Global Port Development Report (2019)

Shanghai International Shipping Institute (SISI)

May 2020

Preface

The world economy growth continued to be moderate in 2019, along with a loss of momentum. Some economies represented by the United States announced protectionist policies, raising global trade barriers and complicating the global trade order, leading to a slow-down of the trade growth. This had a cascading effect as the world seaborne trade growth also fell. In addition, the global port industry also began facing new challenges such as surging shipping cost because of the low-sulfur fuel oil restriction and crippled trade demand because of the COVID-19 pandemic, putting the port and shipping industries under multiple pressures.

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 2019 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 2019; 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 2020. 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 (2019)* 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.

Shanghai International Shipping Institute

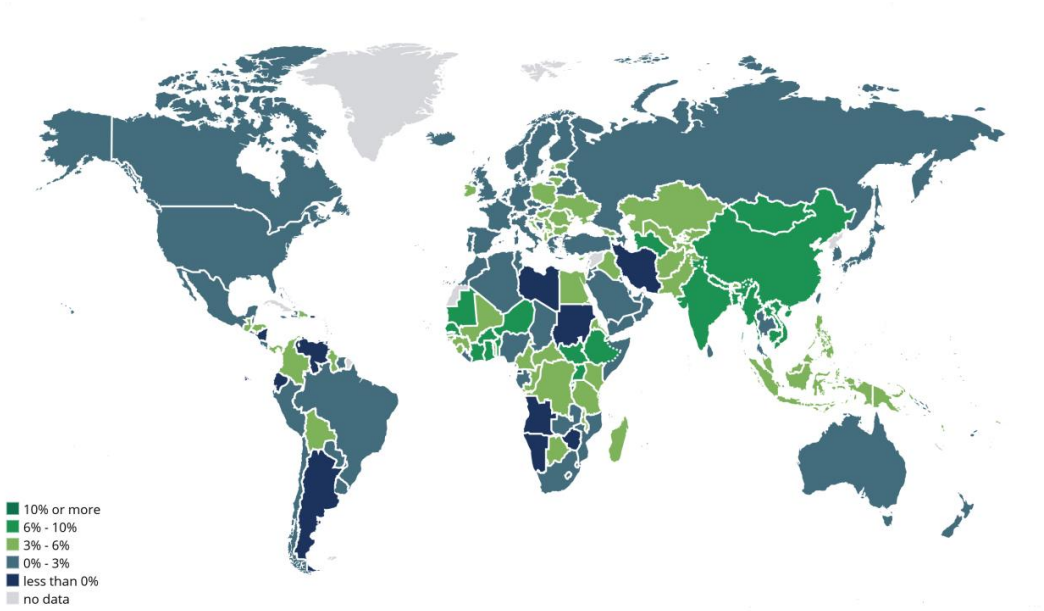
May 2020

CATALOG

I. Overview of Port Development Environment in 2019

1.1 Overview of Global Economic Development

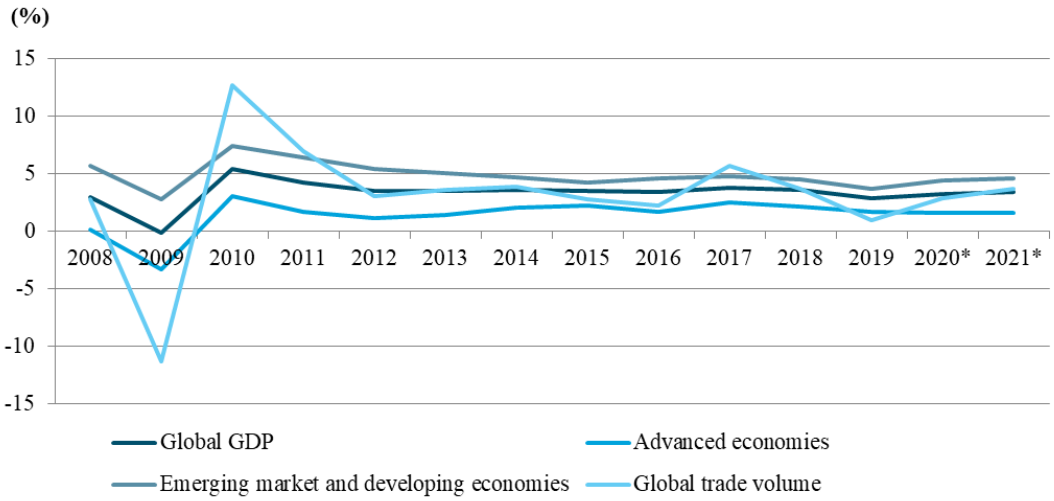
The world economy grew slowly in 2019 with the sluggish momentum continuing. The global economy continued to head downward in 2019, with major economic indicators falling to historical lows. The International Monetary Fund (IMF) forecast a global economic growth rate of 2.9% for 2019, a new low since 2009, in its *World Economic Outlook* released in January 2020, 0.1 percentage points lower than the projection issued in the October 2019.



Source: IMF data.

Figure 1-1 GDP Growth Rate of Major Global Economies in 2019

Since the international financial crisis in 2008, the world economy failed to recover even after 11 years. In 2018 and 2019, the global economy continued to stay sluggish, and the economic growth of major economies slowed down. Specifically, the US economy fell by 0.6 percentage points due to trade frictions; Europe (especially Germany) introduced a new standard for automobile emissions, resulting in weakened external demand and supply; a number of emerging markets and economies such as Brazil, Mexico and Russia also witnessed economic slowdown.



Note: * indicates projections.

Source: IMF data.

Figure 1-2 Growth Rate of Global Economy (2008-2021)

Table 1-1 GDP Growth Rate of of Major Economies

Major economies	2018	2019	Change(Percentage)
United States	2.9	2.3	-0.6
Germany	1.5	0.5	-1.0
United Kingdom	1.3	1.3	0
Italy	0.8	0.2	-0.6
China	6.6	6.1	-0.5
Japan	0.3	1	0.7
Mexico	2.1	0	-2.1
Brazil	1.3	1.2	-0.1
South Africa	0.8	0.4	-0.4
Russia	2.3	1.1	-1.2

Source: IMF data.

1.2 Overview of Global Trade Development

The latest World Trade Outlook Indicator (WTOI) released by the WTO showed that the WTOI for all the four quarters of 2019 was below 100, the lowest level since March 2010. This trade growth slowdown was a comprehensive result of multiple factors, including the downturn in investment, the impact of intensified trade tensions on capital goods (the areas with high transaction volumes), the technology cycle, and the sharp decline in auto and auto parts trade.

Table 1-2 Growth Rate of Global Trade Volume (2015-2019)

		2015	2016	2017	2018	2019*	Change(%)
Global Trade Volume		2.3%	1.6%	4.6%	3.0%	1.2%	-1.8
Export：	Developed countries	2.4%	1.0%	3.6%	2.1%	0.4%	-1.7
	Developing countries	1.7%	2.3%	5.6%	3.5%	2.1%	-1.4
Import：	Developed countries	4.2%	2.0%	3.3%	2.5%	1.6%	-0.9

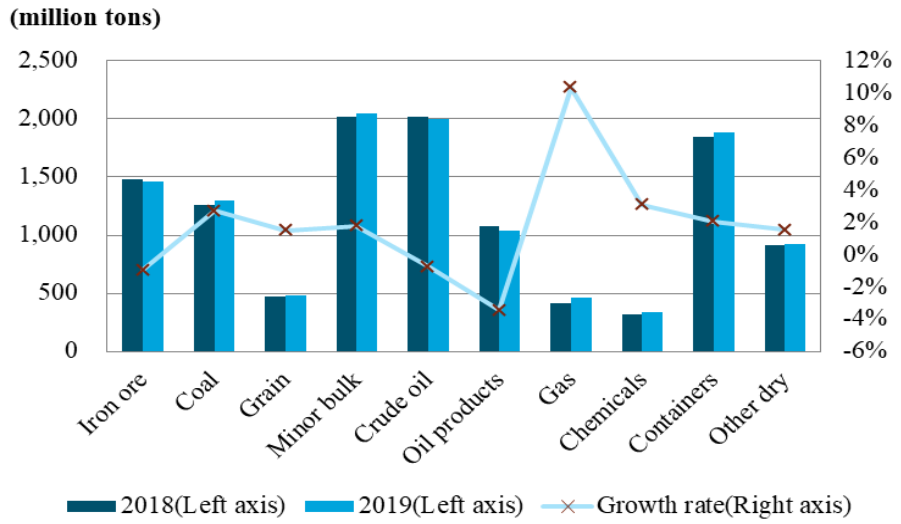
Developing countries	0.6%	1.3%	6.8%	4.1%	1.1%	-3.0

Note: * indicates projections.

Source: WTO.

1.3 Overview of International Shipping Market Development

The global seaborne trade remained weak in 2019. The trade volume is expected to be 12 billion tons, with just 1% of growth, the lowest growth rate since 2009.

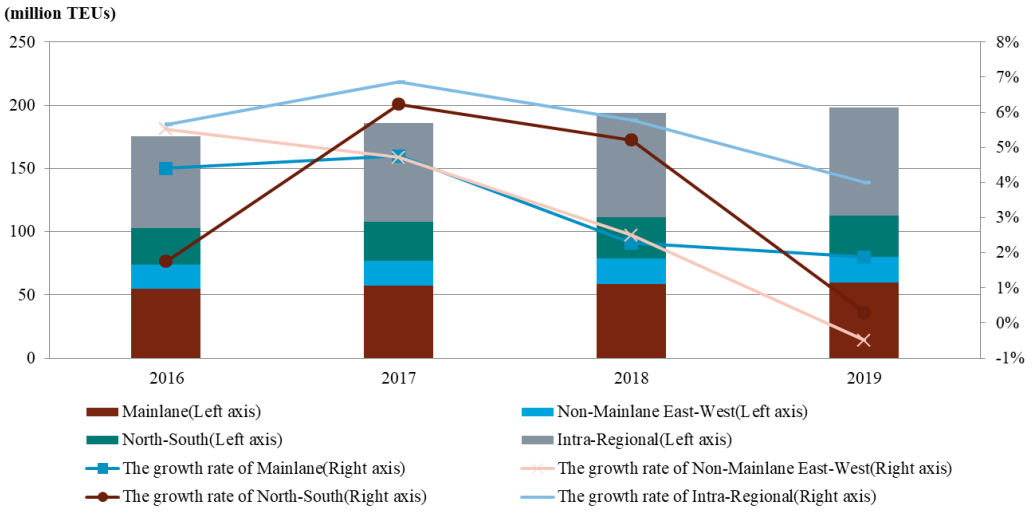


Source: Clarkson website.

Figure 1-3 Growth Rate of Seaborne Volume of Global Cargo by Different Types (2018-2019)

1.3.1 Growth of Global Container Volume Slowed Down

The international seaborne containers were expected to grow by 2.1% to 1.9 billion tons in 2019, which was nearly half of the 4.3% growth seen last year. Specifically, the growth decline on the east-west non-mainlane was the major contributor to the slowed growth of global seaborne containers. The trade growth on mainlane was limited in 2019, primarily due to the negative impact of US-China tariffs on trans-Pacific trading volume during peak seasons. In general, the shipping volumes of various routes were basically the same as those in 2018.

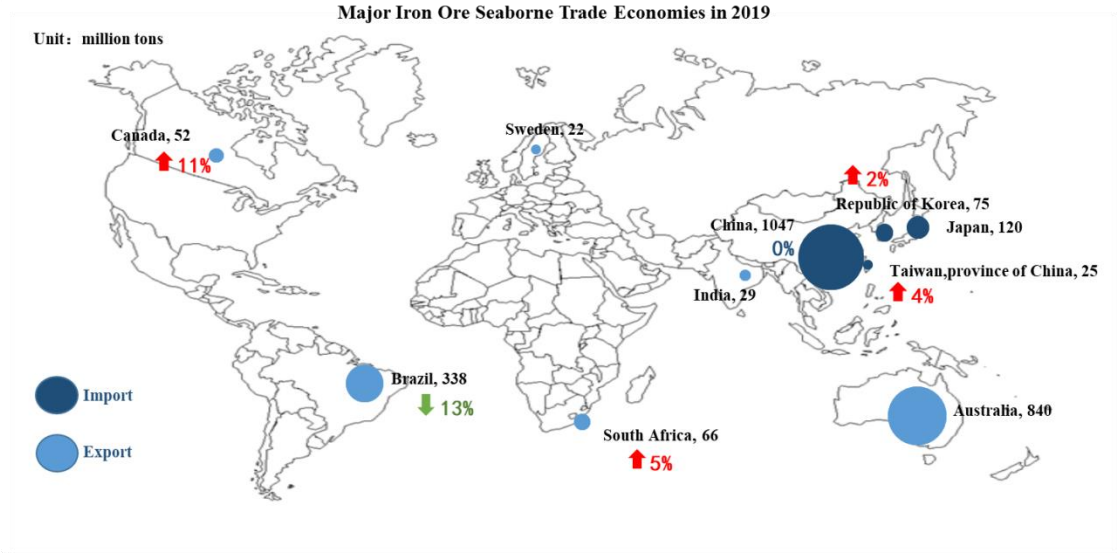


Source: Clarkson website.

Figure 1-4 Container Shipping Volume and Growth Rate of Various Routes around the world (2016-2019)

1.3.2 Global major bulks growth remained sluggish

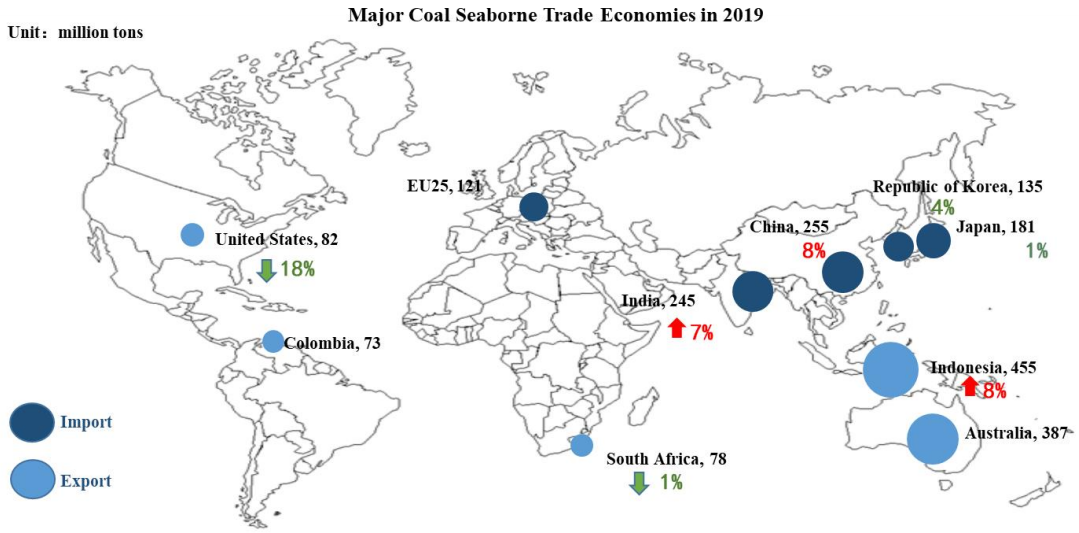
Growth rate of shipping volume demand continued to slow down in the year, and iron ore trade demand declined. In 2019, the global dry bulks shipping volume in 2019 was about 5.3 billion tons, up by 1.2% year-on-year, with the year-on-year growth rate continuing to decline. Specifically, iron ore totalled 1.5 billion tons, down by 1% year-on-year; coal, 1.3 billion tons, up by 2.7% year-on-year; grain, 479 million tons, up by 1.5% year-on-year; and minor bulks, 2.1 billion tons, up by 1.8% year-on-year. In 2019, China's iron ore market was severely impacted as the mine mishap of Vale of Brazil and the hurricanes in Australia undermined iron ore trade volumes. While China's imports from major mines kept declining, its imports from non-major mines increased significantly, with the imports from India, Ukraine and Canada rising by the widest margins.



