckland also launched a project on the first hydrogen production and injection facility to accommodate increasing popularity of hydrogen fuel-cell vehicles, in order to realize zero emission by container trucks by 2040.

7.2 Ship Emission Reduction Needs Green Ports

Ships, as the largest user group of sulfur-containing fuel oil in the shipping industry, have been high on the agenda in global campaign of emission reduction. As a shipping and trade power, China saw its ships emit 853,000 tons of carbon dioxide and 1.346 million tons [2]of nitrogen oxide in 2017. Taking two key port cities as example, Shanghai and Hong Kong, carbon dioxide emission and nitrogen oxide emission by ships accounted for 25.7% and 29.4% against total local emissions for Shanghai, and 49% and 37% for Hong Kong. In the case of Hong Kong, ships emitted 38% and 44% [3]of local emissions of PM 10 and PM 2.5, respectively. From statistics, we can see the importance in ship emission reduction. Governments should place restrictions on ship emissions in order to promote maritime trade and protect the environment. A prioritized task for greener port is to reduce ship emission of carbon, sulfur, and particulate matter.

7.2.1 Requirements on ship emission reduction by global ports

The global ECAs have implemented increasingly strict requirements on how much sulfur can be contained in ship-use fuel oil. The IMO requires that from 2020, ships voyaging in the four ECAs should use ship fuel with no more than 0.1% sulfur content, and ship fuel with no more than 0.5% when voyaging outside the four ECAs. These standards are way lower than the current average level of 2.58% sulfur content in fuel oil. The latest version of Paris Agreement has proposed requirements on ship emission of nitrogen oxide and carbon dioxide.

Source: American Bureau of Shipping

Figure 7-2 Examples of Regional and Local Scrubber Related Regulations

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[2] Data source: Ministry of Ecology and Environment of China, Annual Report on Motor Vehicles Environment Management 2018.

[3] Shanghai data is proportionality value of 2015 statistics, and Hong Kong data is proportionality value of 2016 statistics.

After the Chinese government implemented the *Implementing Schemes for ECA in Pearl River Delta, Yangtze River Delta and Bohai Rim (Beijing, Tianjin, Hebei)*, progress has been achieved on sulfur oxide emission by ships visiting the Chinese ports. The Yantian Port in the Pearl River Delta managed to reduce sulfur oxide concentration by 38% year-on-year before implementation, while the Tangshan Port in Bohai Rim reduced it by 56% year-on-year. At the end of 2018, the Chinese government upgraded the implementation plan to *Implementation Plan on Controlling Ship Emission in Emission Control Areas*, and expanded the self-defined ECAs to incorporate main coastal and inland river regions, in addition to Pearl River Delta, Yangtze River Delta, and Bohai Rim. It is required that ships entering the ECAs should use fuel oil with sulfur content of no more than 0.5% from 2019, and fuel oil with sulfur content of no more than 0.1% from 2025. Requirements have been placed on nitrogen oxide emission by engines and shore power facilities.

As the IMO sulfur restrictions will take effect in 2020, shipping companies can choose to use low-sulfur fuel oil on the effective date, which does not require any changes to their ships. However, as the requirements on nitrogen oxide emission will also be implemented, replacing fuel oil will not be enough (China requires that ships on global routes built after 2011 must meet IMO Tier II requirements on nitrogen oxide emission, and those built after 2022 must meet IMO Tier II requirements. Two IMO ECAs, namely Baltic Sea ECA and North Sea ECA, require that ships built after 2021 must meet IMO Tier III requirements).

Typically, ships can install Selective Catalytic Reduction (SCR) systems onboard, which can reduce nitrogen oxide emission by up to 90%. But each system costs more than 1 million yuan. Installing an Exhaust Gas Recycling (EGR) system and using clean energy (such as LNG) can only cut emission by 20% to 80%. New technologies aimed at reducing nitrogen oxide emission by ships, such as the intake humidification technology, the oil-water emulsification technology, and the direct water spraying technology, have emerged. But it will take time before any of them can be commercialized. The regulatory controls on NOx emission have brought greater challenges for shipping enterprises.

7.2.2 Global ship emission reduction solutions

The current ship emission reduction solutions implemented include phasing out outdated ships, improving ship energy efficiency design, using clean energy, applying engine post-processing technologies, and using shore power at berth. Among these measures, using clean energy such as LNG proves to be the most effective way. This was why many ports started to build LNG terminals. But it is still too early to tell if LNG will be the shipping industry's way out amid increasing environment protection pressures.

1. Low-sulfur fuel oil

Using low-sulfur fuel oil (LSFO) has been top on the list of solutions for shipping enterprises to meet IMO emission reduction requirements in the short to mid-term. As LSFO is more expensive than the regular fuel oil, it is estimated that fuel cost will go up by 68%. But as IMO has only imposed requirements on sulfur oxide emission for ships sailing on global routes after 2020, it is a proper solution to meet regulatory expectations by using LSFO. In this way, shipping enterprises save on renovation costs, in case of potential policy change (such as restrictions on nitrogen oxide and greenhouse gas emissions). Shipowners can also transfer extra cost burden to trade companies through collection of fuel oil surcharges. For trade companies, as transport cost is just one fraction of their cost structure, there will not be any changes to the trade scale or industrial structure. Overall, LSFO has been a preferred solution among most shipowners.

2. Desulfurization system

Based on a significant price gap between LSFO and high-sulfur fuel oil (HSFO), the payback period on installing a desulfurization system is 12 to 14 months. If the gap widens, the payback period shortens too. In fact, globally only 420 ships (including new ship orders) are confirmed to have installed or will install desulfurization systems[4]. Among the new ship orders placed within the year, only 1.5% new ships will be equipped with desulfurization systems. Cruise and ro-ro ships were

[4] Clarkson statistics, as of the end of 2017.

two main ship types requesting these systems, while only 37.5% of container ships newly ordered chose to install desulfurization systems. It is estimated that by 2020, 2,000 ships will have desulfurization systems onboard globally, which will be only 4% of ocean-going ships.

3. Clean energy

According to HIS, globally, fewer than 300 ships used LNG as fuel, including the new orders. Most of them are coastal ships, marine engineering ships, and ferries operating in coastal Norway and North Europe. But other types of ships lack motivation to adopt LNG as fuel. The underlying causes include: (1) high complexity and costs on ship renovation. As LNG has lower density than conventional fuels, it takes four times in volume than non-LNG fuel. LNG bunkers, after renovation, take up larger space, therefore undermining cost-effectiveness of ship operation; (2) high initial cost on newly built ships. A 14,000-TEU container ship using LNG costs additional US$10-15 million; (3) higher safety requirements and incomplete regulations on LNG-powered ships. In addition, as global LNG fuel supply and refueling system has not been in place, fuel supply and price stability over long term remains questionable.

4. Shore power

To mitigate increasing costs on shipping fuel oil, ports took measures to meet power needs by ships at-berth through installing shore power facilities. But it turns out that government policies on shore power are heavily skewed toward construction rather than utilization. According to a survey on the world's largest container port, Shanghai Port, typical shore power facilities that charge five 100,000-ton ships simultaneously will require a direct investment up to 20 million yuan. But the shore power facilities have been rarely used after completion. Considering the electricity tariff and fuel cost, shore power does not have a clear price edge. It also takes more time and efforts to connect the ship with shore power facilities, hence a lack of motivation. Ports are not properly motivated as they can only charge ships at a rate for electricity used, which is lower than the service cost due to low tariff.

In view of the above issues, ships will use more LSFO in the coming future, and the LSFO price is expected to rise. Ships will only choose to install desulfurization systems when investment payback period for system installation is significantly shortened, which is possible if LSFO price rises above regular fuel oil by a great margin. Shore power service provided by ports will be an effective addition for ships to refuel power at-berth.

7.2.3 Global green port initiatives

Shore power systems have been adopted by global ports to facilitate the visiting ships to meet sulfur emission control requirements. Some ports have planned for LNG refueling services before market is matured. At a beginning stage, ports collaborate with shipping enterprises to trial out on LNG refuel services for small and medium-sized ships on certain routes or barges within the port region to promote new energy ships and LNG refuel service at terminals.

1. Promotion of shore power and clean energy

In March 2018, Antwerp Port Authority and Alfa Port-VOKA entered into an agreement on shore power facility construction, in order to reduce ship emissions of NOx, SOx and particulate matter for better air quality. In May, the authority, in joint effort with LNG infrastructure contractor Fluxys, started on the LNG infrastructure at its terminals to offer LNG refuel services to barges and small marine ships. In July, Port of Auckland worked with shipping companies to increase shore power utilization. 78% container ships at-berth stopped engine and used shore power there, which reduced diesel particle emission by 81%. Cruise terminals at Port Metro Vancouver in Canada cut air pollutant emission by 524 tons and GHG emission by 18,300 tons through using shore power. As of the end of 2018, Vancouver Fraser Port Authority completed a shore power project at Centerm Container Terminal. It was estimated that over 95 tons of air pollutant and GHG emissions will be reduced for a large ship at-berth for 60 hours with help of shore power.

California's At-Berth Regulation also requires greater use of shore power. Each shipping company has to meet certain thresholds (times using shore power/total times at-berth at a California port). For the period of 2017-2019, the threshold was 70%, and for the period from 2020, the threshold will be 80%. Tallinn Port in Estonia adopts a policy of differentiated port fees, where ships fueled primarily by LNG are given a 4% tonnage fee discount. Effective since 2019, ships participating in Environmental Ship Index (ESI) are also entitled to a tonnage fee discount of up to 8% upon approval. A differentiated fee policy provides incentives for shipping companies to adopt environment-friendly technologies, and in turn facilitates sound development of port ecosystem.

2. Prevention of secondary pollution by desulfurization system

Port of Singapore is among the first hub ports to apply environment-protection policies. In November 2018, Maritime and Port Authority (MPA) announced that discharge of wash water into port is banned from 2020. Ships fitted with hybrid scrubbers will be required to switch to the closed-loop mode of operation, in order to oblige ships to use cleaner fuels. MPA will also work with fuel suppliers to ensure that Singapore has sufficient supply of fuel before 2020. The authority also collaborated with Singapore Shipping Association (SSA) to issue a technical guideline to provide Singaporean and visiting ships with operational instructions. It also conducts routine underwater cleaning practices, collecting about 110 kilos of garbage. Waste collectors are dispatched by the authority to operate along the routes and at anchorage.