Source: Clarkson website.

Figure 1-5 Import and Export Seaborne Volume of Global Iron Ore in 2019

Global coal shipping volume showed an obvious growing trend. China's coal imports maintained the high-speed growth, and Vietnam's coal demand soared. China retained its coal importing advantage because of the continued wide gap between domestic and foreign coal prices. In 2019, China was expected to import a total of 255 million tons of coal, up by 8% year-on-year. The coal demand in Southeast Asia continued to rise at high speed. Specifically, Vietnam posted the most eye-catching performance. Throughout the year, Vietnam's coal imports totalled 43.9 million tons, a year-on-year increase of 91.9%, nearly doubling the 22.9 million tons in 2018. India's coal imports in the year were expected to reach 245 million tons totally, a year-on-year rise of 7%.

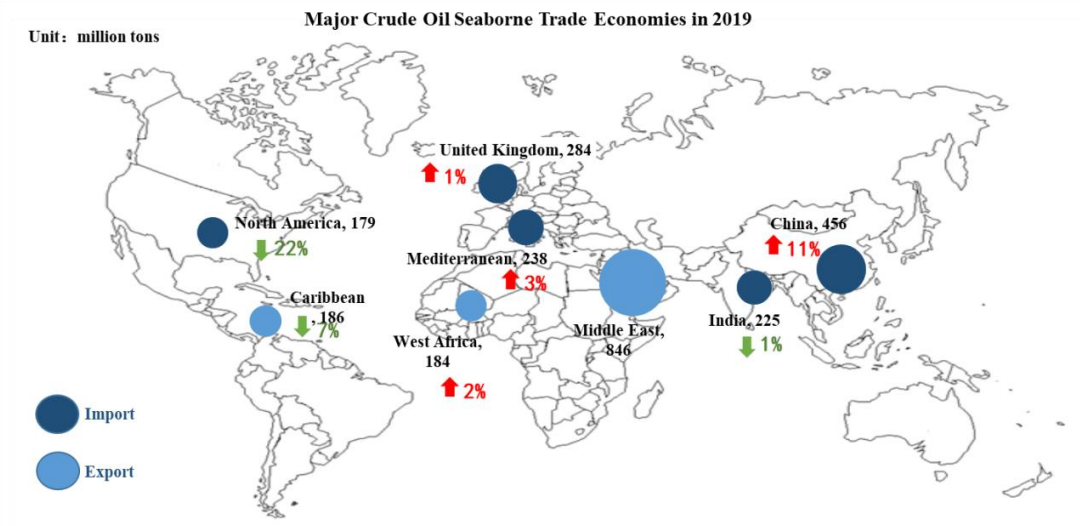


Source: Clarkson website.

Figure 1-6 Import and Export Seaborne Volume of Global Coal in 2019

1.3.3 Global liquid bulks growth sliped

In 2019, the global seaborne crude oil trade volume is expected to decline by 0.7% year-on-year to 2 billion tons due to the entry into force of the OPEC and non-OPEC oil producing countries' agreement to cut production by 1.2 million barrels per day and the significant decline in the US trade volume. In addition, the prolonged connecting time of refineries in some regions, weak refining margins, and weak oil demand growth globally have also imposed pressure on imports in some nations. Although China's crude oil imports increased by 11% in 2019, this rise seems insufficient to offset the declines in imports in other regions. In the United States, the sustained rapid growth of domestic oil production has seriously undermined the annual import trade volume. The seaborne crude oil imports in North America are expected to decline by 22% year-on-year.



Source: Clarkson website.

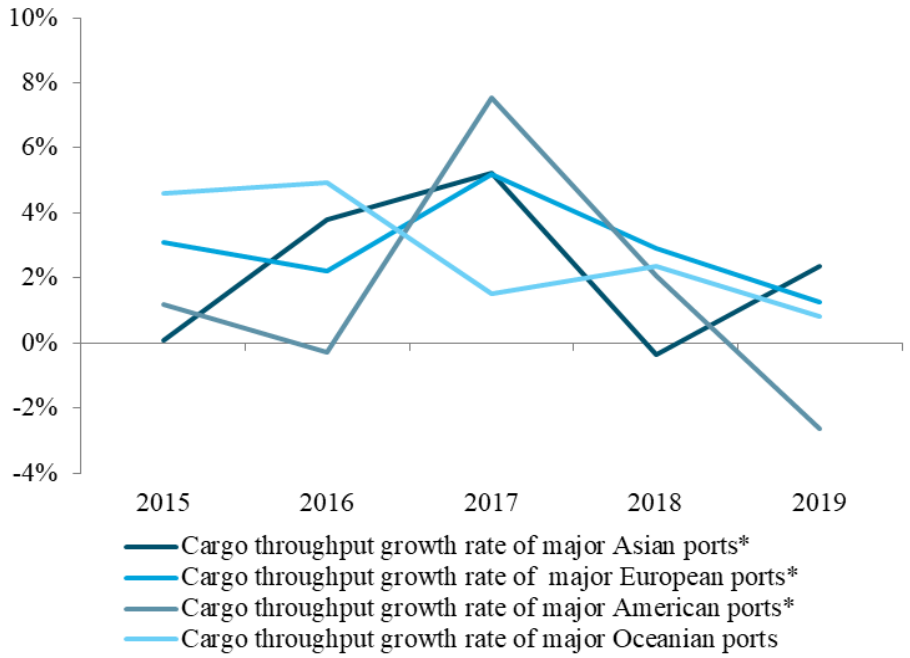
Figure 1-7 Import and Export Seaborne Volume of Global Crude Oil in 2019

II. Comments on Port Production Situation in 2019

2.1 Overview of Cargo Throughput at Global Ports

2.1.1 Analysis of cargo throughput of global ports

In 2019, the cargo throughput growth of grobal major ports remained low on the whole. About 75% of major ports recorded a growth rate in the range of 5% to -5%, with 12% of all ports posting a growth rate above 5%, and these ports were primarily in China and Europe. About half of the ports' cargo throughput growth fell into the negative range, and these ports were mostly in Japan, South Korea, and other Asian regions excluding China, as well as the Americas.

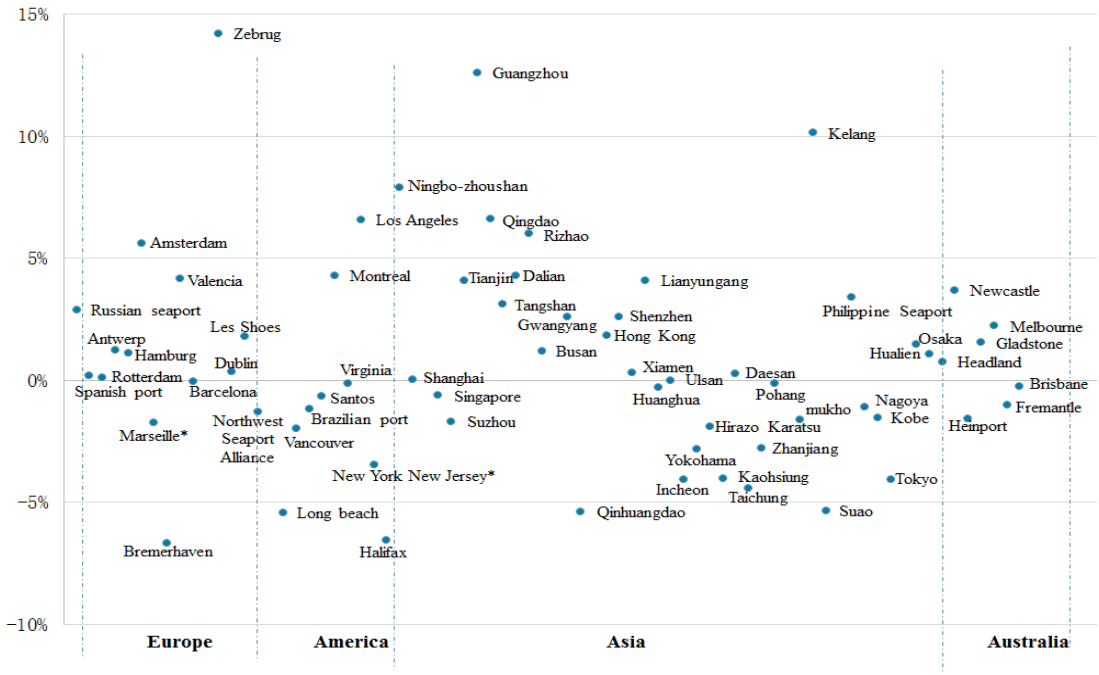


Note: * indicates projections.

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

Figure 2-1 Cargo Throughput Growth Rate of Grobal Major Ports in Various Regions (2015-2019)[1]

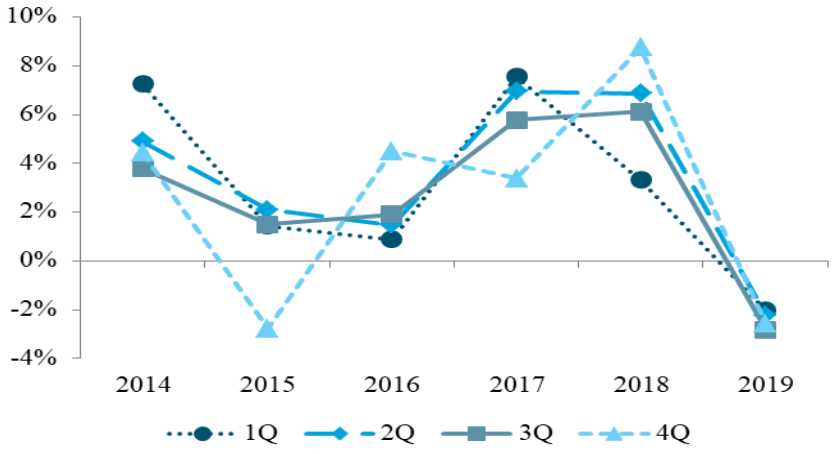
[1]The global major ports refer to ports which statistic data are available. The throughput of global major ports in this report accounts for about 65% of the global port throughput.



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

Figure 2-2 Cargo Throughput of Global Major Ports in 2019

Throughput growth of global ports in 2019 slowed down quarter by quarter. Quarter-wise, the global economy showed a significant decline in the first quarter of 2019. The intensified US-China trade frictions forced cargo owners into a rush to transport cargoes in advance in the fourth quarter of last year, overdrawing the cargo shipping demand and suppressing the growth of port throughput. The growth of global major ports fell by 5.3 percentage points. In the second quarter, the global economic and trade environment deteriorated, and trade growth stayed low. The trade frictions between major economies in the world suppressed the growth of port throughput, which led to a decline in global port throughput growth in the second quarter; the intensified trade frictions and geopolitical tensions in the world continued to suppress the growth of port throughput.



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

Figure 2-3 Cargo Throughput of Global Major Ports by Quarter (2014-2019)

Among the global top 20 ports in terms of cargo throughput, except the ports in China which recorded stable throughput growth overall, all other ports maintained a relatively low growth rate. Among China's ports, Ningbo Zhoushan Port ranked first in the world with an absolute advantage of 1.12 billion tons of throughput; Zhenjiang Port became the fastest growing port because of themeasures taken to resolve illegal inland river terminals and the sound growth of Zhenjiang's infrastructure investment. Among international ports, Port of Rotterdam, Port of Hedland, and Port of Busan continued to record low growth rates, while Port of Singapore recorded negative growth in production.

Table 2-1 Global Top 20 Ports by Cargo Throughput in 2019

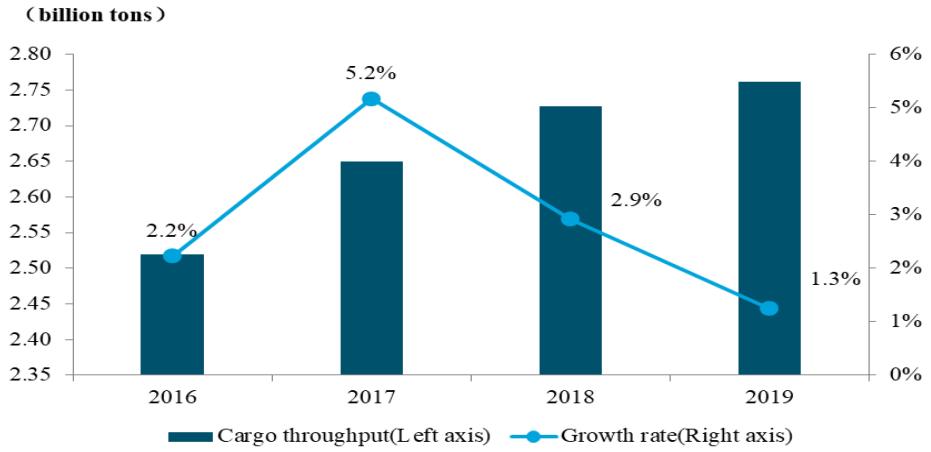
Ranking	Port	2019(million tons)	2018(million tons)	YoY growth rate
1	Ningbo Zhoushan	1120.09	1038.08	7.9%
2	Shanghai	716.77	716.59	0.0%
3	Tangshan	656.74	636.99	3.1%
4	Singapore	626.18	630.13	-0.6%
5	Guangzhou	606.16	538.33	12.6%
6	Qingdao	577.36	541.61	6.6%
7	Suzhou	522.75	531.79	-1.7%
8	Headland	521.88	517.99	0.8%
9	Tianjin	492.20	472.81	4.1%
10	Rotterdam	469.40	468.98	0.5%
11	Rizhao	463.77	437.52	6.0%
12	Busan	455.91	450.22	1.3%
13	Yantai	386.32	333.61	15.8%
14	Dalian	366.41	351.30	4.3%
15	Nantong	336.20	265.98	26.4%
16	Zhenjiang	329.16	157.72	108.7%
17	Huanghua	287.16	287.16	0.0%
18	Taizhou	282.43	255.13	10.7%
19	Gwangyang	276.04	268.13	3.0%
20	Hong Kong	263.32	258.54	1.8%

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

2.1.2 Analysis of cargo throughput at ports by region

1. Cargo throughput of European ports grew slower

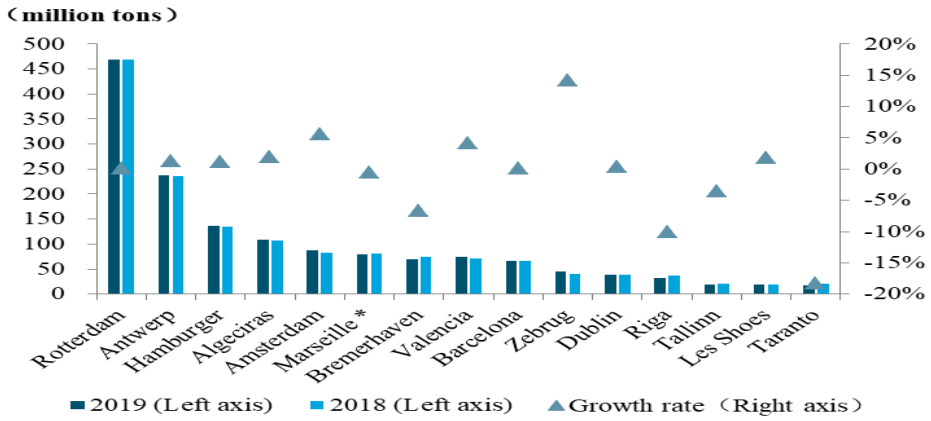
The economic growth in Europe was weak in 2019, with the growth rates of all economies slowing down synchronously and external demand continuing to shrink. In addition, due to the continued impacts of the Brexit uncertainty and the escalated trade frictions between Europe and the United States, the trade situation in Europe was depressed, restraining the growth of European port throughput.