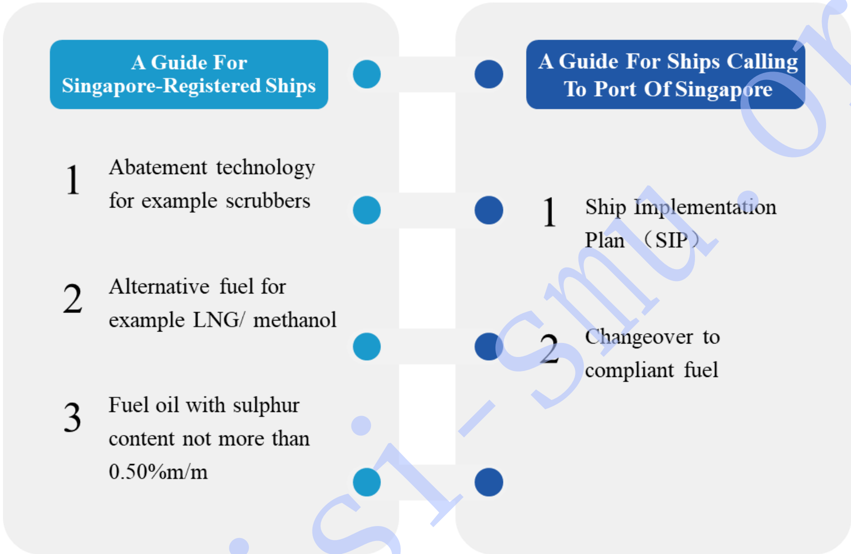


Figure 7-3 Guidance for Singapore-registered Ships & Ships Calling at Port of Singapore

3. Development of new fuel for ship use

For the purpose of meeting emission cut targets for ports and ships, innovation on energy and raw materials should be sought. Ports can be greener through promoting a port energy system fueled by new energies, and applying new technologies, such as solar power generation, hybrid photovoltaic-wind power generation, solar heating system, and air source heat pump system.

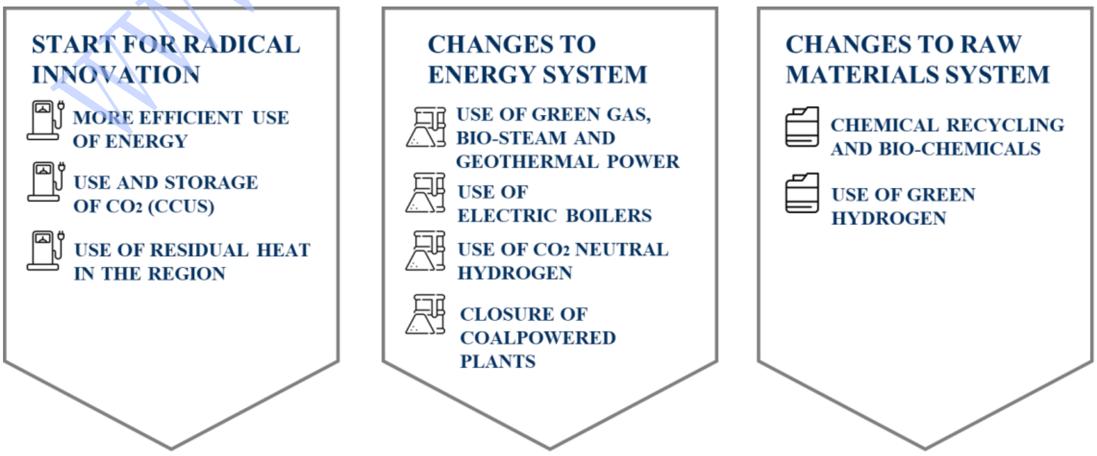


Figure 7-4 A New Energy System

4. Regulation enhancement by port authorities

Shore power and clean energy are offered by ports as auxiliary services, with no mandatory requirements on ships. Penalties or levies are usually imposed on ships failing to meet certain standards by IMO. However, ports should come up with detailed plans on how to determine whether the visiting ships meet emission reduction and control requirements.

Researchers in northern Europe such as Belgium and Denmark improved monitoring efficiency and precision with the help of high-precision sniffers and sensors, and high-definition cameras. The Johor Port Authority (JPA) and Technological University of Malaysia launched a project of On-line Ship Emission Management System (SEMS) for terminal operators to report ship activities, and for the port authority to monitor and manage emissions.

7.3 Green Port Development Measures

7.3.1 Green development strategy

1. Identify environment-protection priorities

Europe has led the world in green port development, as it has put in place well-designed policies and controls on green ecology. From the green port development history in Europe, the first item on the agenda should be to determine the development targets. To this end, the European Sea Ports Organization (ESPO) determines and announces top 10 environmental priorities each year. In 2018, ESPO listed air quality as the top priority, followed by energy consumption and noise pollution. Though Europe already has had two key ECAs in Baltic Sea and North Sea, it placed air pollution as a top priority, proving how much air quality is valued in Europe. It is also why Europe has been such an active advocate of the Paris Climate Agreement and IMO emission reduction targets.

Ports around the world have inconsistent development targets, which are based on their own needs of environment protection and economic development. Following these targets, ports have set up plans detailing the tasks. Developing nations should prioritize an approach on energy consumption reduction, which is an important way toward greener environment, cost reduction, and economic growth. For inland river ports, water quality should be a leading task to ensure that port activities do not lead to severe pollution to inland waters. Non-compliant discharges should be banned. For example, ban inland river ships with improper desulfurization facilities from pouring sewage directly into waters and contaminating inland systems.

Figure 7-5 Top 10 Environmental Priorities of European Ports for 2018

2. Enhance green port collaboration

In September 2018, port authorities in Hamburg, Barcelona, Antwerp, Los Angeles, Long Beach, Vancouver and Rotterdam collectively launched the World Ports Sustainability Program (WPSP), covering five areas of inter-port cooperation: elastic infrastructure, climate and energy, safety and security, community outreach and port-city exchanges, and governance and ethics, with an aim to coordinate the sustainability of global port development by strengthening international cooperation.

Figure 7-6 World Ports Sustainability Program

From the WPSP initiated by IAPH, the priorities are placed on infrastructure renovation and clean energy use, with additional focuses on port collaboration in greater areas to launch collective policies. This serves to clear the gaps in competitiveness among port actors and to prevent distortion of market demands, due to differences in green policies.

3. Use strategic toolkits

IMO has been dedicated to global shipping and port emission reduction for a long term. To facilitate global authorities in setting up policies on air pollution control and ship emission reduction, IMO has released Ship and Port Emissions Toolkits, and updated the toolkits ongoingly in line with the best practices.

The toolkit for port emission includes two parts:

Guide No.1: Assessment of port emissions:

The guide is intended to serve as a resource guide for ports intending to develop or improve their air pollutant and/or GHG emissions assessments. It incorporates the latest emission inventory methods and approaches. It recognizes that ships do not operate independently from shore-based entities in the maritime transportation system and that port emission considerations must extend beyond the ships themselves to include all port-related emission sources including: seagoing vessels, domestic vessels, cargo handling equipment, heavy-duty vehicles, locomotives, and electrical grid.

Guide No.2: Development of port emissions reduction strategies:

The guide is intended to serve as a resource guide for ports intending to develop an emissions reduction strategy for port-related emission sources. It describes the approaches and methods that can be used by ports to develop, evaluate, implement, and track voluntary emission control measures that go beyond regulatory requirements.

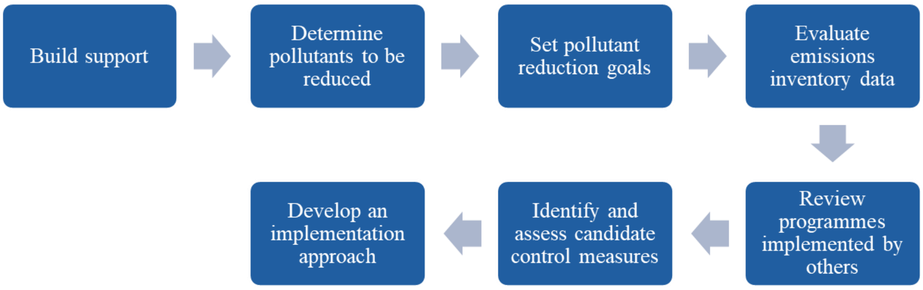


Figure 7-7 Steps for Developing an Emissions Reduction Strategies Plan

7.3.2 Equipment replacement driven by technical innovation

1. Hydrogen production and refueling facility

In 2018, Port of Auckland in New Zealand announced that it was committed to building its first hydrogen production and refueling facility at its Waitematā Port. The company's project partners Auckland Council, Auckland Transport and KiwiRail will offer technical support and invest in hydrogen fuel cell vehicles, as part of the project, in order to realize the goal of "Zero Emission by 2040". Kalmar, a port equipment supplier, and its affiliated company, Navis, were chosen to a supply state-of-the-art fully automated intermodal terminal solution for Qube's Moorebank Logistics Park (MLP) in south-western Sydney - becoming the world's first automated intermodal terminal. Kalmar provides a range of automated cargo handling solutions, including automated stacking cranes, automated rail-mounted gantry cranes, as well as hybrid autoshuttles and their charging stations, while Navis provides their N4 terminal operating system (TOS). The joint solution aids the MLP project in achieving a positive ecological impact by reducing CO_2 emissions at the terminal through electrical container handling and reducing diesel truck traffic significantly around Sydney.

In September 2018, California Air Resources Board granted Port of Los Angeles US$41 million, and Port of Long Beach US$50 million to support their projects on zero-emission cargo handling equipment. Port of Los Angeles will work with Kenworth/Toyota to deploy 10 electric trucks powered by hydrogen cell and two heavy hydrogen refueling stations, while Port of Long Beach will work with Peterbilt/TransPower to deploy 15 electric trucks.

2. Replace diesel truck for transport

Besides ships, another major source of pollution is cargo collecting and distributing trucks in the port area. Global port areas have released requirements on truck emissions, ranging from fuel consumption, fuel standards, to gradual replacement by clean energy trucks, for the purpose of port pollution alleviation. In 2018, the Port of Los Angeles and Port of Long Beach enacted new standards on clean trucks as part of its amendments to tariff act. As of October 1, 2018, new trucks entering service at the Port of Los Angeles must be model year 2014 or newer. It was a key measure under part of the San Pedro Bay Ports Clean Air Action Plan (CAAP) to endorse truck upgrading, phase out old trucks, reduce heavy truck emissions, and realize the target of zero-emission trucks by 2035. Going forward, more incentives will be provided, including collecting cargo handling fee on regular trucks, waiver of annual PDTR fee or levy on zero-emission trucks. Port of Oakland also released a draft Seaport Air Quality 2020 and Beyond Plan, proposing to reduce diesel emission by 85% by 2020. In line with California's 2030 and 2050 Climate Commitments, the state will promote zero-emission equipment, and construct infrastructure with electrical systems, to support goods handling facilities and trucks less dependent on diesel.

7.3.3 Further improvement of port's cargo collection, distribution and transportation systems

1. Land-to-water transport among port terminals

To improve the cargo collection, distribution and transportation systems of ports, focus should be on emissions by not only logistics freight systems in and out of the port area, but also on container trucks and vehicles within the port area. To this end, the Port of Antwerp in Belgium owned by Antwerp Port Authority plans to invest EUR35 million over the next three years in innovative and sustainable projects in a bid to transition to a circular low-carbon economy, including a project on upgrading cargo collection, distribution and transportation system within the port area, to coordinate economic, social and ecological benefits. It has been working with Dutch company Port-Liner to build five hybrid barges that will ply between De Kempen intermodal terminal in the Netherlands and Antwerp, in order to reduce truck use, cut energy consumption and emission, and improve operational efficiency in-between ports.

2. Shorter ship waiting time at ports

Another approach to realizing energy conservation and emission reduction in ports through a better cargo collection, distribution and transportation system is to reduce non-production energy consumption while keeping the old transport means unchanged. The European ports take a lead again in this regard. In 2018, Port of Rotterdam partnered with IBM on a multi-year digitization initiative to transform the port's operational environment. Under the initiative, it put in place sensors on quay walls, dolphins, and roads to collect data in the port area and have the data processed using the Internet of Things technology in the cloud. The information will be utilized by the port in decision-making in order to shorten ship waiting time, determine scheduling of berth and handling, release as many berths as possible, and facilitate sustainable development of the port.

3. Establish cargo collection, distribution and transportation systems for railways

To upgrade traditional cargo collection, distribution and transportation systems, multimodal transport has been a critical component. Water-water transfer and sea-railway intermodal transport, replacing the conventional road transport, played a key role in energy conservation and emission reduction for mid-to-long distance cargo transport.

From 2018, the Chinese coastal ports have offered sea-railway intermodal transport, with subsidy and grants awarded by local governments. The Chinese cities with coastal ports prioritize the tasks on "last mile" project connecting railroad and port, and target to meet over 60% rate of railway connectivity among key coastal ports by 2020. For years to come, the sea-railway intermodal transport is expected to achieve over 10% annual average growth among key container ports in China. From these targets and tasks, it is clear that the Chinese government is determined to support emission reduction and port cargo collection, distribution and transportation system optimization. In the year 2018, Shanghai Port, the largest Chinese port, realized direct growth of 40% in its sea-railway intermodal transport, and targets for doubling growth in 2019.

7.3.4 Energy conservation and emission reduction measures implemented by ports

1. Construct carbon dioxide neutral ports

Ports that did well in green development, in addition to success in sulfur oxide and nitrogen oxide emission reduction, have worked on emission reduction targets and strategy on GHG (that is, carbon dioxide). For example, the Port of Rotterdam Authority aims to be a CO_2 neutral port through partnership with companies. By CO_2 neutral, it means that the port has an industrial landscape that has no net negative consequences for the climate, which is consistent with the targets in Paris Climate Agreement. This concept reflects the port's devotion to addressing global climate change. To realize the ambition for a CO_2 neutral port, it partners with companies for technical means to reduce energy consumption of port operation and improve port management on work procedures for higher efficiency.

2. Project collaboration on emission reduction

In 2018, the Port of Rotterdam Authority invested 450 million euros on infrastructure upgrading, mostly involving new technology and the Internet of Things, for better efficiency and emission clearing. The authority, as a leader in sustainable port development, also partnered with other parties to sponsor a number of innovative projects. Its strategy focused on encouraging intra-regional cooperation.

Table 7-1 Innovative Collaboration Projects by Port of Rotterdam

Project	Partner	Description	Expected Outcome
Exhaust to methanol	Enerkem, Air Liquide, AkzoNobel Authority	To turn exhaust into syngas and then use it for methanol purification in the chemical and transport sectors. The purification device was introduced to Europe for the first time.	Annual CO_2 emission reduction by 300,000 tons
Thermal network in southern Netherlands	Provincie Zuid-Holland, Gasunie, Eneco, WBR	To use port waste heat and geothermal heat to heat households and offices in southern Netherlands and to reduce use of natural gas	Annual CO_2 emission reduction by 2 million tons
CO_2 storage	Gasunie, EBN	To store CO_2 in the fields under the North Sea under a port-wide infrastructure project	Annual CO_2 emission reduction by 2-5 million tons
Artificial North Sea island	TenneT, Energinet, Gasunie	To convert wind energy into electricity and hydrogen by establishing off-shore wind power plants	—
Clean transport	—	To provide port fee cuts or waiver for owners and tenants of ships using low-carbon or zero-carbon fuels	—
Solar cell	—	To install solar cell panels in port area	Power for 15,000-30,000 households

Source: Port of Rotterdam Authority website

3. Renovation of port companies on a case-by-case basis

Antwerp Port Authority recently released its energy plan for 2018-2020, targeting to further improve energy efficiency of its own buildings and facilities, and to reduce internal carbon dioxide emission by 10% from the 2016 level. The port introduced tugboats, electric trucks and transport equipment of higher energy efficiency, and utilized renewable energies collected by the water gate facilities of solar cell panels and heat pumps.

7.4 Social Benefits of Green Ports

1. Restore ecological habitat at terminals

Many American ports made progress on green ecological development. Since obtaining Green Ocean Certificate in 2017, Port Hueneme has introduced environmental policies and launched green projects such as a new zero-waste policy, LED lighting on high mast, and upgraded patrol crafts. In November, the Port of Seattle released its investment plan for 2019-2023, including an investment of US$30 million on apron electrification, in order to reduce GHG emission of apron facilities and cruises at-berth and to improve port's air quality, in addition to an investment of US$17 million on habitat recovery.

2. European ports implement a polluter pays principle

Fee collection systems for ships producing excessive wastes (including hazardous wastes) should be optimized. Identical fee collection standards only serve to encourage waste and sewage discharge by ships. There should be incentives on garbage reduction. European Sea Ports Organization (ESPO) suggested that ports set limits on how much garbage is covered in fixed fees. Ships should pay the ports for unreasonable quantities of waste delivered by ships of certain types and sizes over certain thresholds. Similarly, ships can apply for green rebates if they successfully reduce quantities of garbage produced. According to ESPO, about 50% European ports have rebated ships with lower waste delivery after the policy went into effect

Special Topic IV: Ship Emission Reduction Breeds LNG Terminals

Into the 21st century, global shipping capacity has seen rapid expansion. From practices in developed countries and regions, setting up environmental control areas (ECAs) where ship emissions are controlled is a popular approach taken to keep ship emissions in inshore regions under control. According to a report by the US Environment Protection Agency (EPA), emissions of ships sailing and at-berth in the North American ECAs (areas within 200 nm off the coastline) will be reduced by 86% by 2020.

I. Increasingly stricter emission reduction requirements on international ships

The International Convention for the Prevention of Pollution from Ships (MARPOL) (Annex VI) in 2005 sets out clear requirements on monitoring and inspecting sulfur content in fuel oil used by all ships sailing in the sulfur environmental control areas (SECAs) (excluding military vessels). In October 2008, the MARPOL (Annex VI) was amended by the IMO's MEPC 58 session, further clarifying that the ECAs can take special enforcement measures to control ship emission of sulfur oxide, particles, and nitrogen oxide. In 2016, the MEPC 70 session of IMO made a resolution that all ships sailing outside ECAs should use fuel oil of no more than 0.5% sulfur content starting 2020.

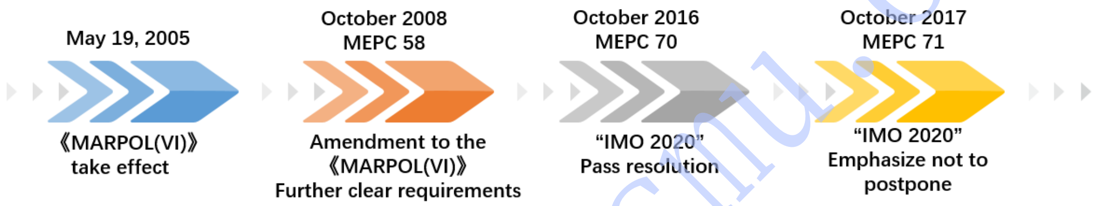


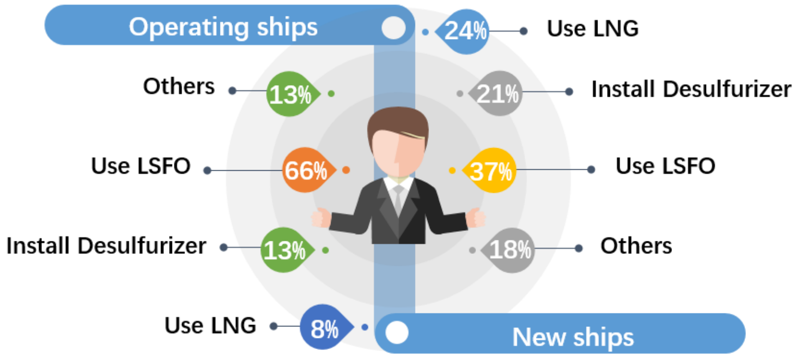
Figure 1 Evolution of International Convention on Vessel Sulfur Environmental Control

The IMO has four ECAs, including Baltic Sea and North Sea (including the English Channel) designated as SOx Emission Control Areas (PM emission indirectly controlled), the North America area (including certain sea areas located off the Pacific coasts of the United States and Canada) and United States Caribbean Sea (including Puerto Rico and the United States Virgin Islands) designated to control SOx, PM, and NOx emissions. ECAs set by the IMO has stricter controls on sulfur content in fuel oil. The cap was tightened to 0.1% in 2015, way below the world's average at 2.58% (2016 data by IMO) and the global cap on sulfur content in ship-use fuel oil at 3.5%.

Figure 2 IMO's Four ECAs and Time Line for Limits Increasing

II. Market responses to ECAs

According to IMO's estimation, by 2020, over 70,000 ships will be impacted by this regulation globally. Shipowners are increasingly weighing their options in wish of the most cost-effective way to meet compliance. There are three mainstream solutions. First, to use LSFO; second, to install prior approved ship exhaust desulfurization equipment, or "post-treatment"; and third, to use clean energy LNG to replace fuel. The best option depends on ship type, size and operation mode.