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

Figure 2-4 Cargo Throughputs and Growth Rates of Major Ports in Europe (2016-2019)[2]

Among main ports covered in statistics, Port of Rotterdam was negatively impacted by the weak economy in Europe and the trade slowdown in Asia, and recorded an annual cargo throughput of 470 million tons, a rise of only 0.1% year-on-year. Port of Antwerp's liquid bulks throughput growth fell by 5.0% year-on-year, with an annual total cargo throughput of 240 million tons, an increase of 1.2% year-on-year. Port of Hamburg, boosted by the new liner service and the trade agreement between the European Union and Singapore, recorded an annual cargo throughput of 140 million tons, a rise of 1.1% year-on-year. Port of Amsterdam was driven by the strong growth in exports to non-traditional markets (such as Asia and the Black Sea region), recording an annual total cargo throughput of 86.9 million tons, a year-on-year increase of 6%. With a growth rate of 14.2%, Port of Zeebrugge became the fastest-growing port among European ports. Meanwhile, Russian seaports maintained a low growth rate of 2.9%, handling a total cargo throughput of 840 million tons this year.



Note: * indicates projections.

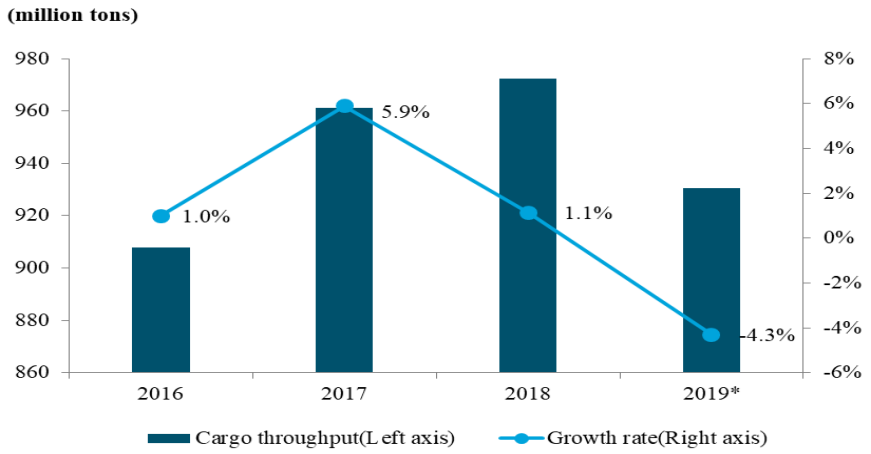
Source: Websites of various port authorities, sorted by SISI.

Figure 2-5 Cargo Throughput and Growth Rate of Major Ports in Europe (2018-2019)

[2] Major ports in Europe in this report only cover those with statistic data available. The statistics may be not exhaustive, so the data only reflects the growth trend of port trade in Europe.

2. Growth of North American ports declined dramatically, while South American ports remained sluggish

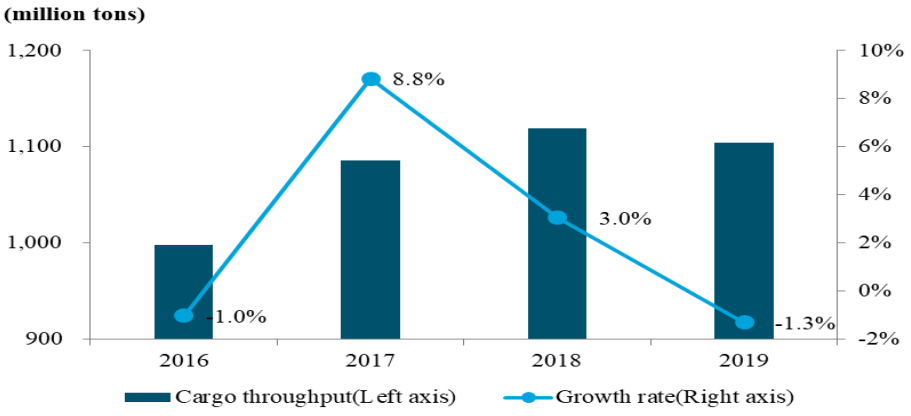
In 2019, constrained by unfavorable factors such as unstable consumption performance, declining private investment, and worsening trade deficit, the economic growth of the US, a major North American economy, slowed down, which dealt a heavy blow to the West Coast ports, espectioally Los Angeles and Long Beach. Economic growth of Mexico and Brazil in South America was weak, and trade growth in the Latin America region was restrained, which slowed down the production of American ports to a certain extent.



Note: * indicates projections.

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

Figure 2-6 Cargo Throughput and Growth Rate of Major Ports in North America (2016-2019)[3]



Note: * indicates projections.

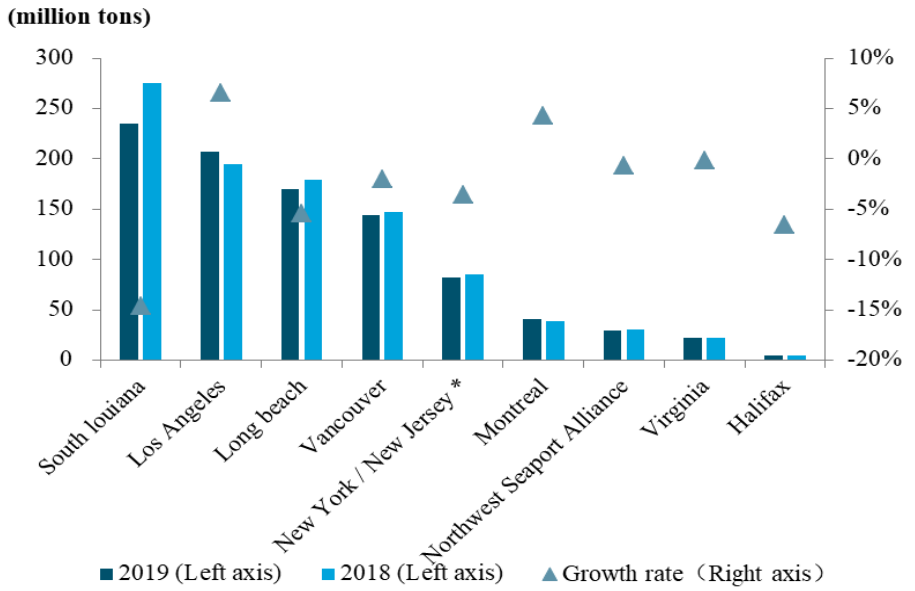
Source: Websites of various port authorities, sorted by SISI.

Figure 2-7 Cargo Throughput and Growth Rate of Major South American Ports (2016-2019)[4]

[3] Major ports in North American in this report only cover those with statistic data available. The statistics may be not exhaustive, so the data only reflects the growth trend of port trade in North American.

[4] Major ports in South American in this report only cover those with statistic data available. The statistics may be not exhaustive, so the data only reflects the growth trend of port trade in South American.

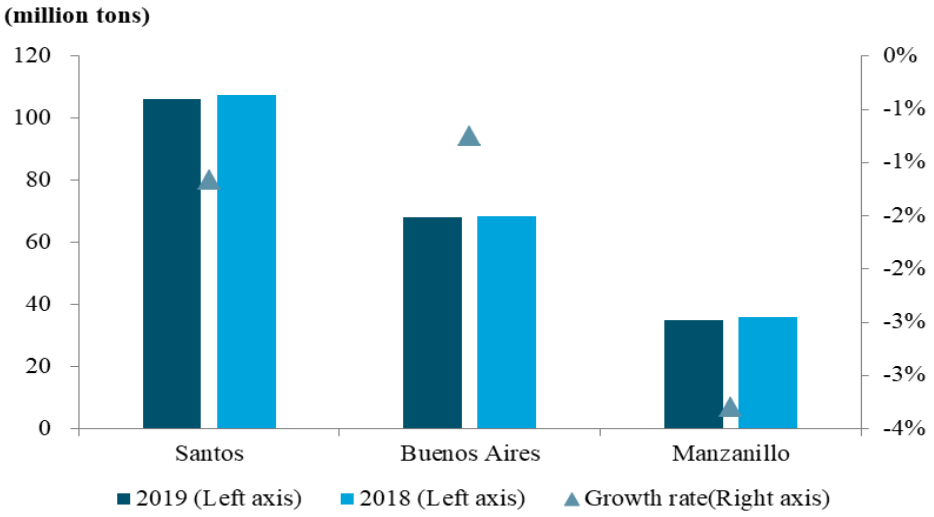
Among North American ports, Port of Long Beach on the West Coast recorded a cargo throughput of 170 million tons in 2019, a year-on-year decrease of 5.4%. Among South American ports, Brazilian ports' throughput fell slightly by 1.3%, of which the cargo throughput growth of Port of Santos decreased by 1.2%. In addition, Port of Buenos Aires and Port of Manzanillo both recorded negative growth in cargo throughput.



Note: * indicates projections.

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

Figure 2-8 Cargo Throughput and Growth Rate of Major Ports in North America (2018-2019)

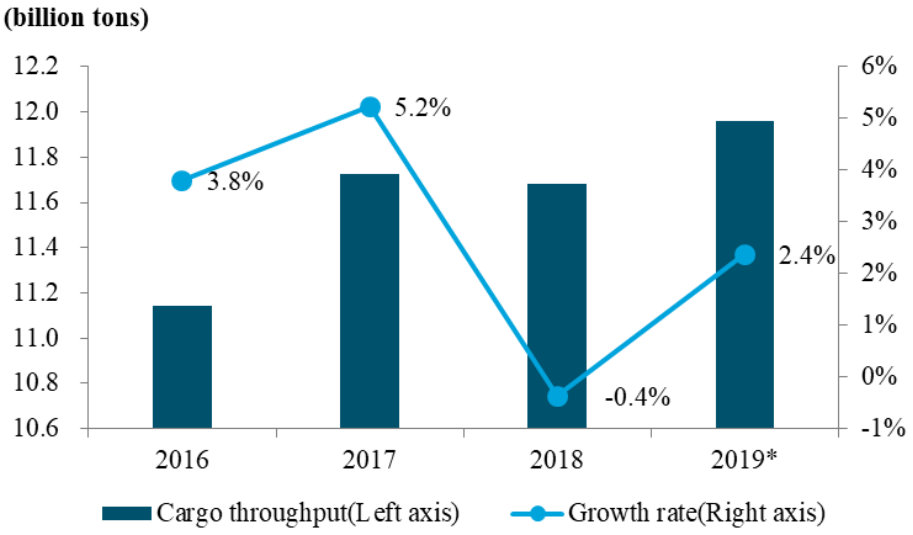


Source: Websites of various port authorities, sorted by SISI.

Figure 2-9 Cargo Throughput and Growth Rate of Major Ports in South America (2018-2019)

3. Throughput of Asian ports grew slowly overall

Asia's economic growth slowed down in 2019. Specifically, the economic growth in East Asia slowed down; the new retail tax policy in Japan affected the economic recovery momentum; the economic growth of China slightly slowed down impacted by the US-China trade frictions; the exports of Southeast Asian economies continued to decline, with falling investment; and the expected growth rates of Singapore and Thailand were revised down. However, benefiting from the steady progress of trade cooperation between China and ASEAN as well as between China and the economies involved in the Belt and Road Initiative, the import and export trade values increased by 14.1% and 10.8%, respectively, and the cargo throughput growth of Asian ports maintained steady growth on the whole, being 2.4 percentage points higher year-on-year.

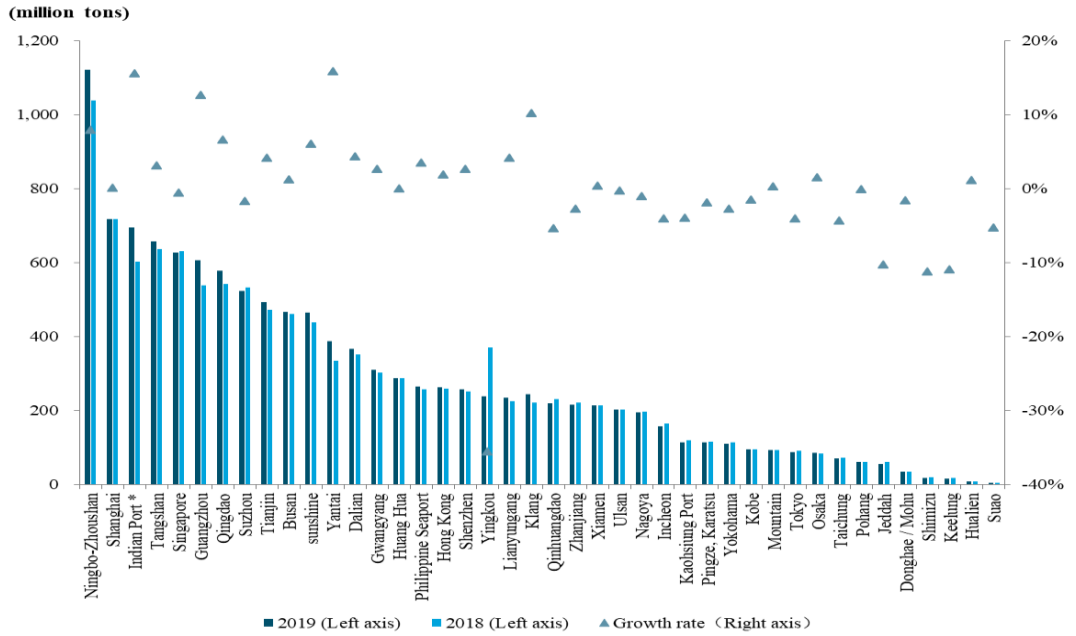


Note: * indicates projections.

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

Figure 2-10 Cargo Throughput and Growth Rate of major Asian ports (2016-2019)

Among major ports, China's ports performed well, with Guangzhou Port and Yantai Port recording strong growth in cargo throughput, namely by 12.6% and 15.8%, respectively. Affected by the trade frictions between Japan and Korea and the weak economic growth of the country, the cargo throughput of South Korean ports only rose by 0.1% year-on-year. Port of Singapore, whose prosperity relies on international trade, recorded only 630 million tons of cargo throughput in 2019, a year-on-year fall of 0.6%, due to the stagnant global trade. Meanwhile, Indian ports benefited from improved port mechanization and strong growth in iron ore transshipment, and handled a total of 690 million tons of cargoes in the year, a year-on-year increase of 15.5%.

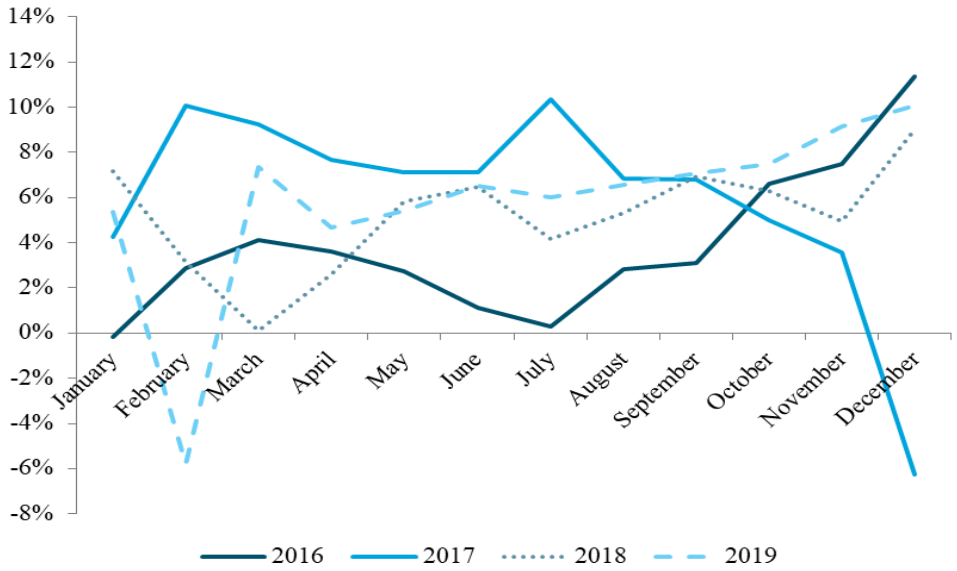


Note: * indicates projections.

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

Figure 2-11 Cargo Throughput and Growth Rate of Major Asian Ports (2018-2019)

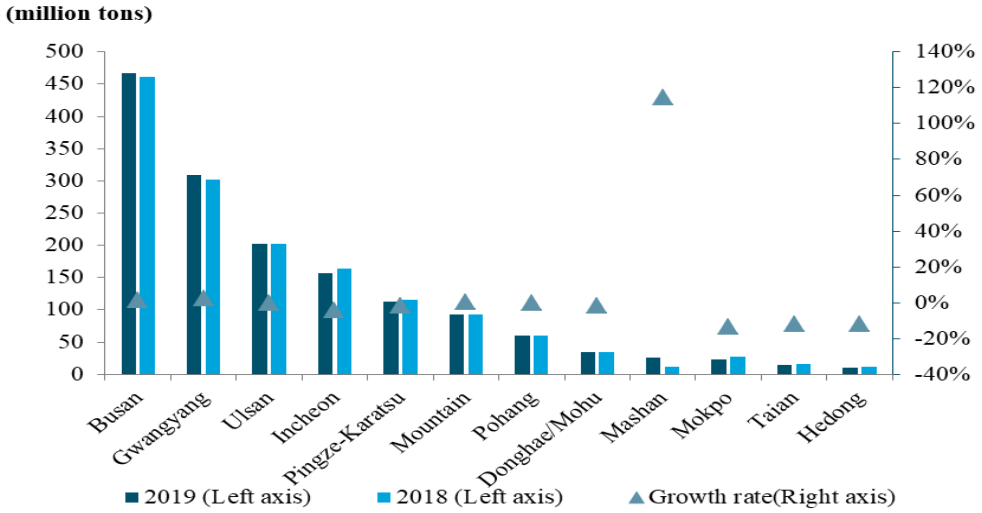
China's ports maintained strong growth in cargo throughput. China's consumption growth in 2019 gained speed on an already high base. Its inland ports recorded strong growth in cargo throughput boosted by the domestic demand and became the main driver for cargo throughput growth of ports in China. With this boost, China's ports which have a designated scale or above accomplished 13.95 billion tons of cargo throughput, rising by 8.8% year-on-year.



Source: Ministry of transport of the people's republic of China, sorted by SISI.

Figure 2-12 Growth Rate of Cargo Throughput of Major Chinese Ports (2016-2019)

Growth of South Korean ports dipped. South Korea's economic growth reached a 10-year low in 2019, namely just 2%. The deteriorated bilateral trade relations between Japan and South Korea further crippled the the cargo throughput increases of ports in South Korea. Major ports in South Korea recorded a cargo throughput of 1.64 billion tons in the year, rising by 0.1% year-on-year. Specifically, Port of Incheon recorded 160 million tons, down by 4.1% year-on-year.



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

Figure 2-13 Cargo Throughput and Growth Rate of Major South Korean Ports (2018-2019)

Southeast Asian ports managed to sustain slow growth. Southeast Asian economy showed signs of weakness overall in 2019. Vietnam benefited from the industry transfer from other economies, especially the transfer from China, and sustained a high growth rate in annual GDP by 7%. Singapore and Thailand recorded a GDP growth rate of 0.7% and 2.4%, respectively, hitting a 10-year and five-year low, respectively. The economic growth of other Southeast Asian economies also slowed down. As an economically open city, Singapore was exposed to the weak global economic and trade environment and recorded an annual cargo throughput of 630 million tons, a year-on-year decline of 0.6%.

Table 2-2 Cargo Throughput and Growth Rate of Major Southeast Asian Ports

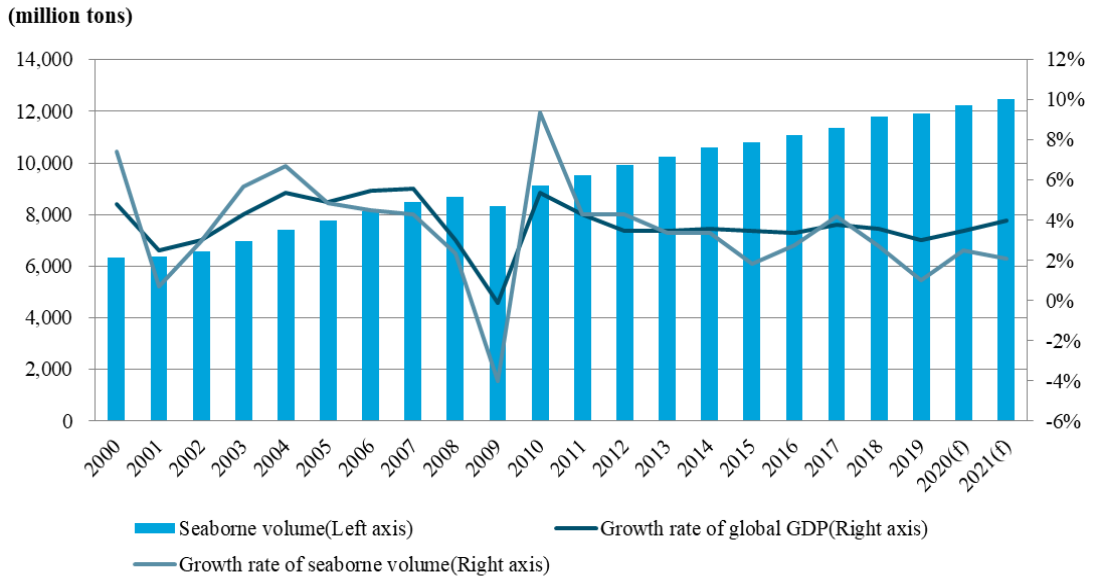
(unit：million tons)

Port	2016	2017	2018	2019	Growth rate(2018)	Growth rate(2019)
Philippines	243.76	253.56	256.33	265.08	1.1%	3.4%
Malaysia	567.02	533.61	567.57	595.24	6.4%	4.9%
Singapore	593.30	627.69	630.13	626.18	0.4%	-0.6%

Feature 1: Global Port Development Scale and Expected Growth by Region

I. Trends of global seaborne trade

As the economy develops, the global demand for raw materials, energy and consumer goods also increases, resulting in the rising global seaborne trade demand, which is highly related to the world economy. From 2000 to 2019, the average growth of the global seaborne trade volume was 3.6%. During that period, the Asian financial turmoil and the US subprime crisis led to negative growth of the global seaborne trade volume in 2009. The world's seaborne trade fluctuated significantly along with the world economy. After the subprime crisis, the asset prices were unprecedentedly inflated and the the real economy was stagnant with the continuous liquidity releases by the central banks of various economies,which further contracted the average growth of seaborne trade which has lagged behind the economic growth in recent years.

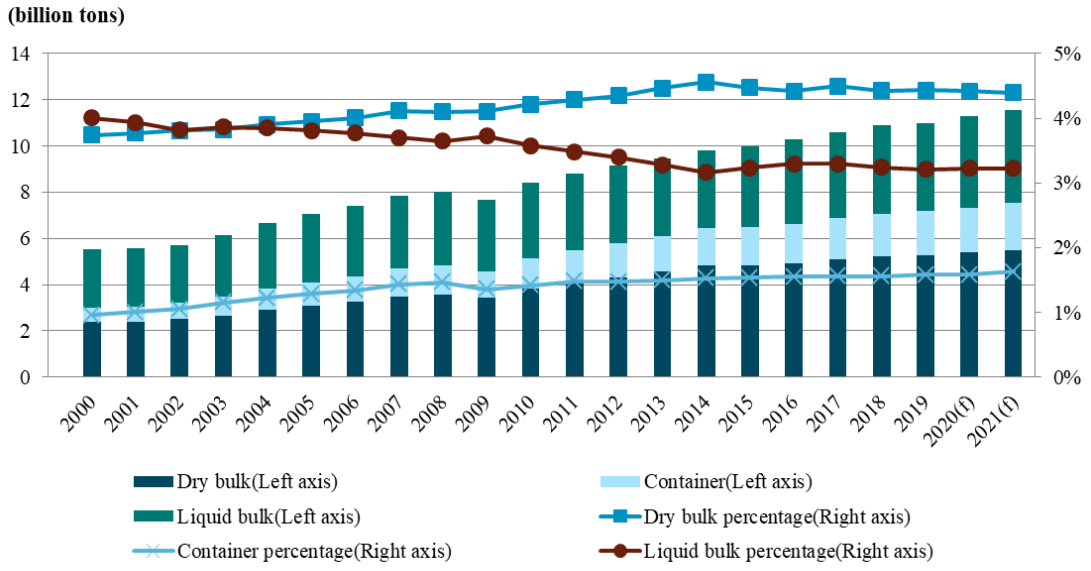


Source: Clarkson website.

Figure 1 Growth Rate of Global GDP and Seaborne Trade Volume (2000-2021)

In recent years, due to the insufficient new economic drives in various economies, the recovery of developed economies such as Europe and the United States has been slow, the economy of developing economies has been restructured, and the growth has slowed down. The world's seaborne trade volume has stepped on a low-speed growth track.

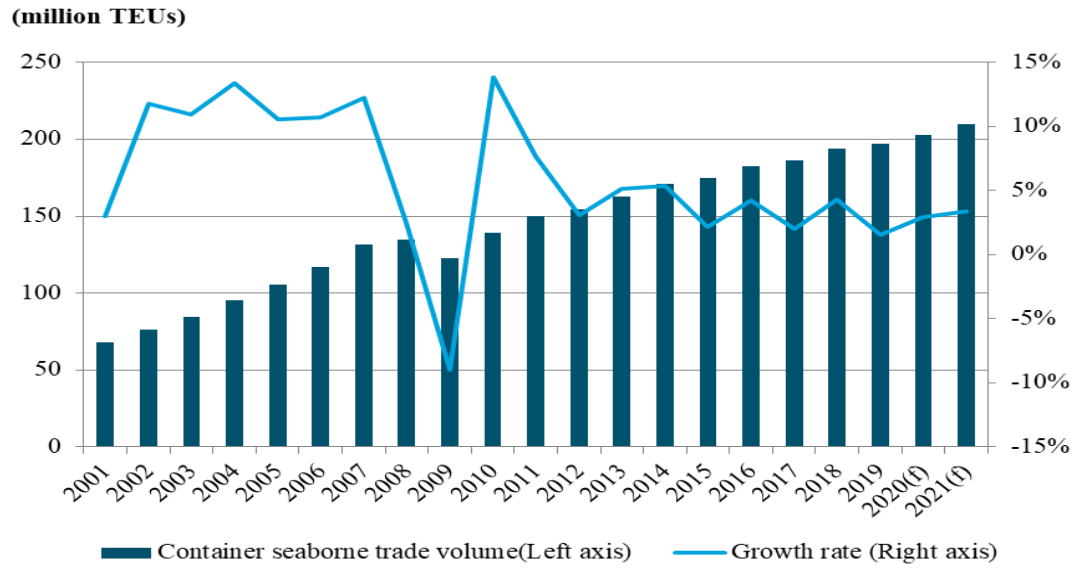
From the perspective of seaborne trade structure, the shares of container and dry bulks shipping volumes in the total global shipping volume have been on a rise year by year in the past 20 years, while the share of liquid bulks has been going down overall.



Source: Clarkson website.