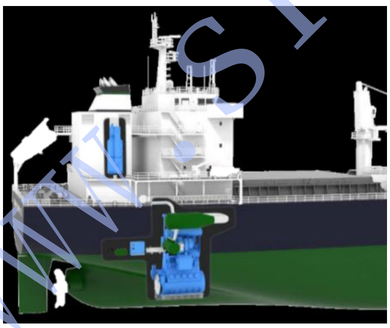
Source: Drewry.

Figure 3 Response Plan and its Proportion for IMO2020

According to a survey of shipowners and ship management companies by Drewry, a UK-based shipping consulting firm, shipowners globally have two approaches to address ship emission reduction regulation requirements, namely, for ships in active service and for newly built ships respectively. About 66% of owners of ships in service preferred to use LSFO as an interim measure, while owners of new ships had dispersed options, including new energy, desulfurization equipment, and LSFO. As renovation of ships in active services is costly and complex, more solutions emerge in the market for new ship orders to address emission reduction requirements. There are higher proportions of ships choosing LNG and shore power, among others, reflecting a trend of future development.

1.Room for desulfurization equipment reserved for new ships

Among the available solutions, LNG, desulfurization equipment and shore power need prior technical preparation. Relatively speaking, the LNG solution has a higher cost and lower operational cost-effectiveness as it requires a change in ship structure. In view of a great number of wait-and-watch shipowners, there is a tardy progress on LNG ship building. As desulfurization equipment also requires a high cost, coupled with potential concerns on improper sewage treatment due to technical limitation, ships - old and new - have not installed the equipment right away. However, considering the world is approaching the effective date for ECA sulfur caps, more and more new ships have reserved space for desulfurization equipment onboard.



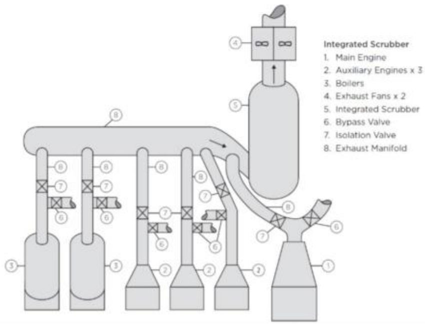
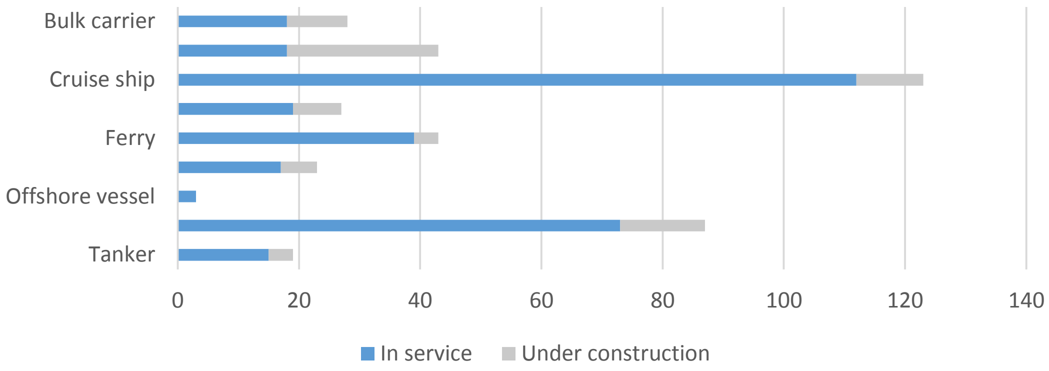


Figure 4 Desulfurization Equipment on the Ship **Figure 5** System Configuration and Integration

Based on a significant price gap between LSFO and high-sulfur fuel oil (HSFO), the payback period on installing a desulfurization system is 12 to 14 months. If the gap widens in 2020, the payback period shortens too. If technical issues on sewage treatment are set aside, there will be a huge demand for desulfurization equipment from new and existing ships. For ships choosing this solution to meet emission reduction targets, no additional pressure will be placed on green port projects. They will not, in the unlikely event, have a need to access the existing LNG refueling stations or shore power facilities.



Source: IHS Market.

Figure 6 Type and Quantity of Ships with Desulfurization Equipment by the End of 2018

2. Fuel cost to be a deciding factor

A deciding factor influencing decision-making of shipowners and ship renovation is cost-effectiveness. The most cost-effective solution, which is compliant with environment regulations, is destined to be a mainstream trend. Under the current market conditions, there are uncertainties on LSFO prices, desulfurization equipment installation costs, sewage treatment costs, LNG prices, and shore power rates. In particular, turbulent oil prices make it harder for shipowners to make a decision. With its radiation to the upstream and downstream along the industrial chain, implementation of global green port initiatives has been prevented from going further at full speed.

Use of LSFO and desulfurization equipment effectively alleviates stress on offering of green services by ports, while LNG and shore power solutions require technical preparation and LNG terminal infrastructures. Green ports are increasingly important as a result. Most of the shipowners preferred the LSFO solution. On the one hand, use of LSFO does not require any changes to ship systems or equipment, nor needs additional investment on equipment or maintenance, nor involves any policy or regulatory risks. On the other hand, thanks to enhanced refining capacity world-wide, LSFO market has been expanding with increasingly diversified product offering. Some shipowners have prepared for desulfurization equipment onboard, taking into consideration the significantly higher price of LSFO over HFO. It is estimated that by 2020, unit fuel cost will go up by 68%. Under high cost burdens, small and-medium-sized shipowners, who cannot afford desulfurization equipment or LSFO, will be phased out of the market. More and more shipowners will have to raise fuel surcharge to offset higher costs.

III. Port transitioning promoted by alternative energy

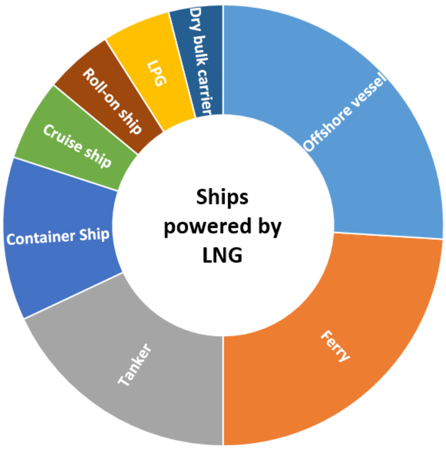
Despite the fact that ship emission is the greatest source of emission at ports, the LSFO or desulfurization solution, which does not involve a role of port, is preferred by shipowners, as evidenced by market responses. Among these two, LSFO enjoys a brighter prospect than desulfurization equipment (LSFO refinery is based on using low-sulfur petroleum fractioning of diesel or wax oil to replace high sulfur residual fuel oil; or desulfurizing the HSFO, which is more efficient than having onboard desulfurization equipment). But overall, it is based on processing of crude oil, which is non-recyclable. Overtime, as the world runs out of oil reserve, the market supply-demand will perhaps re-balance. In a longer term, electrification or LNG solutions will have a better market outlook.

1. Increasing LNG-fueled ships

The IMO 2020 sulfur emission caps have significantly driven growth of LNG-fueled ships on a worldwide basis (typically an LNG-fueled ship costs about 20% more than a regular ship[5]), and LNG refueling business is ready for a new round of growth. According to Clarksons, as of the end of 2018, the world had 559 LNG-fueled transport ships, with a capacity of 44.895 million DWT, and was expecting another 136 ships to be delivered with a capacity of 11.235 million DWT. Most

[5] Data source: Xinde Marine website, http://www.sohu.com/a/232906713_175033.

of the new orders will be delivered by 2021. LNG transport capacity will be up by 25% upon delivery. DNV GL's data suggested that, as of the end of 2017, the world had 117 LNG-fueled ships, with over two-thirds of them sailing on European waters. Additionally, there are orders for 111 new ships and 114 LNG-ready ships. [6]

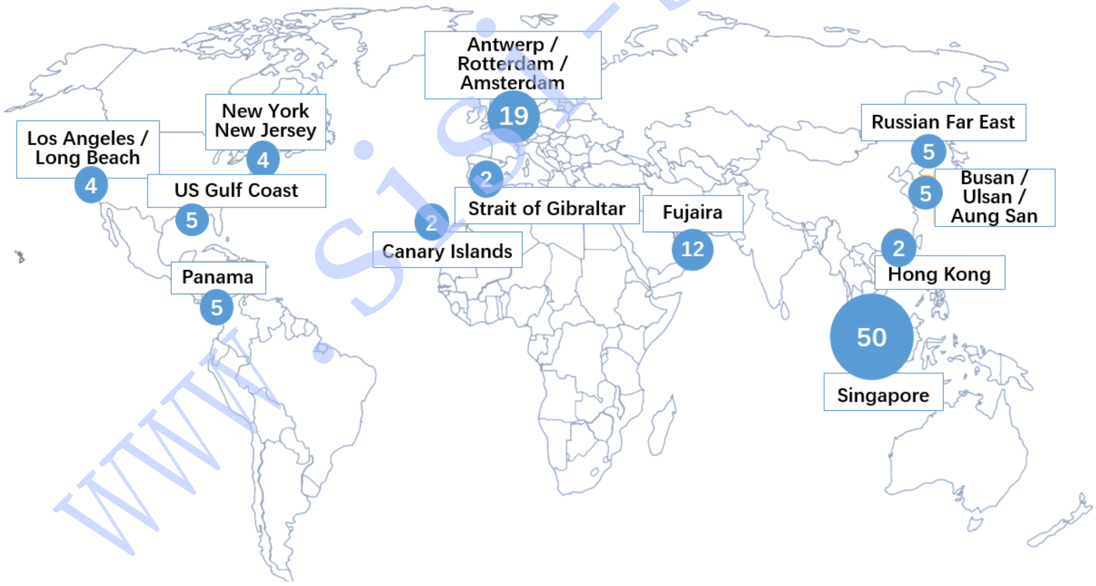


Source: IHS Market.

Figure 7 Type Proportion of LNG Power Vessel in 2018

2. Growing LNG refueling terminals

There are currently eight specific-purpose LNG refueling terminals globally, with another four projects to be delivered in 2020 (see Figure [7]). Over 60 ports provide LNG refueling in North America, North Europe and East Asia. Countries such as China, Japan, South Korea, Singapore and the Middle East have launched LNG refueling infrastructure projects.



Unit: million tons.

Source: IHS Market.

Figure 8 Global Distribution of Major Refueling Ports and Their Annual Fuel Sales.

By 2025, 14 large-scale LNG refueling stations will be completed, meaning at least one LNG refueling station in every continent but the Antarctica. But it is not enough considering the growing expectation of LNG refueling needs. In 2017, CMA-CGM ordered nine large container ships using

[6] Data source: DNV GL, http://www.ship.sh/news_detail.php?nid=27726.

[7] Data source: Xinde Marine website, http://www.sohu.com/a/232906713_175033.