Figure 2 Changes in the Global Trade Structure of Various Goods (2000-2021)

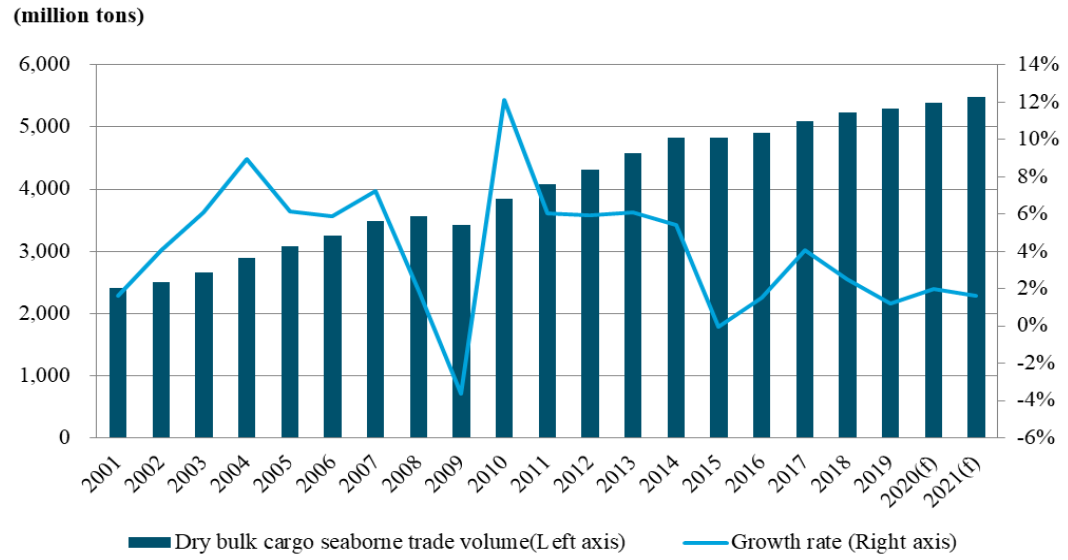
With people's living standards improving, their sensitivity to prices decreases, and they become more concerned about quality and efficiency. The fundamental concept of trade has also gradually shifted from comparative advantages to competitive advantages. Because of the inherent safety and convenience of container shipping, the containerizeable cargo sources have grown rapidly in recent years. In addition, with the popularization of the e-commerce trade model globally, more and more cargoes are transported through containers, which has driven up the share of containerized shipping year by year. However, the global container trade growth has been growing at a low rate since the global financial crisis in 2008.



Source: Clarkson website.

Figure 3 Seaborne Trade Volume and Growth Rate of Global Container (2001-2021)

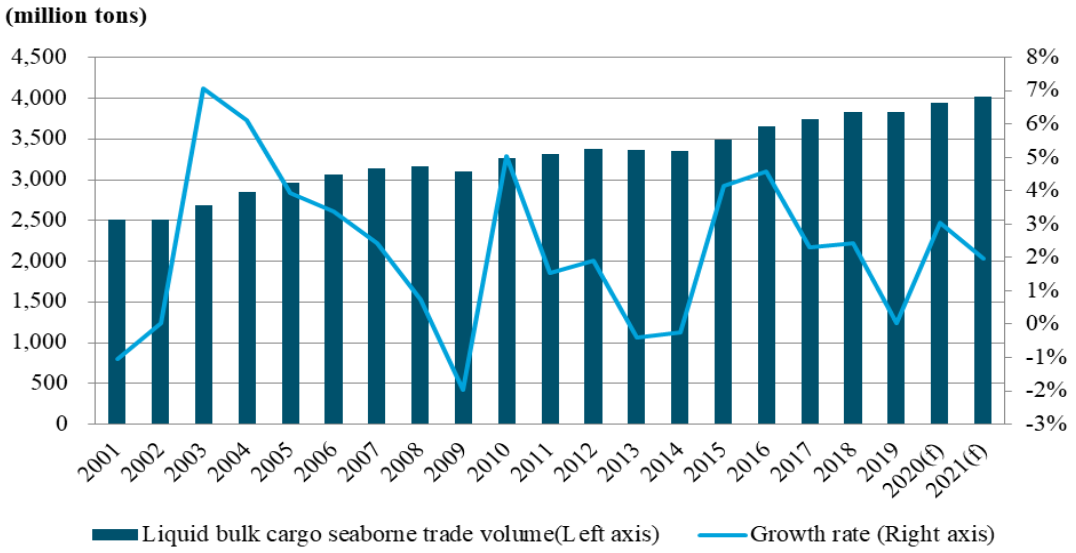
Driven by major bulks shipping, dry bulks shipping has maintained about 6% of annual growth on average after a peak in 2010, until its first negative growth in 2015. The growth rates of dry bulks trade have been on a decline since 2017, but its share has increased by 7 percentage points to 43.3%.



Source: Clarkson website.

Figure 4 Seaborne Trade Volume and Growth Rate of Global Dry Bulk Cargo (2001-2021)

From 2000 to 2019, the global crude oil trade volume grew at a low rate, and its share in global trade declined year by year, as a result of the rapid development of clean energy. Solar energy, wind energy, and electrical energy gradually replaced crude oil as the main energy sources, resulting in the sluggish growth of global demand for crude oil.



Source: Clarkson website.

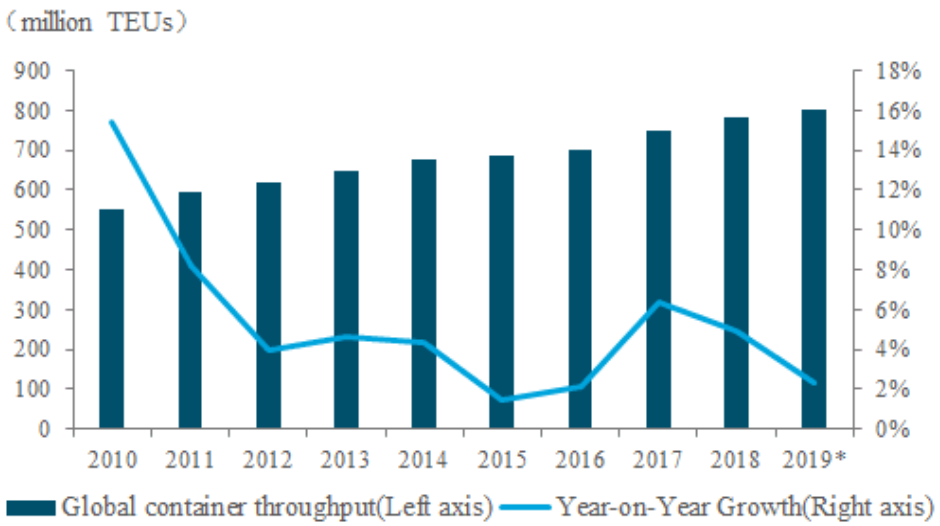
Figure 5 Seaborne Trade Volume and Growth Rate of Global Liquid Bulk Cargo (2001-2021)

In summary, the global seaborne trade structure has changed in the past 20 years, and the share of containerized shipping has gradually increased. However, the global economy has maintained

moderate growth since the financial crisis. The global trade showed a "low-speed growth" trend in general and is forming the "top" of the curve. The supply and demand of the market are finding it difficult to support the booming development of the port industry.

II. Global port development scale

Due to the global economic and trade trend, the throughput trend of global ports as a whole was moderate and showed a slow growing trend since the 2008 financial crisis, echoing the economic trend. According to Drewry, the trade scale of global container ports from 2009 to 2019 only increased by about 46.1%, and the overall growth rate has remained relatively low since 2011. In addition, due to the changes in the route network, a large number of transit routes also witnessed port throughput growth indirectly. As a result, the actual throughput growth rates of global container ports were weak.

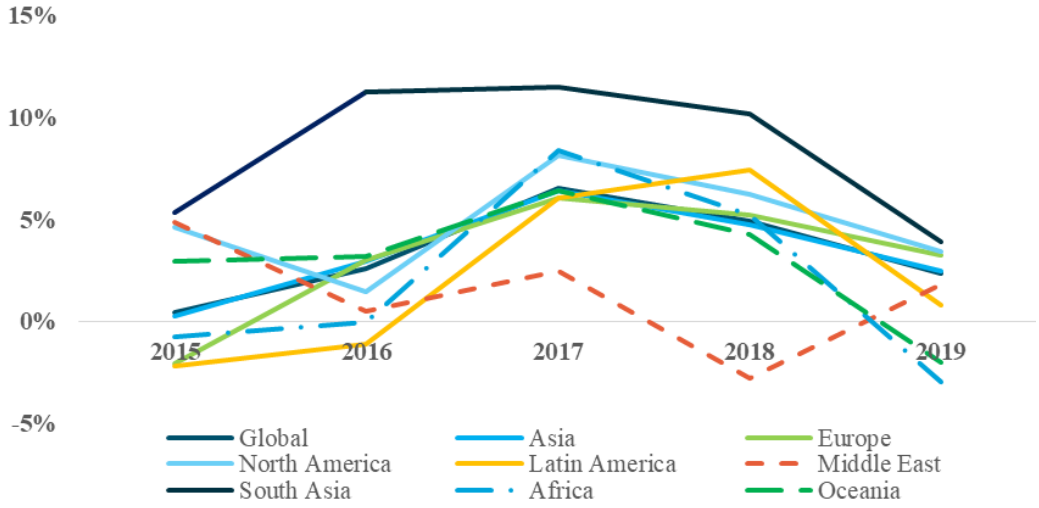


Source: Drewry Shipping Report, sorted by SISI.

Figure 6 Global Container Port Throughput from 2010 to 2019

Region-wise, the throughput growth trends of ports in different regions of the world were gradually differentiating. In recent years, Asian developing economies such as China, India and Vietnam have maintained high growth. The strong economic growth has driven the trade development of major Asian economies, with their port throughputs maintaining steady growth, especially China. To meet the urbanization development needs and the increasing consumer demand, China's ports have maintained high growth in cargo throughput in recent years. However, the high-speed growth is expected to reach its "curve top" as China's economic growth slows down, and China's ports are expected to shift from **medium-to-high growth to low growth.** Benefiting from the demographic dividend, the stable and cheap labor market, and the strong growth in infrastructure construction, other Asian developing economies such as India, Vietnam, Malaysia, and Indonesia have become much favored for overseas investment, while some companies in the United States and Europe have transferred their factories from China to lower-cost economies such as Vietnam, the Philippines and Cambodia. The trade demand in some developing economies in West Asia and Southeast Asia has grown rapidly, and their port development has entered a stage of **medium-to-high development.** The economic growth in advanced economies such as Europe and North America was slow, with

their trade demand relatively stable, and port cargo throughput maintained low growth overall. In the African region, due to the underdeveloped national economy and port infrastructure, as well as the low production capacity, port production **growth was low.**



Source: Drewry Shipping Report, sorted by SISI.

Figure 7 Throughput and Growth Rate of Global Container Ports in Various Regions from 2015 to 2019

III. Expected growth of global port development

(1) Global container ports face 'midlife crisis'

In recent years, the development of the global container port industry has suffered setbacks. From the impact of the global economic and trade environment, the global trade scale has entered a stage of slow growth. Since the financial crisis, the global economy has maintained moderate growth, and market supply and demand have found it difficult to support the booming container port industry. In terms of shipping industry development, on the one hand, the terminal capacity is getting increasingly oversupplied, with the market competition pressure continuing rising. Besides, ship upsizing and centralized logistics have greatly increased the cost of port operations. On the other hand, as the international line alliances evolve, shipping route networks are constantly adjusted. Port enterprises are subject to increasingly higher business risks to adapt to the changes in alliance routes. In addition, shipping enterprises participate in port investment and prefer to choose their own ports in the route network, resulting in declining profits of port enterprises. In addition, port development is also subject to the competition between upstream and downstream shipping logistics companies. This fully demonstrates the heavy pressure on global container ports for development, and the ports are already facing a "midlife crisis".

(2) Coal throughput of Asian ports continued to grow

The International Energy Outlook 2019 released by the US Energy Information Administration (EIA) showed that coal production and consumption in most regions are expected to stay at the current levels, and India and non-Organization for Economic Cooperation and Development (OECD) Asian economies are expected to grow in the long term. Many Asian economies are projected to gradually replace coal with natural gas and renewable energy in power generation between 2020 and 2030, because of production costs and government policies, and the coal

consumption is expected to decline as a result. However, the increasing power demand in non-OECD Asian economies excluding China and the rising industrial coal consumption will both fuel the growth of coal consumption during 2030-2040. With the industrial coal consumption increasing and the Asian power market developing, the global coal trade is expected to continue to grow by 2050.

(3) American ports expected to become new impetus for crude oil exports growth

In the medium and long term, the growth rate of crude oil exports from the Middle East, the world's most important crude oil exporting region, will slow down, and the region's share in the global crude oil exports will decline. Meanwhile, unconventional oil fields and offshore oil fields in American economies such as the United States, Canada and Mexico have become main engines of global crude oil exports growth. Their increasing production will drive up the crude oil exports from these major oil producers to China, India, and other major crude oil importers in Asia, leading to more diversified export destinations. As a result, American ports are expected to become new points of crude oil exports growth.

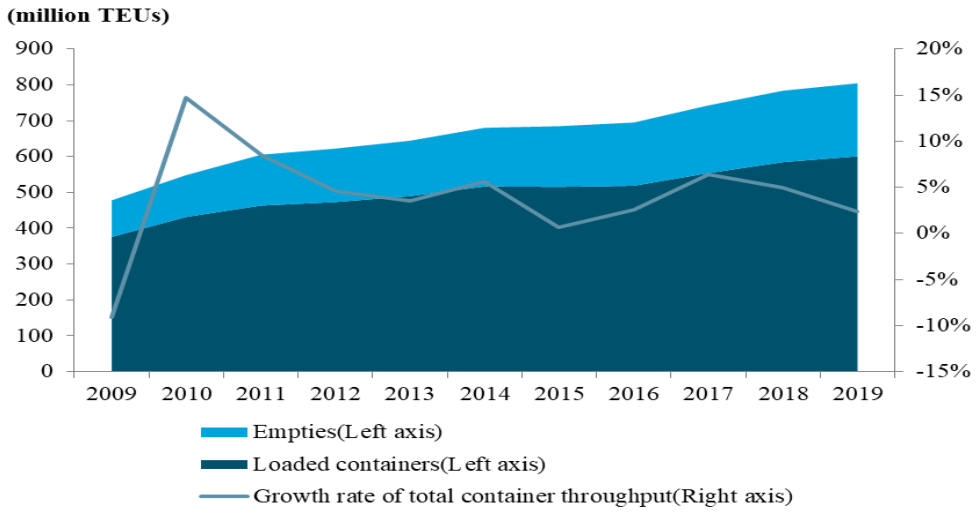
(4) New energy affects global coal and crude oil trade

New rounds of scientific and technological revolution and industrial reform have promoted the rapid development of new energy and renewable energy. Governments across the world are promoting the clean, low-carbon, and intelligent transformation of energy development. It is estimated that the annual demand for renewable energy will grow by an average of 7.6% by 2030. The renewable energy development plan proposed by the US government primarily eyes to achieve the goals by replacing fossil energy with hydropower, wind power, solar photovoltaics, and biomass energy. The EU proposes to bring the proportion of renewable energy in the energy structure to 50% by 2050. Japan has accelerated hydrogen energy and geothermal energy development and utilization, and a new energy reform is brewing on a global scale. The demand for refined oil products such as gasoline and diesel may reach a peak in 2035. The global excessive oil refining capacity, especially in the Asia-Pacific, will face transformation, upgrading or elimination, and the global demand for crude oil will decline. In addition, as developed European economies are making effort to use relatively low-carbon energy sources reduce dependence on coal, a high-carbon energy source, the coal consumption in Western Europe and North America is falling. Coal phase-out plans have also been developed across Europe. As the coal demand in Western Europe and North America declines, the coal throughput of ports in the regions will continue to fall.

2.2 Overview of Container Throughput of Global Ports

2.2.1 General analysis of container throughput of global ports

The international container trade maintained low growth in 2019, and the overall demand in the seaborne market was sluggish. The growth of container shipping volume was slow. The container throughput growth of global ports dropped year-on-year, only increasing by 2.3% year-on-year to 800 million TEUs in 2019.



Source: Drewry, sorted by SISI.

Figure 2-14 Container Throughput and Growth Rate of Global Ports (2009-2019)

2.2.2 Rankings of global top 20 ports by container throughput

Rankings of the world's top 20 container ports in 2019 changed little compared with the previous year. Except narrow fluctuations in spots of a few ports, other ports on the list maintained their positions on the whole. Impacted by worsened global economic and trade environment, the container throughput growth rates of the world's top 20 ports slowed down across the board. Hong Kong (-6.3%), Dubai (-5.6%), Dalian (-10.3%), and Long Beach (-5.7%) ports posted sharp declines. Hong Kong Port and Port of Long Beach were impacted by the US-China trade frictions, with the former also subject to the implications of the continuous large-scale protests and demonstrations, resulting in lackluster port production. Qingdao (8.8%), Tianjin (8.1%), Kelang (10.3%), and Hamburg (6.1%) ports performed well. Qingdao Port was driven by the port integration initiative in Shandong province and posted strong growth in container throughput. Guangzhou Port posted significantly more arrivals of international large ships as the number of foreign trade routes increased, and its foreign trade container sources remained stable, pushing up the significant growth of container throughput. Cities in the Hanse alliance launched new liner services with ports in the United States, Canada and Mexico, making Port of Hamburg a hub port, driving the port's container shipping volume. Moreover, the trade agreement between the European Union (EU) and Singapore further promoted the growth of seaborne trade volume at the Port of Hamburg.

Table 2-3 Global Top 20 Ports by Container Throughput in 2019

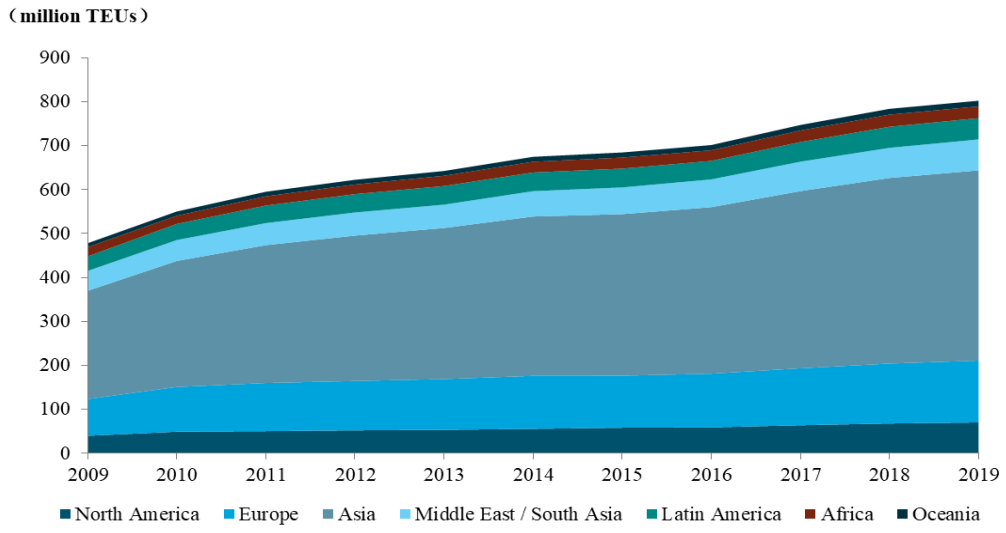
Ranking	Port	2019 (million TEUs)	2018 (million TEUs)	Growth rate
1 (1)	Shanghai	43.31	42.01	3.1%
2 (2)	Singapore	37.20	36.60	1.6%
3 (3)	Ningbo Zhoushan	27.53	26.35	4.5%
4 (4)	Shenzhen	25.77	25.74	0.1%

5 (5)	Guangzhou	22.83	21.53	5.7%
6 (6)	Busan	21.91	21.66	1.1%
7 (8)	Qingdao	21.01	19.32	8.8%
8 (7)	Hong Kong	18.36	19.60	-6.3%
9 (9)	Tianjin	17.30	15.90	8.1%
10 (11)	Rotterdam	14.81	14.51	2.1%
11 (10)	Dubai	14.11	14.95	-5.6%
12 (12)	Klang	13.58	12.32	10.3%
13 (13)	Antwerp	11.86	11.10	6.8%
14 (14)	Xiamen	11.12	10.70	3.9%
15 (15)	Kaohsiung	10.43	10.45	-0.2%
16 (17)	Los Angeles	9.34	9.46	-1.3%
17 (19)	Hamburg	9.26	8.73	6.1%
18 (18)	Tanjung Parapas	9.08	8.96	1.3%
19 (16)	Dalian	8.76	9.77	-10.3%
20 (20)	Laem Chabang	7.98	8.07	-1.1%

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

2.2.3 Analysis of container throughput of ports by region

In 2019, growth rates of global container throughputs further differentiated. Specifically, the container throughput growth in Latin America dropped by 6.6 percentage points year-on-year, and those of Africa and Oceania even fell into the negative range. The growth of Asia, which holds the largest share, also declined slightly to 2.5%.

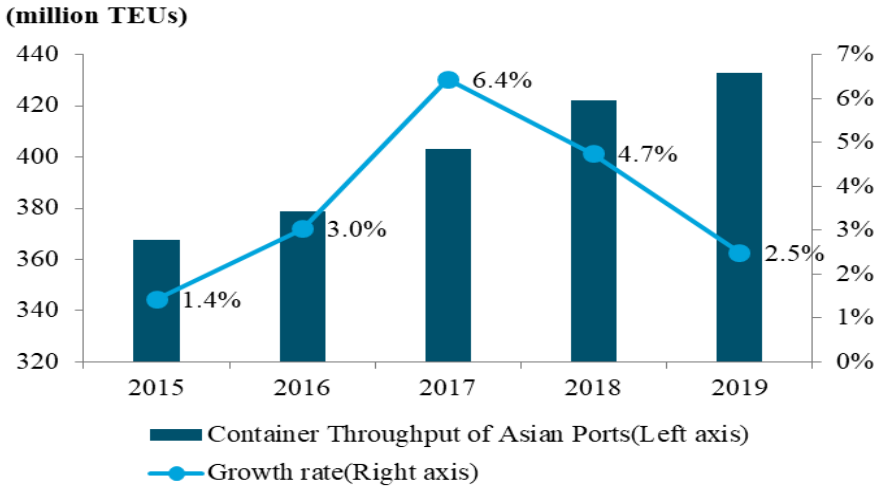


Source: Drewry, sorted by SISI.

Figure 2-15 Container Throughput of Regional Ports (2009-2019)

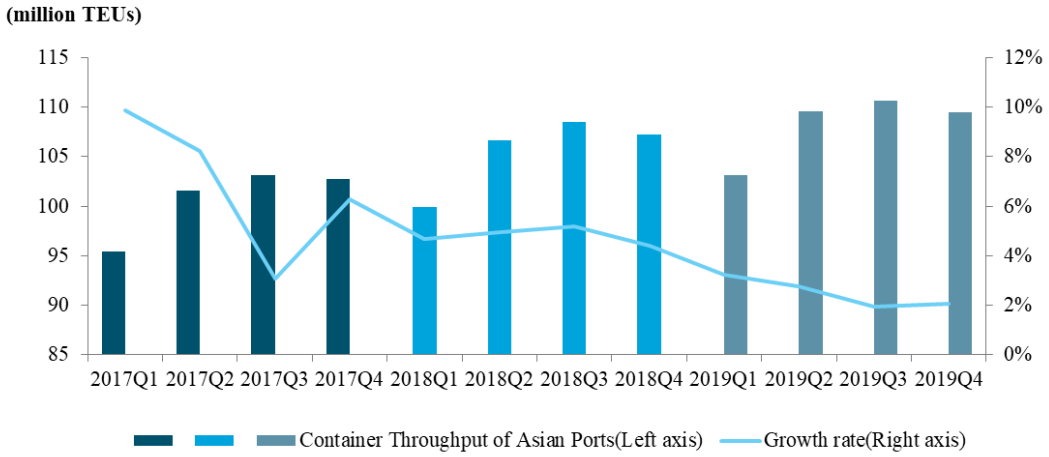
Container throughput growth of Asian ports kept declining. In 2019, the Asian economy went down. In addition, the intensified trade frictions between Japan and South Korea and between the

US and China impacted the production of Asian ports. As a result, Asian ports recorded low-speed growth of container trade, handling 430 million TEUs of containers in the year, with the growth rate dropping by 2.2 percentage points.



Source: Drewry, sorted by SISI.

Figure 2-16 Container Throughput and Growth Rate of Asian Ports (2015-2019)



Source: Drewry, sorted by SISI.

Figure 2-17 Container Throughput and Growth Rate of Asian Ports by Quarter (2017-2019)

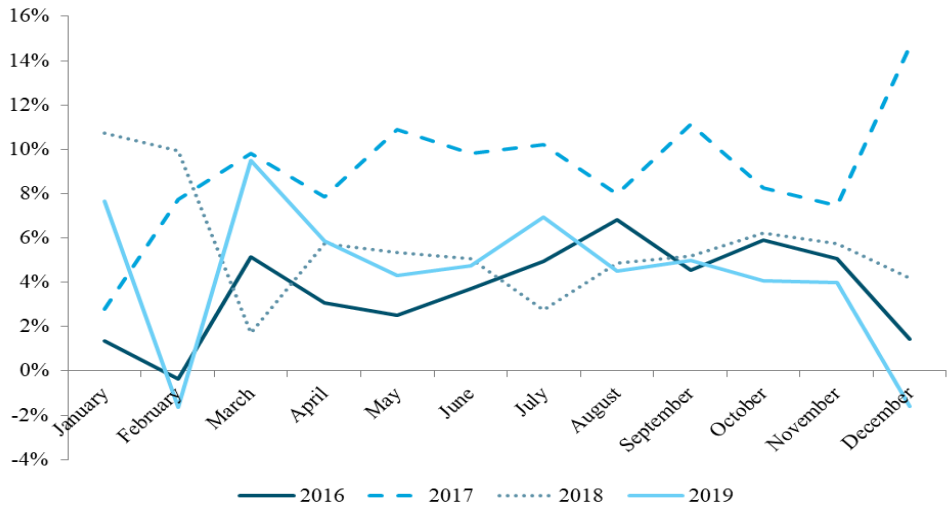
Top 20 container ports in Asia secured their rankings. In 2019, the rankings of the top 20 container ports in Asia did not change much. Specifically, the top 13 remained unchanged from last year. The ranking of Dalian Port declined slightly, while those of other ports stayed flat. China's ports posted remarkable performance, with Guangzhou Port, Qingdao Port and Tianjin Port showing strong growth. Hong Kong Port's container throughput growth continued to fall as it did last year. Dalian Port and Yingkou Port both recorded more than 10% of declines in the year due to the bitter competition for port resources and the cancellation of shipping routes caused by US-China trade frictions. In addition, Port of Singapore and Port of Busan maintained slow growth.

Table 2-4 Container Throughput and Growth Rate of Asian Top 20 Ports in 2019

Ranking	Port	2019 (million TEUs)	2018 (million TEUs)	Growth rate
1	Shanghai	43.31	42.01	3.1%
2	Singapore	37.20	36.60	1.6%
3	Ningbo Zhoushan	27.53	26.35	4.5%
4	Shenzhen	25.77	25.74	0.1%
5	Guangzhou	22.83	21.53	6.0%
6	Busan	21.91	21.66	1.1%
7	Qingdao	21.01	19.32	8.8%
8	Hong Kong	18.36	19.60	-6.3%
9	Tianjin	17.30	15.90	8.8%
10	Dubai	14.11	14.95	-5.6%
11	Klang	13.58	12.32	10.3%
12	Xiamen	11.12	10.70	3.9%
13	Kaohsiung	10.43	10.45	-0.2%
14	Tanjung Parapas	9.08	8.96	1.3%
15	Dalian	8.76	9.77	-10.3%
16	Laem Charbang	7.98	8.07	-1.1%
17	Philippine Seaport	7.87	7.54	4.3%
18	Suzhou	6.27	6.36	-1.4%
19	Yingkou	5.48	6.33	-13.5%
20	Nehru	5.10	5.05	1.0%

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

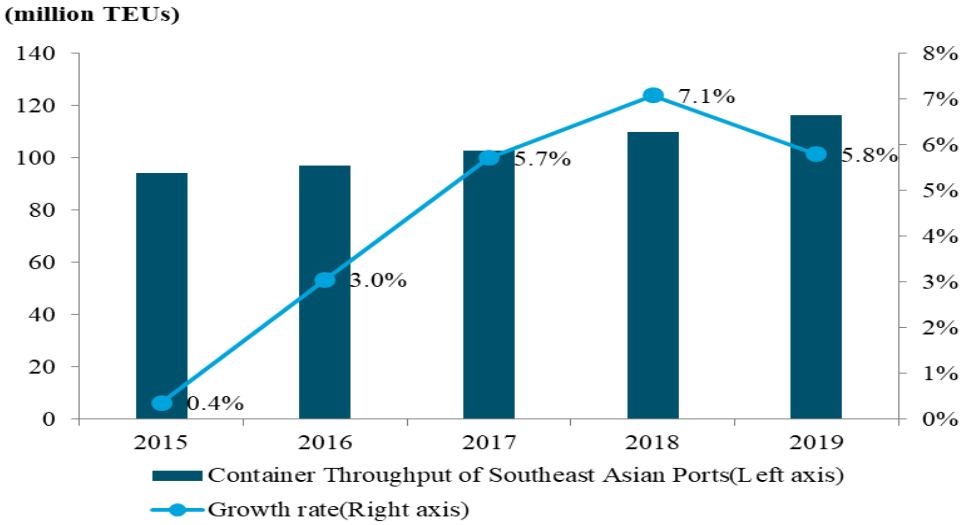
Container throughput growth of China's ports dipped. The global economic and trade environment was grim in 2019. China's foreign trade was affected, and its container throughput growth slowed down. China's container throughput in the year was 260 million TEUs, an increase of 4.4% year-on-year and less than the 5.3% growth last year. In the container shipping structures of Chinese ports, foreign trade containers accounted for 60% of the total. The global trade situation had a greater impact on foreign trade containers. The intensified US-China trade frictions in 2019 have to some extent inhibited the growth of China's container trade at ports.