LNG as fuel from China, marking a new chapter of LNG-fueled mega container ships. Maersk Line and Hapag-Lloyd have followed suit shortly after. It is expected that the capacity of LNG-fueled ships will expand.

As development of LNG-fueled ships is directly linked to port refueling infrastructure, ports taking a lead in providing LNG refueling services will enjoy greater shipping resources and higher port value. Currently, the world's top 10 fuel terminals take up about 50% of global market share, with Singapore being the largest fuel supply center in the world. China, though with a substantial domestic market for ship-use fuel oil, has moderate planning on LNG refueling terminals. The planned ones concentrate on Yangtze River trunk line and the Beijing-Hangzhou Grand Canal. China should pace up efforts on LNG refueling terminal projects in coastal ports, in order to promote LNG-fueled ships and facilitate green port initiatives.

VIII. Comments on Comprehensive Services of Global Container Ports in 2018

8.1 Evaluation Method of Comprehensive Service Efficiency of Container Ports

8.1.1 Meaning of comprehensive service efficiency at container ports

In the traditional sense, the evaluation and comparison analysis of ports usually depends on the indicator of throughput. However, the evaluation based on throughput can only reflect one aspect of ports, which may lead to non-comprehensive results. First, the handling capacity of port has a strong correlation with the investment in shoreline and land resources. It is difficult to evaluate port efficiency based on throughput, especially for ports with similar throughputs. For instance, with the integration of port resources, the cumulative throughputs of integrated ports are statistically calculated, which results in the rapid increase in the port throughput ranking, but cannot reflect the improvement of port efficiency. Second, geographical locations and distribution characteristics of ports are different. Some ports are island ports or located at the juncture of river and sea, while some are land-based. The former typically has much larger handling frequency than the latter, so the handling capacity factor alone is not sufficient. Third, the efficiency of a port is not only the production efficiency, loading and unloading efficiency, but also the comprehensive efficiency, including towing, pilotage, mooring waiting, and other port services which occur after ships enter the ports. However, it is difficult to quantify these efficiency indicators by traditional port statistics. To overcome the above obstacles, the Port Research Department of Shanghai International Shipping Institute would like to use the AIS data to study the comprehensive efficiency of the port from multiple perspectives and provide more detailed analysis.

8.1.2 Assessment method of comprehensive service efficiency of container ports

Arrival behavior of ships. When ships enter the port area and stay in-berth for some time, their activities such as pilotage, tug, inspection and quarantine, container handling are called arrival behavior. Based on actuality, it is a great waste of port resources when ships at berth have no operations. It is quite rare. So, this report treats the process of ship entering the port, entering the berth, leaving the berth, and leaving the port as one arrival behavior (see Figure 8-1). A ship entering the port but not entering the berth is called a "pass-by ship".

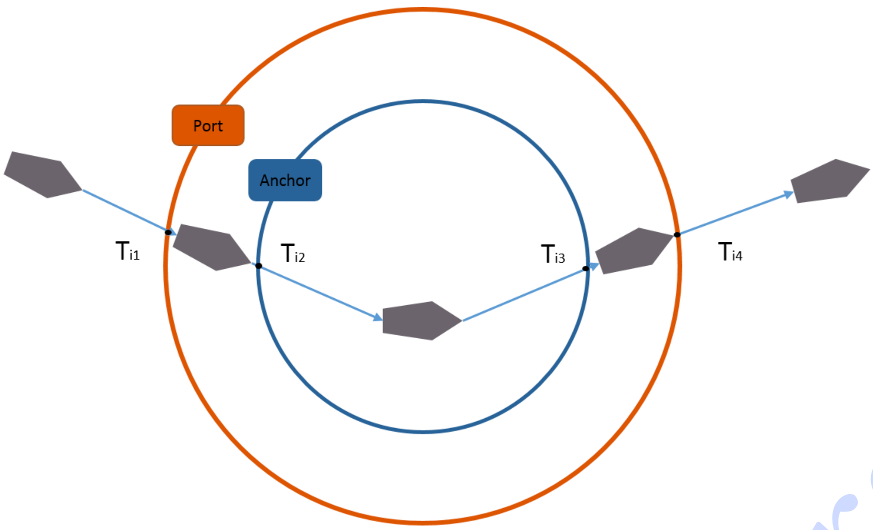


Figure 8-1 One Arrival Behavior of Ships.

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 primarily used to reflect the production organization and water management capability of ports. So we use this factor, average auxiliary operation time by each ship at port V_S (hours/ship), to assess the efficiency. If the *ith* ship enters the port at T_{i1}, and leaves at T_{i2}, then the *ith* ship has a auxiliary operation time as $T_{i\mathrm{S}} = T_{i2} - T_{i1}$.

$$V_\mathrm{S} = \left(\sum_{k=1}^{n} T_{i\mathrm{S}}\right)/Q$$

Where: V_S means the average auxiliary operation time per ship (hours/ship);

Q means total ship arrivals;

$\sum_{k=1}^{n} T_{i\mathrm{S}}$ means the sum of auxiliary operation time (ship hours).

Berth operation efficiency. This term refers to the time needed for loading and unloading operations when container 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 to ship size, the number of supporting units and port logistics. Therefore, this indicator is based on the average ship hours V_T that will affect ships directly. By average ship hours, it means the average handling time for a ship at berth, which reflects the production technicality and coordination capacity of a port. If the *ith* ship enters the terminal at T_{i2}, and leaves at T_{i3}, then the *ith* ship has a has a berth handling time as $T_{i\mathrm{T}} = T_{i3} - T_{i2}$.

$$V_\mathrm{T} = \left(\sum_{k=1}^{n} T_{i\mathrm{T}}\right)/Q$$

Where: V_T means the average handling time per ship (hours/ship);

Q means total ship arrivals;

$\sum_{k=1}^{n} T_{iT}$ means the sum of handling time (ship hours).

8.2 Features of Comprehensive Service Efficiency of Global Ports in 2018

1. Overall robust ship arrivals in 2018

According to AIS figures, the ship arrivals at global container ports from January to August 2018 rose by around 20% over that in the same period of 2016, implying the brisk performance overall in the global container shipping sector in terms of ship arrivals. Moreover, starting 2016, the ship arrivals at global container ports have been on a steady rise on a yearly basis. This can be attributed to three major reasons. First, the global cargo trade keeps growing, driving up the cargo imports and exports between ports and leading to higher density of liner shipping on container routes and a larger number of ship arrivals. In the past two years, the top 20 container ports in the world witnessed their throughput grow by 5.6% and 3.8%, respectively. Second, the big data concept has been sweeping the world in recent years. The information technologies are becoming advanced, and more and more AIS big data base stations were put into use, leading to a general increase of AIS data for ships. Third, most of the world's top 20 container ports are located along the Pacific routes, such as ports of Shanghai, Shenzhen, Hong Kong and Los Angeles. Subject to the Sino-US trade frictions, some containers were shipped ahead of schedule, leading to the increased density of liner ships.

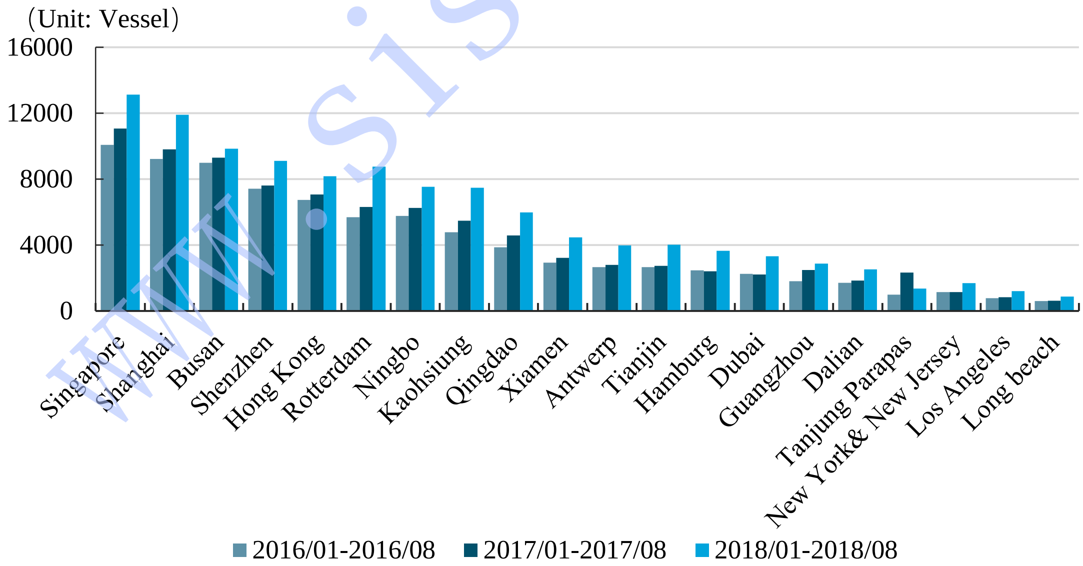


Figure 8-2 Ship Arrivals at Global Top 20 Container Ports in Jan-Aug from 2016 to 2018

2. Surge of mega container ship capacity delivery

According to statistics, there has been a sudden surge of 19,000 TEUs and above mega container ship capacity released in the past three years. Compared to the same period in 2016, arrivals of such ships at port for the period January to August in 2018 rose 1.5 times. The mega container ships of 20,000 TEUs and above had near to zero arrivals in 2016, which started to move upward in 2017, and saw an increase of around one fold in 2018 over 2017. According to Clarksons, shipping industry has been sluggish over the years, but the trend of mega ship has sustained. The number of container ships of 15,000 TEUs and above has been on the rise since 2012, but took a dip in 2016 before picking up again thereafter. The AIS data showed that increase of mega ship capacity since 2016 was attributed to continued delivery of ships of 19,000 TEUs and above.