Source: Ministry of transport of the people's republic of China, sorted by SISI.

Figure 2-18 Growth Rate of Container Throughput of Major Chinese Ports (2016-2019)

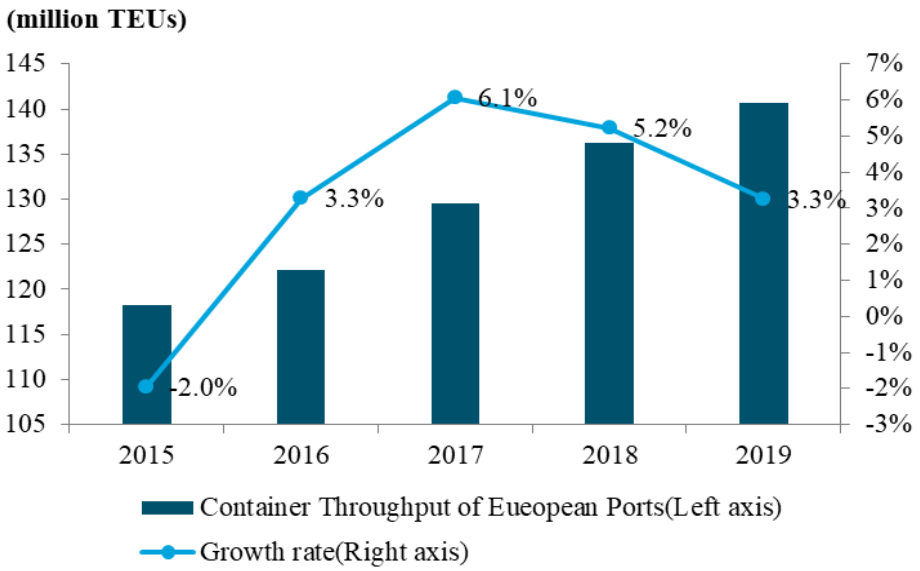
Growth of Southeast Asian ports slowed down. In 2019, Southeast Asian ports performed steadily in terms of production, recording a container throughput of 120 million TEUs in the year, a year-on-year increase of 5.8%, which was lower than last year's 7.1%. Specifically, Singapore, affected by the sluggish global trade, witnessed negative growth in total foreign trade value for months. Port of Singapore handled 37.2 million TEUs of containers throughout the year, with the growth rate dropping by 7.1 percentage points to 1.6%. Thailand's ports were adversely affected by the economic downturn and the decline in commodity exports. The port production situation was depressed. Port of Laem Chabang recorded a container throughput of 7.98 million TEUs, a decrease of 1.1% year-on-year. Meanwhile, ports in the Philippines posted a container throughput of 7.87 million TEUs in 2019, a year-on-year increase of 4.3%.



Source: Drewry, sorted by SISI.

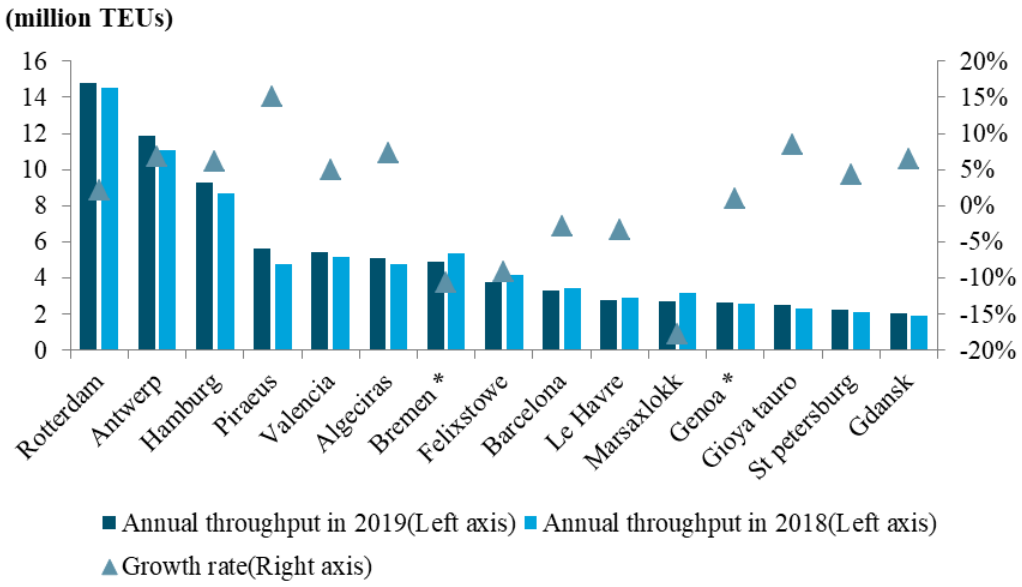
Figure 2-19 Container Throughput and Growth Rate of Southeast Asian Ports (2015-2019)

Throughput of European ports grew at a low rate. Affected by factors such as the weak global economy, international trade tensions, and the uncertainty in the Brexit process, the annual container throughput of European ports reached 140 million TEUs, a rise of 3.3% year-on-year, and the growth rate marked a decline for two consecutive years.



Source: Drewry, sorted by SISI.

Figure 2-20 Container Throughput and Growth Rate of European Ports (2015-2019)

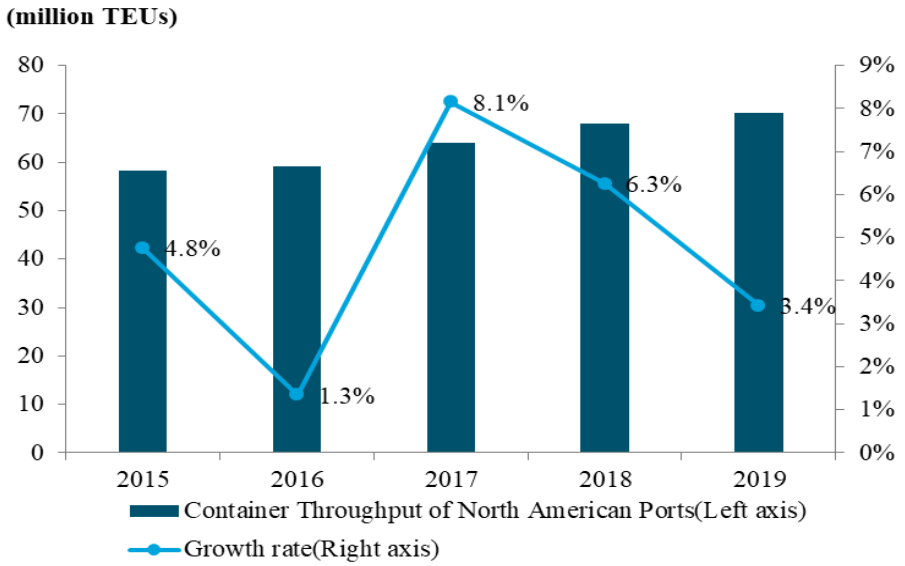


Source: Websites of various port authorities, sorted by SISI.

Figure 2-21 Container Throughput and Growth Rate of European Top 15 Ports in 2019

North American ports maintained low growth. The US economic growth slowed down in 2019 due to adverse factors such as trade frictions, and its container growth rate fell back. Due to the continued impact of the US-China trade frictions and the escalated US-Europe trade frictions, the

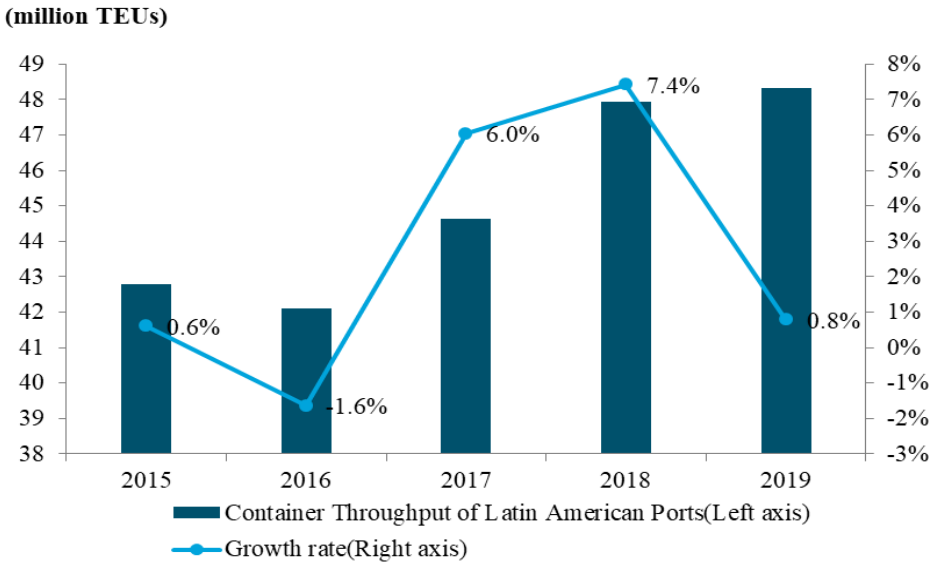
US port trade volume declined. In 2019, the container throughput growth of North American ports increased by 3.4% year-on-year to 70.26 million TEUs.



Source: Drewry, sorted by SISI.

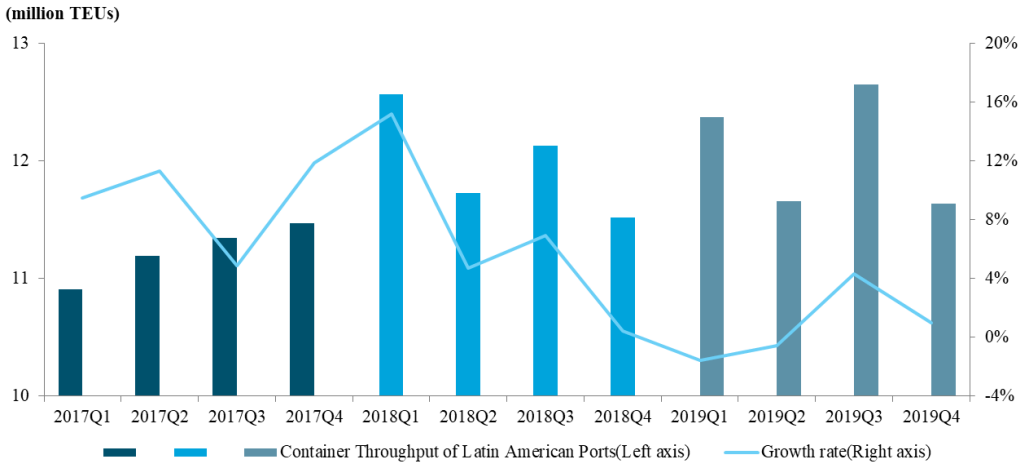
Figure 2-22 Container Throughput and Growth Rate of North American Ports (2015-2019)

Growth of South American portsdeclined. Due to the US' unilateral trade protectionism, Latin American exports to the US were heavily hit. The US-China trade frictions hindered the expansion of global value chains, further increasing the uncertainty of Latin American import and export trade. In this backdrop, the Latin America region recorded a container throughput of 48.35 million TEUs in 2019, an increase of 0.8% year-on-year.



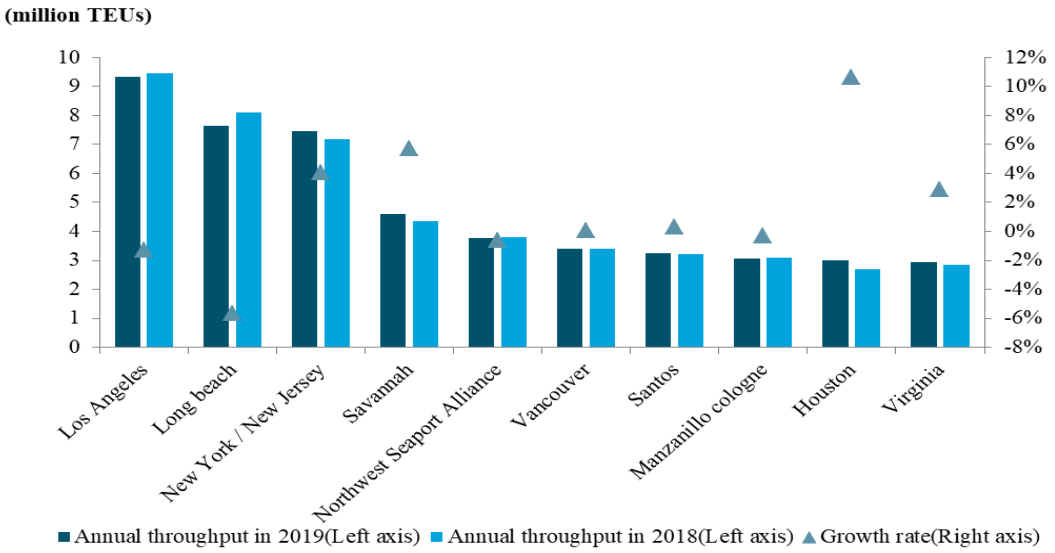
Source: Drewry, sorted by SISI.

Figure 2-23 Container Throughput and Growth Rate of Latin American Ports (2015-2019)



Source: Drewry, sorted by SISI.

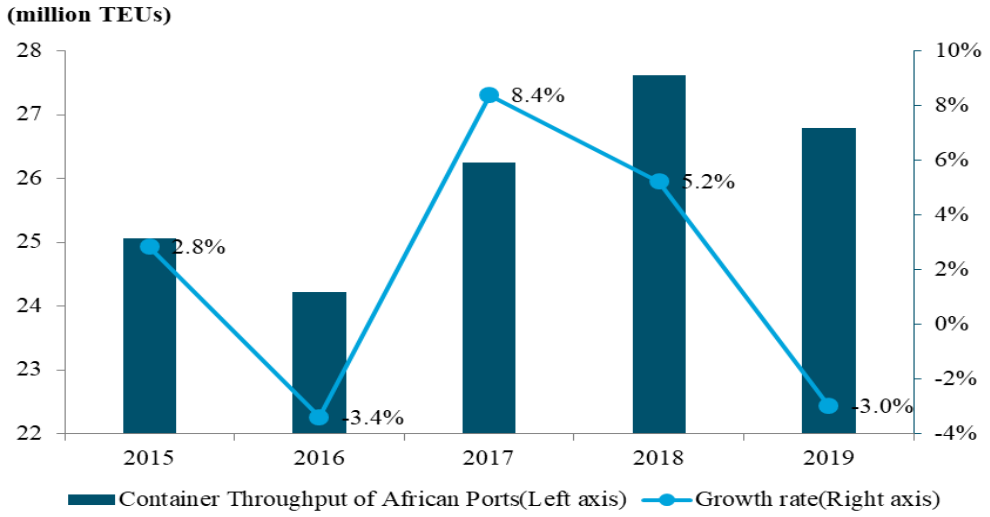
Figure 2-24 Container Throughput and Growth Rate of Latin American Ports by Quarter (2017-2019)



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

Figure 2-25 Container Throughput and Growth Rate of American Top 10 Ports in 2019

Container throughput growth of African ports fell significantly. The China-Africa trade volume growth in 2019 was only 2.2%, which is far from the growth rate of 19.7% in 2018. Given this situation, African ports recorded a container throughput of 26.79 million tons in 2019, down by 3.0% year-on-year, 8.2 percentage points lower than that of the previous year.