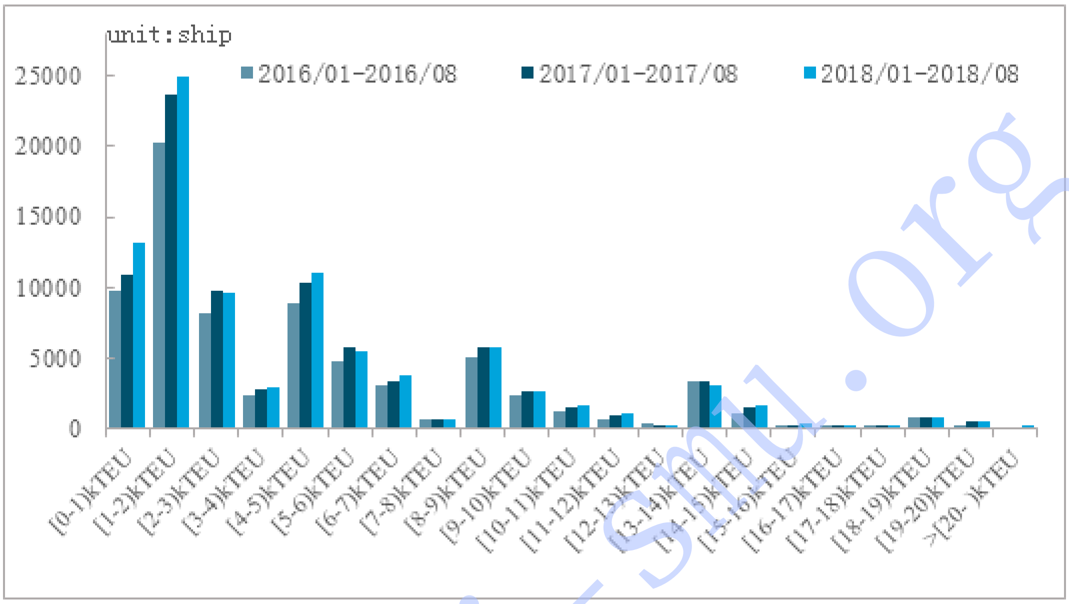
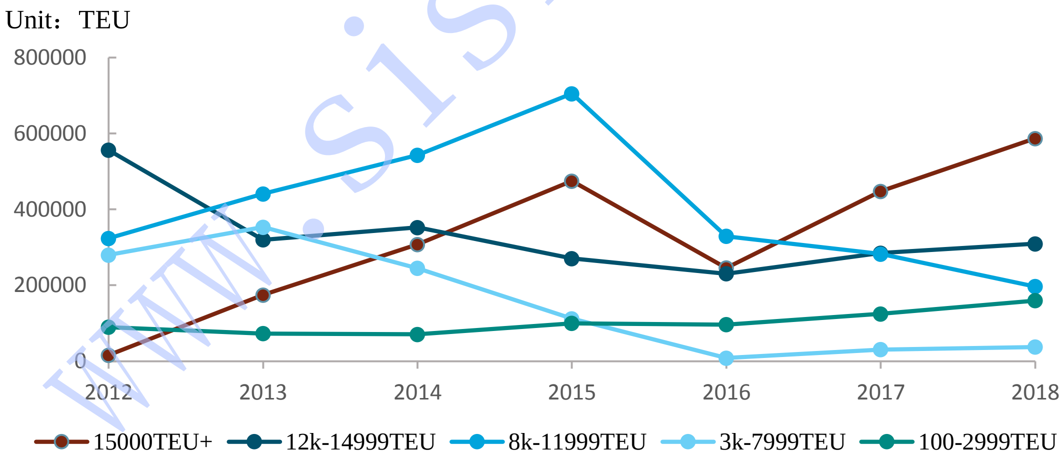


Figure 8-3 Ship Arrivals by Type in at Global Top 20 Container Ports in Jan-Aug from 2016 to 2018



Source: Clarkson

Figure 8-4 Global Container Fleets by Ship Type from 2012-2018

3. Increasing auxiliary operation efficiency

The world's largest 20 container ports have witnessed growth of efficiency on auxiliary operations, and minor decreases of berth operation efficiency. In recent years, port enterprises have been affected by an overall weak shipping market. Competition among regional ports has enhanced by industry-wide re-alliance and routes realignment. Port managers, in order to improve comprehensive competitiveness, have worked on enhancing service efficiency in tug, pilotage and handling. From statistics, since 2016, major ports around the world have improved efficiency on auxiliary operations. However, in view of structural changes of container ships, mega ship capacity has been increasing, and the share of small and medium-sized container ships shrinking. Due to factors such as allocation of quay cranes, the handling capacity of megaships is lower than the smaller ones, hence lower berth operation efficiency.

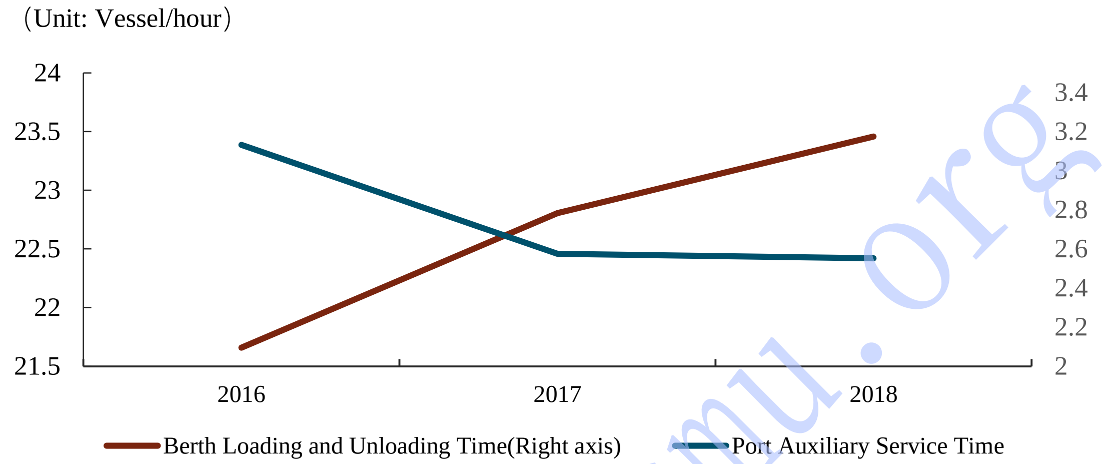


Figure 8-5 Berth Loading and Unloading Time and Auxiliary Service Time of Global Top 20 Container Ports from 2016 to 2018

4. Highest comprehensive efficiency witnessed in Shanghai Port and Port of Singapore

Through the data, container ships have a shorter operation time at Shanghai Port and Port of Singapore, which also record greater numbers of ships served and greater container handling volumes. At the two ports, more container ships are served and more containers are handled in a shorter time than elsewhere. Their overall service efficiency are quite high. On the other hand, the Port of Los Angeles and Port of Long Beach in the United States, subject to stricter labor protection polices, have lower efficiency overall, evidenced by a longer handling time, fewer ships served, and lower handling capacity. Additionally, the comprehensive efficiency values of most of other ports are recorded in the third quadrant, meaning an at-port time between 10-40 hours, a handling capacity of 10 million-25 million TEUs, and an average level of ship arrivals.

8.3 Evaluation of Global Container Ports in 2018 by Segmented Indicators

8.3.1 Structural analysis on ship arrivals of global top 20 container ports

1. Singapore is the busiest port in the world.

According to the AIS statistics for ships during January to August 2018, the Port of Singapore remained the busiest port in the world. If conducting a statistic analysis on the ship arrivals at 20 major container ports in the world, it can be found that the ships can be primarily divided into three echelons. The first echelon is represented by Singapore, Shanghai, Busan, Shenzhen, Hong Kong and Ningbo ports with their average annual vessel arrivals exceeding 10,000 vessels/times. We can find that the first echelon only involves core and hub ports in the Asia-Pacific region. Port of Rotterdam, Kaohsiung Port, Qingdao Port, and Xiamen Port form the second echelon, with their average annual ship arrivals between 5,000-10,000 vessels/times. Port of Antwerp, Tianjin Port, Guangzhou Port, Port of Dubai, Port of Tanjung Pulapas, Port of Hamburg, Dalian Port, New York-New Jersey Port, Port of Los Angeles, and Port of Long Beach form the third echelon, with their average annual ship arrivals lower than 5,000 vessels/times. The Port of Singapore was the world's busiest port beyond controversy in terms of ship arrivals.

2. "Smaller ships" taking up higher proportion at regional hub ports

From the structure of arriving container ships in the world in 2018, it can be seen that regional hub ports such as Port of Busan, Dalian Port and Kaohsiung Port saw a higher proportion of ships of under 4,000 TEUs, the share being higher than 50% among all arriving ships. Take Dalian Port, a regional container hub port in Northeast China, for example. The containers for domestic trade at the port took a share of 45%, and more than 90% of containers for foreign trade in the three provinces of Northeast China were transshipped at Dalian Port. Most of its foreign trade routes lead to Japan, Korea and Europe, and the routes to Japan and Korea take nearly half of all foreign trade routes. As a result, small container ships on near-sea shipping routes contributed a large part of ship arrivals at the port.

Source: Shanghai International Shipping Institute

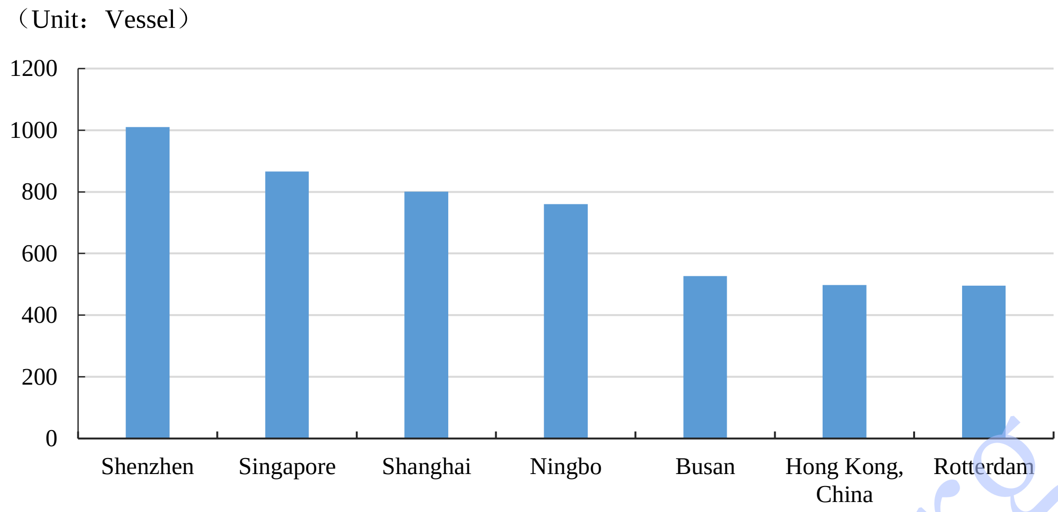
Figure 8-6 Arrival Vessels' Structure of Global 20 Major Container Ports

3. Higher proportion of 8,000-12,000 TEU ships at US ports

Data shows that among the 20 major container ports in the world, the ports with the highest proportions of 8,000-12,000-TEU container ships were all located in the U.S., including the Port of Long Beach, the New York-New Jersey Port and the Port of Los Angeles. Canada, Mexico, China, Japan and eurozone economies were major destinations of trade shipping routes of the U.S. In the aftermath of the Panama Canal expansion, the most ships launched to the Far East-North America and North America-Europe routes were of 8,000-12,000 TEUs, while ships of above 12,000 TEUs on ocean-going international trunk routes were less seen. In addition, ships launched to the south-north routes between North America and South America were dominated by ships of above 4,000 TEUs. Therefore, ships of above 12,000 TEUs and of below 4,000 TEUs took a smaller share in the ship arrivals at ports in the U.S.

4. Shenzhen, Singapore, Shanghai, and Ningbo are typical ultra-large ports for ship receiving and unloading

The statistics show that the ports handling ultra-large ships of above 12,000 TEUs in 2018 mostly served the Asia-Europe routes. In terms of the size of ports receiving ultra-large ships of above 12,000 TEUs, Shenzhen, Singapore, Shanghai, and Ningbo ports ranked among the top. Shenzhen is the most called port for ships of above 12,000 TEUs in the world. From January to August 2018, it received more than 1,000 such ships. This is primarily because the throughput of containers from Shenzhen Port to Europe and America accounted for 50% of all the port's containers for foreign trade, hence the higher proportion of bigger ships on ocean-going routes.



Source: Shanghai International Shipping Institute

Figure 8-7 Calls of Large Ships at Global Hub Ports

8.3.2 Evaluation of berth operation efficiency of global top 20 container ports

As the port customer, the shipping company would like to judge the service quality of a port in two aspects: time and cost, and even will be more sensitive to time requirements. The service efficiency of the port can be reflected by the time cost of the ship in port. In general, the services provided by the port for ships can be divided into two categories: berth loading and unloading services and auxiliary services. Auxiliary services include towing, pilotage, mooring and port inspection. Therefore, the efficiency of port includes not only the efficiency of berth loading and unloading services but also the efficiency of auxiliary services.

The following figure summarizes the auxiliary operation time and berth operation time for the global top 20 container ports from 2016 to 2018.

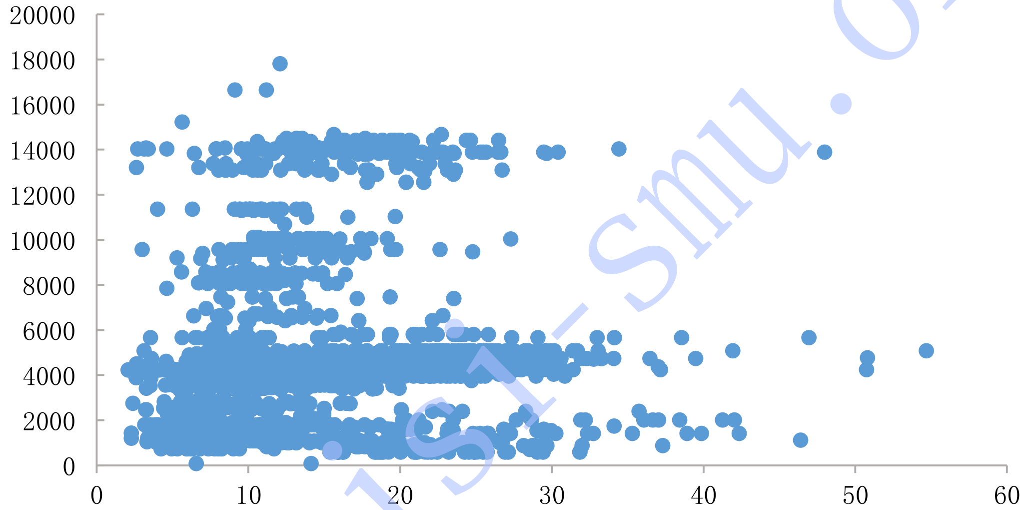
(Unit: Hour/vessel)

Figure 8-8 Operation Efficiency of Global Top 20 Container Ports Based on AIS Data in 2016-2018

I. Terminal operation efficiency of global top 20 container ports

1. Loading and unloading efficiency of major container ports in China is generally high

On the one hand, China's container ports above designated size are densely distributed, which diverts the volume of container ships, resulting in a relatively short loading and unloading time for single ships at berth. On the other hand, technology and operation level of Chinese ports are indeed leading the world, and the low berth loading and unloading time cost is a relatively favorable proof. Among major ports in China, Guangzhou Port has the shortest berth loading and unloading time for all types of ships, concentrated between 5-20 hours. In addition to the high efficiency of loading and unloading, another reason for the shorter berth time at Guangzhou Port is that the loading and unloading volume of a single container ship is relatively small, usually between 500 - 1,000 TEUs/ship.



Note: The horizontal axis is time/hour; the vertical axis is the ship type/TEU.

Figure 8-9 Loading and Unloading Time of Ships at Guangzhou Port

2. The berth loading and unloading time of American ports is higher than that of others.

Among the 20 major container ports in the world, the berth loading and unloading efficiency of ports in the US is significantly lower than that of other ports. For example, for a container ship of 0-4,000 TEUs, the berth loading and unloading time of several ports in the United States is almost three times that of the most efficient port. And a ship of8,000 TEUs needs to stay in berths for up to seven days. Although compared with Chinese ports, US ports have relatively high loading and unloading capacity for a single large ship, but the difference between the scale and time is not proportional. The main factor influencing the loading and unloading time is the labor regulation limitation of the United States.

3. Higher handling efficiency of Guangzhou Port container terminal

In the past three years, Guangzhou Port's container terminal has jumped six places in handling efficiency to the fifth spot in 2018, resulting from a series of measures implemented by the

Guangzhou Municipal Government after Nansha Port Area started operation. In order to promote the "Belt and Road" Initiative and the Guangdong-Hong Kong-Macao Greater Bay Area, Guangzhou Port has made commitments to the industry and its customers on improving container operation service standards in Nansha Port Area, including liner bridge time efficiency at 30 TEUs/hour, barge bridge time efficiency at 18 TEUs/hour, average external vehicle's operational time at 30 minutes, and tugboat on-time arrival rate no less than 99%. It also commits to no wait time for customer request at terminal, no wait time for tugboating, direct berthing service for container ships arrived as scheduled, prioritized services for international passenger liners and container ships in sequence management for port entry and exit. The government's focus on port service efficiency has enabled a higher handling efficiency of Guangzhou Port.

4. The longer time for ships handling at Singapore Port is due to its comprehensive service supply.

Compared with other international container hubs such as Hong Kong Port and Shanghai Port, the loading and unloading time for ships at Singapore Port is relatively long. The main reason is that Singapore Port is an international supply port, which can provide other services, including ship supply and maintenance after the ship is docked. According to statistics, after arrival in Singapore Port, 36.2% of vessels carried out refueling and loading and unloading services at the same time, 4.5% of vessels carried out cargo handling and material supply, 10.8% of vessels carried out the above three services, while just 32.8% of vessels were only for cargo handling.

5. Operation efficiency of berths at container ports is positively correlated to overall size of ships.

Statistics show that the operation efficiency of berths at container ports is positively correlated to the overall size of ships. The larger the container ship, the longer the stay at berths. The handling efficiency at berths of all the global top 20 container ports roughly conform to this law. For example, the average stay per ship of up to 4,000 TEUs, 4,000-8,000 TEUs, 8,000-12,000 TEUs, and above 12,000 TEUs at berths for operation is 10.4, 12, 16, and 18.1 hours, respectively, at Hong Kong Port. Major reasons behind include, first, the cargo handling volume is correlated to the container ships size to some extent. Container ships tend to grow larger. In particular, ultra-large container ships prefer to call at fewer ports to highlight the economic effectiveness by using more time for sailing and reduce the shipping cost per container of cargoes. Therefore, the global top 20 container ports usually depend on a hub-and-spoke network for operations when serving large container ships - the larger the ship of call, the higher the handling volume. Second, the handling efficiency of large ships at container terminals is lower than that of small container ships. Subject to the impact of shore crane equipment, a container ship of 20,000 TEUs will see its handling efficiency significantly lower than the total of two container ships of 10,000 TEUs each.

Figure 8-10 Operation Efficiency at Berth of Global Top 20 Container Ports by Ship Type

II. Terminal operation efficiency of global top 20 container ports

1. US Ports have higher efficiency in port auxiliary services

Although the loading and unloading time is longer for the ships operated at the ports of the United States, the auxiliary service time is shorter and the relative efficiency is higher than that of others. For example, the Port of New York & New Jersey, and the Port of Los Angeles ranked higher by auxiliary operation time among the global 20 major ports.

2. Auxiliary service time is longer for the ports at the junction of rivers and seas

According to statistics, ports of Rotterdam, Hamburg, Antwerp, and Guangzhou have longer auxiliary service time for each type of ship than other ports. The reason is that the distribution of the berths is dumbbell-shaped, except for the berths at outermost seaside piers. Some berths are located in the places where the ships need longer time to pass through. The services such as towing and pilotage often need a long time for ships. The ports located along the inland rivers are often berthed by small vessels of below 4,000 TEUs due to water depth restrictions. From the data, it can be found that ports of Guangzhou and Rotterdam rank relatively low for the auxiliary service time of ships of above 4,000 TEUs.

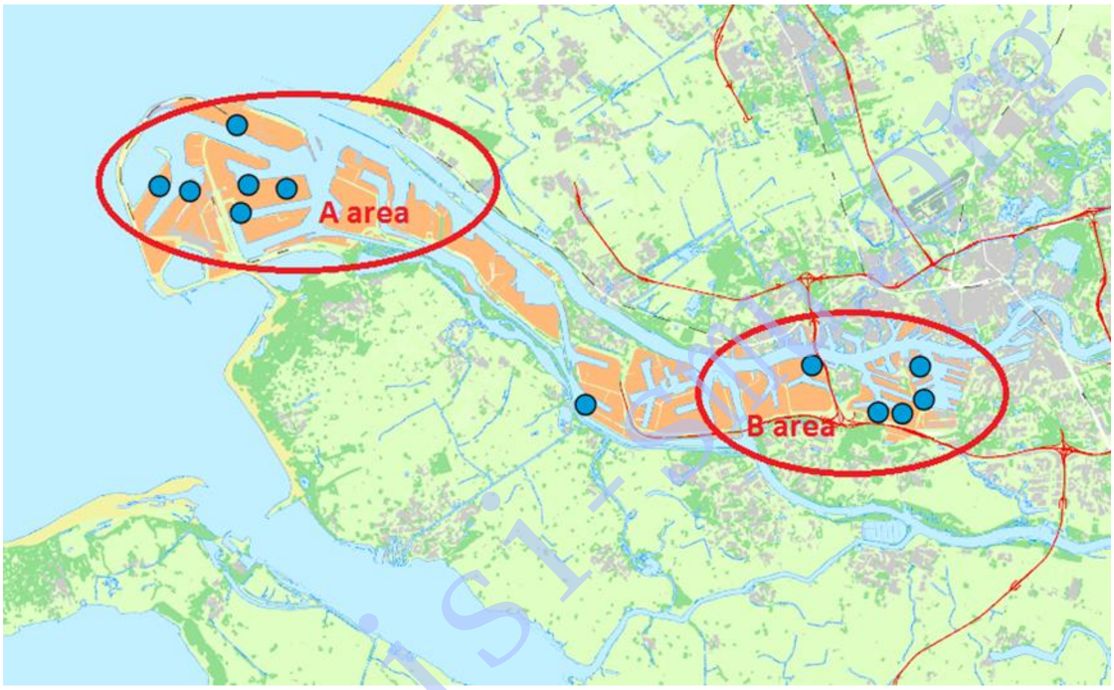


Figure 8-11 Berth Distribution of Container Terminal in the Port of Rotterdam

3. Small ships often require more mooring time

It can be found that container ships of below 4,000 TEUs generally require longer non-berthing auxiliary service time than ships of other types. The global major container hub ports often prioritize the calling of large ships. Therefore, the time cost of small vessels at the ports is often put under the limitation of berth.

4. Ultra-large hub ports face capacity strains

In view of the data for different ships types, Shanghai, Shenzhen and Tianjin ports, though equally matched with other ports in terms of auxiliary service duration, have no superiority in terms of rankings. In particular, Shanghai and Tianjin ports are known for their longer auxiliary services for ships of above 8,000 TEUs. A major cause lies in the fact that the high ship arrivals lead to tensions in the port capacity and ships usually need to line up to enter the port. The entry speed depends on ship size and queuing status, and small ships may retard the entry of large ships. But overall, the time difference is marginal compared with other ports.

IX. Development Trend of Global Ports in 2019

9.1 Development Trend of Global Ports

9.1.1 Global port growth to slow down modestly

It is hard to make projections on 2019. On the one hand, the global trade war started by the US is evolving, while on the other hand, multilateral and bilateral trade arrangements are engaged in discussions for collaboration. The prospect of global trade is elusive. According to IMF's projection, in the year 2019, the global GDP growth rate may continue to narrow. Developed economies are projected to have weakened growth momentums, while emerging economies may see growth slowdown. Global trade growth expectations will remain high, but the increasing trade tensions may drag the global trade down again. Also, to address the global financial crisis that has lasted for years, most of the emerging economies have released growth momentums way too early with fiscal and monetary incentives. So in the aftermath, trade growth prospect has turned sluggish.

The global economies in 2019 are expected to have weaker growth than 2018. Due to uncertainties in global trade relations and possible trade frictions, the global trade and shipping volume growth in 2019 will further slip. Slowing economic growth and weaker trade demands will be witnessed among emerging economies, while the developed economies will initiate policies to protect domestic industries and trade, undermining global trade development. In conclusion, the global port handling volume in 2019 is expected to target a low level of growth at 2.3%, and the container shipping trade may sustain a growth rate of 3.5%.

➢ **Asian ports growth to slow down, a similar trend among the European and US peers**

Region-wise, amid global trade tensions arising from the US-China trade war in 2018, many companies managed to deliver goods early, ahead of tariffs, which in turn drove trade growth on the Pacific routes. But overall, Asian ports will see weakening growing momentums, as it approaches the "top of the arc" with increasing capacities. When it comes to the European and US markets, also impacted by trade frictions themselves, they sustained growth of trade as a result of lower market resilience of trade complementarity. Some of them even realized higher growth than emerging economies. The gap in port growth has been narrowing between emerging economies and developed economies. In the meantime, major bulks trade, which has been a cornerstone of port business, slowed down as well. On the one hand, along with a growing awareness of environment protection, prices and freight rates on raw materials such as ore and coal have been increasing. On the other hand, new demands have slowed down after completion of large infrastructure projects. Australian and Asian ports and other major bulk traders will see further decline in terms of cargo volume.

➢ **Container trade growth to slow down, but growth potential remains**

The global container trade business, vulnerable to implications of trade wars and multi/bilateral trade agreements, will be subject to a much higher uncertainty. Based on the current international economic and trade development, the global container port volume growth in 2019 is expected to slow down. Increased tariff and trade agreement quota will further squeeze container goods demands in a short term. Stimulated by pro-domestic industry policies among the multiple economies, complementary trade will see declining needs over a certain period. However, in an age of internet and economic globalization, protectionism that is against globalization is not a feasible option. Trade wars eventually will hurt everyone. We will not only see higher costs of domestic manufacturing, but also loss of employment from trade business and relevant industries. In view of the fast development of cross-border e-commerce platforms and overseas direct shopping, buyers will have a good appetite for globally sourced goods. As container shipping is secure and less costly, the market still has great potentials.

9.1.2 Port investment diverted to supportive facilities

In 2019, global port investment will continue to be prudent. In the past five years, concentrated port projects have been releasing port capacity. As the supply and demand re-balance, the market lacks motivation in making more investment in new regular terminals. On the other hand, the demand for self-use terminals by cargo owners has been expanding, which is against the purpose of integrated use of coastline. Overall investment in port terminals, in developed economies of Europe and America and developing economies of Asia and Africa alike, has cooled. Thanks to environment protection policies, LNG terminals and other functional terminals have made progress, but at a slow rate due to uncertainties in policy implementation and market volatility. In the meantime, projects on supportive facilities such as cold-chain transport, warehousing logistics, and cargo collection, distribution and transportation by railways have emerged. Slower trade growth has made it riskier to invest in port capacity or new ports, but projects to upgrade port functionality and extend value-added services of port areas will be favored by port enterprises and terminal operators.

➢ **Developing economies to enhance port resource integration**

After years of construction, developing economies now have abundant port and terminal resources which, though, have taken up a great amount of coastal line resources. Following an extensive mode of development, developing economies have come to realize the importance of environment protection and living quality of their people. So they begin to shift from port construction to integration and recycling of existing port resources. Efforts have been made to integrate ports with outdated capacities and cargo owners' self-owned terminals, to make room for commercial tourism along the coastline, and to enhance productive efficiency for industry-purpose shoreline. Concentrated production, after resource integration, has further enhanced utilization of back-end cargo collection, distribution and transportation systems of the ports. Besides, hub ports in areas of full capacities have been implementing relocation strategies. For example, Port of Singapore and Port of Busan are constructing new sites for relocation, so as to convert coastlines for other use and enhance their own competitiveness with new ports. It is expected that port projects in 2019 will focus on integration of existing port resources, and new port operation.

➢ **Global port terminal structure to readjust**

Terminal functions and cargo source structures are directly relevant to market demands. In recent years, projects on LNG and other functional terminals have seen rapid growth. In view of the global shipping industry structure, transport demands on energy materials will decline. The emerging markets cannot rely on energy consumption for long-term development, considering turbulence in ore, coal, and oil prices and use of alternative energies and natural energies. Trade demands for major bulks will be driven up to a periodical high, while transport demands for bulk-handling ports will decline. Container shipping will slow down due to trade tensions, but needs for regional container terminals remain. Construction need for container terminals in 2019 is expected to be higher than bulk cargo terminals.

9.1.3 Global terminal operators to seek in-depth development

- **Diversification of terminal operator investment**

Global terminal operations do not limit their investments on terminals. Globally, terminal resources with investment value have been shrinking. Investors have been increasingly cautious on investment decisions. Their investment strategies have changed to investing on existing ports to improve logistics infrastructures and transport accessibility. Global operators have been investing on offshore shipping companies, back-end logistics infrastructure, collection and delivery channels, and inland container depots. In 2019, global operators are expected to continue this strategy, and expand asset investments further to industrial upstream and downstream and deeper into the inland, so as to improve terminal asset value while expanding asset capacity. In the area of operation, global terminals will see drop in container volume growth, in particular those working on terminal operation and having no stake in shipping companies.

9.2 Development Trend of Chinese Ports

In 2019, it is expected that the Chinese economy will record a stable growth rate of 6%, along with stable domestic economy and uncertainty in export-oriented sectors due to ongoing trade tensions. But as China has adopted open policies and expressed willingness to negotiate with the US and reform the industries, a consensus is expected to be reached within the year. As China will further liberalize its industries in response to anti-subsidy and anti-protectionism, it is expected that China will apply "zero subsidy" on exports in 2019, which will in turn undermine its global competitiveness. But export trade is expected to sustain growth, as China has strong collaboration with globally complementary industries. The 2019 outlook for export is good for China, but at a lower rate of growth, with an anticipated port handling volume of 2.5% higher than the previous year.

- **Container throughput growth to shrink, while export trade expected to increase**

China's container volume handled by ports has undergone long-term development. Container trade has been growing rapidly after China started to further liberalize the markets in 2010, along with a globalized industrial system and consumption market, as well as pro-trade policies. Consequently, it has a weaker growing momentum amid increasing trade tensions. Subject to the impact of a transport mode change of "bulk-to-container" and environmental protection incentives, China already has a high degree of containerization, and a lower level of cargoes to be containerized. Overall, the container throughput growth of Chinese ports in 2019 will further drop to 3.8%.

- **Dry bulk throughput to drop sharply, and liquid bulks to maintain steady growth**

As global bulk throughput growth further slows down, China's dry and liquid bulk trade has shrunk. Due to lower domestic needs from infrastructure, housing and industries, demand for iron ore and coal has dropped significantly, evidenced by the negative growth in iron ore import, and moderate shrinkage of coal trade. Import of oil liquid bulk cargoes sustains steady growth, while it is expected to also slow down due to higher oil product prices as oil producers cut down production for greater profits. Impacted by global trade frictions, China's trade surplus will narrow. To maintain certain level of foreign exchange reserve, China will control its import of major bulks. In conclusion, China's dry bulk throughput will further decline in 2019 and even dip into negative growth, while liquid bulk throughput will witness weaker growth

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About Shanghai International Shipping Institute

Founded on July 14, 2008, Shanghai International Shipping Institute (SISI) was inaugurated by government officials from the 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, and Shanghai University of International Business and Economics. Our registered council members total nearly 400 as of September 2015.

Against the backdrop of Shanghai International Shipping Center 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 concepts, technologies and trends in the global maritime circle.

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.

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SISI serves as a key government think tank. In August 2012, the 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 developing 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 the 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 a think tank for government maritime policymaking and an advisor for industry players, and strive to be a world-famous consultancy specializing in shipping.

- Function 2. Information release

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- Function 3. Talent service

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

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