Source: Drewry, sorted by SISI.

Figure 2-26 Container Throughput and Growth Rate of African Ports (2015-2019)

Feature 2: Fastest-growing Global Container Ports in Investment and Scale

Due to the lagging monetary tightening policy, the deteriorated global trade situation and the increased geopolitical uncertainty, the world economic growth was sluggish in 2019, and the overall momentum of container throughput growth of global ports was weak. Affected by factors such as the economic and trade environment, location, amount of investment, and attractiveness to cargo sources of the economies that ports are located in, the container throughput growth rates of global ports vary. In order to assess the growth potential of global container ports, this article selects core influencing factors such as "attractiveness to cargo sources", "natural conditions", "economic environment" and "attractiveness to investment" of ports to evaluate the future development potential of container ports.

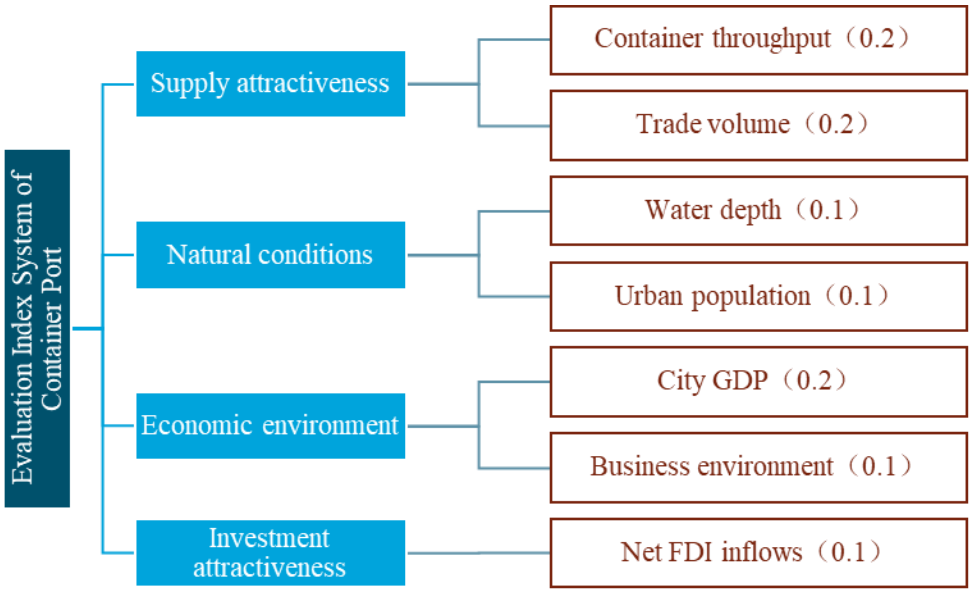


Figure 1 Evaluation Index System of Container Port

To this end, we have listed Lloyd's top 100 container ports in 2018 as objects of study, and carry out statistics, analysis and calculations of the four major indicators of "attractiveness to cargo sources", "attractiveness to investment", "natural conditions" and "economic environment", as well as seven sub-indicators under the four major indicators, so as to rank the container ports by development potential for exchange and reference of industry insiders. The rankings are shown in the following table.

Tabel 1 The Fastest-growing Global Container Port in Investment and Scale in 2019

Ranking	Port	Country	Area	Score
1	Cai Mep	Vietnam	Southeast Asia	97.75
2	Ho Chi Minh City	Vietnam	Southeast Asia	91.49
3	Manila	Philippines	Southeast Asia	83.98

4	Chittagong	Bangladesh	South Asia	77.95
5	Fuzhou	China	East Asia	77.16
6	Gdansk	Poland	Central Europe	77.12
7	Mundra	India	South Asia	76.59
8	Sines	Portugal	Southern Europe	74.36
9	Piraeus	Greece	Southern Europe	74.18
10	Navashua / Nehru	India	South Asia	73.26
11	Tangshan	China	East Asia	72.68
12	Salalah	Oman	West Asia	72.57
13	St petersburg	Russia	Eastern Europe	72.49
14	Rizhao	China	East Asia	71.97
15	Zhuhai	China	East Asia	71.79
16	Beibu Gulf	China	East Asia	71.48
17	Surabaya	Indonesia	Southeast Asia	71.43
18	Rotterdam	Netherlands	Western Europe	67.85
19	Ningbo Zhoushan	China	East Asia	67.54
20	Yantai	China	East Asia	67.03

1. Investment transferred, strong momentum of infrastructure construction in Southeast Asia

Among the top 20 global container ports with the fastest growth in port investment and scale in 2019, the top three are all in Southeast Asia, demonstrating their strong development momentums. Thanks to the huge population base, the fast growing economic strength and the relatively favorable infrastructure environment, Southeast Asia enjoys strong demand for infrastructure construction, with huge market space for investment and construction in the fields of energy and transport. Vietnam's Port of Cai Mep and Port of Hochiminh ranked first and second respectively in the list of the world's fastest growing container ports in terms of investment and scale in 2019. In view of Vietnam's location, policy, and strategic advantages, more and more organizations and institutions have become fully aware of Vietnam's huge potential for development. The Philippines' No. 1 commercial port, Port of Manila, ranked third in terms of scale growth. On the one hand, the port's investment and scale expansion was a result of Philippine President Duterte's increased investment in infrastructure construction in the country after he took office in 2016, and the country's economy maintained rapid growth. On the other hand, the expansion of Port of Manila terminals and the upgrading of surrounding facilities have been completed and put into operation, which has improved the port's turnover efficiency and service level to adapt to the ship upsizing trend while bringing throughput growth.

2. Belt and Road Initiative accelerated port construction in South Asia

South Asia, as an emerging economy and leveraging the advantages in land, labor costs, and access to European and the United States markets, is growing into the destination of a new round of international industrial transfers along with Southeast Asia. Meanwhile, South Asia is the overlapping area of the Belt and Road Initiative (BRI), Bangladesh, China, India and Myanmar Economic Corridor (BCIM) and China-Pakistan Economic Corridor (CPEC)". Its ports are

necessary transshipment points of routes connecting Southeast Asia and West Asia and Africa. South Asia plays a key role in connecting Eastern China's coastal areas, Southeast Asia, South Asia, as well as countries and regions along Africa and Europe routes. Port of Chittagong, ranked fourth on the list, is the largest container port in Bangladesh. Relying on its huge population base and abundant labor resources, Bangladesh has formed a strong consumer market to undertake global industrial transfers. Therefore, its cargo shipping demand is strong. Currently, projects such as the multi-purpose berth are planned at Port of Chittagong. Meanwhile, Bangladesh is located in the overlapping area of the 21st Century Maritime Silk Road and the BCIM, with close cooperation with China and good investment prospects. The main contributor to the sharp increase in container throughput of the Port of Surabaya in Indonesia is that its Lamon Bay Terminal has completed the construction of all automated terminals in 2016. Moreover, the Indonesian government also plans to invest up to $412 billion to develop the economy from 2020 to 2024, with 60% of the investment in transport-related infrastructure projects. This will create opportunities for Chinese enterprises to launch partnerships with Indonesia in the field of infrastructure.

3. China's container ports developed rapidly overall

Among the top 20 fastest-growing container ports in the world in terms of investment and scale in 2019, China's ports take seven spots, and their overall strength is at the forefront on the global scale. Specifically, Fuzhou Port is the most potential port in 2019, primarily due to the accelerated economic growth of Fuzhou city. The container throughput of Rizhao Port in Shandong province has been growing at an average rate of 12% for three consecutive years, and Rizhao Port has become one of the best choices for "south-north shipping" and "global access" among Chinese ports. The container throughput growth of Beibu Gulf Port in Guangxi reached 34.6%, ranking among the top nationwide. Further fueled by the rapid development of regional economy, Beibu Gulf Port has become the world's most potential port for development. In addition to the successive commissioning of industrial projects transferred to Guangxi from eastern areas, the high growth of Beibu Gulf Port container throughput is also due to Guangxi's multi-party synergy to promote construction of a new land-sea corridor in its western area, which has added momentum to the development of the Beibu Gulf Port.

4. Investment and construction strengthen, European container ports to prosper based on accumulated strength

As an important gateway to Central European and Baltic economies, the Port of Gdansk will invest US$3.1 billion for port expansion, and will become the fastest growing port in Europe. The Port of Gdansk boasts the best inland connections to Central and Eastern Europe, attracting huge investments by international port groups in its railway networks and equipment and in its cross-border railways and highways to the Czech Republic, Slovakia, Hungary, Belarus, Ukraine and other economies. This means that the scale of the Port of Gdansk has huge potential for expansion. The Port of Piraeus has rebounded from the crushing loss and nearly paralysed status to become the fourth-largest port in Europe and the largest in the Mediterranean, thanks to the operation of COSCO Shipping. It has formed six business sectors, namely container terminals, cruise terminals, ferry terminals, auto terminals, logistics warehousing, and ship repair and shipbuilding. With the Port of Piraeus as the hub, the "China-Europe Land-Sea Express Route"

links up nine economies, 1,500 points and 71 million people. Through extensive and pragmatic cooperation between China and Greece, the Port of Piraeus will become the largest container transit port in the Mediterranean, a sea-land combined transit center, an international logistics distribution center in the eastern Mediterranean area, and a stronghold of Belt and Road cooperation.

2.3 Overview of Dry Bulks Throughput of Global Ports

The throughput growth of global dry bulks ports continued to fall in 2019, with the iron ore trade demand declining. The global shipping volume of major dry bulks and minor bulks totalled 5.29 billion tons, an increase of 1.1% year-on-year. Among major ports covered in statistics, Port of Hay Point posted a significant drop in coal throughput due to China's limits on coal imports from Australia, namely by 10.2 percentage points year-on-year into the negative growth range. Impacted by the hurricanes in Australia, the annual iron ore throughput growth of Port of Hedland continued the low growth trend last year. Solar, wind and natural gas power generation in the Netherlands and Germany increased, and the share of coal in power plants greatly decreased. As a result, the growth rate of coal throughput at Port of Rotterdam dropped sharply by 14.8% year-on-year. Affected by the tailings dam bursting of Vale of Brazil and the declined demand for soybeans from China, the dry bulks throughput of Brazilian ports fell by 5.1% year-on-year to 680.22 million tons.

Table 2-5 Dry Bulk Throughput of Major Ports in 2019

(Unit：million tons)

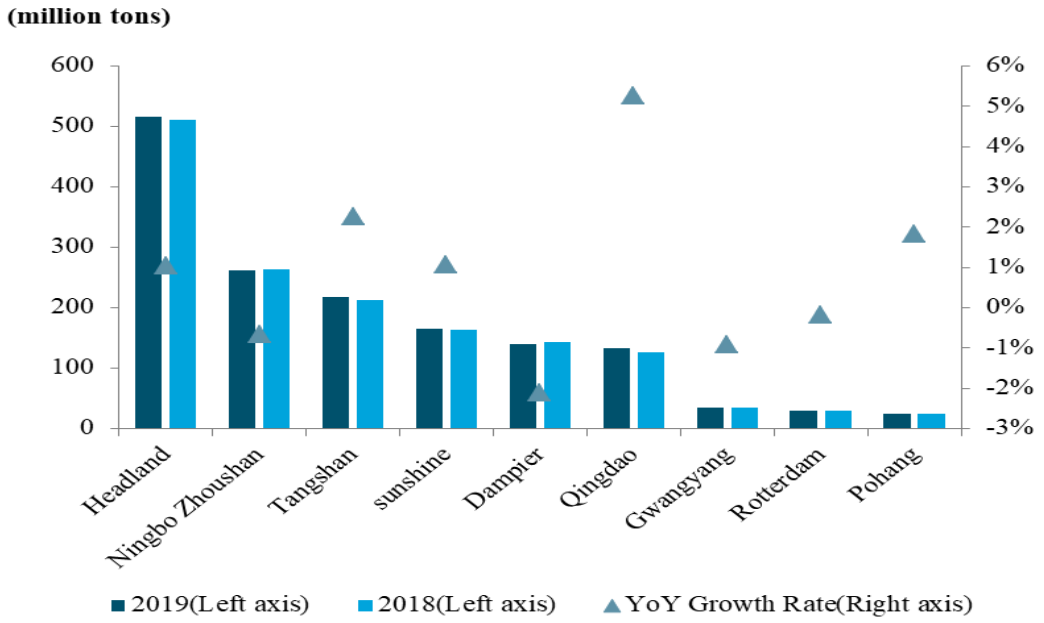
Port	2017	2018	2019					2018 YoY Growth Rate	2019 YoY Growth Rate
			1Q	2Q	3Q	4Q	Total		
Headland	505.33	510.42	117.29	137.14	128.41	132.86	515.71	1.0%	1.0%
Qinhuangdao	221.50	223.26	48.47	56.98	49.48	49.42	204.35	0.8%	-8.5%
Rotterdam	80.17	77.62	19.45	18.63	17.82	18.59	74.49	-3.2%	-4.0%
Singapore	18.60	16.85	4.34	4.21	4.52	4.50	17.57	-9.4%	4.2%
Antwerp	12.18	13.06	3.15	3.71	3.40	3.66	13.93	7.3%	6.6%
Hay point	109.10	118.45	28.00	30.67	28.70	29.20	116.58	8.6%	-1.6%

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

2.3.1 Development of global iron ore ports

The iron ore trade market performed poorly in 2019, and the iron ore shipping volume dropped by 0.9% year-on-year to 1.46 billion tons. Among major iron ore handling ports, the iron ore throughput growth of ports in Australia, Brazil, Japan and Korea all fell to varying degrees compared with last year. The overall performance of iron ore throughput at Chinese ports was not satisfactory. Iron ore throughput growth of large iron ore handing ports such as Ningbo-Zhoushan

Port, Tangshan Port and Rizhao Port remained low. However, Qingdao Port actively explored the market and its iron ore throughput growth in 2019 hit 5.3% against the trend.

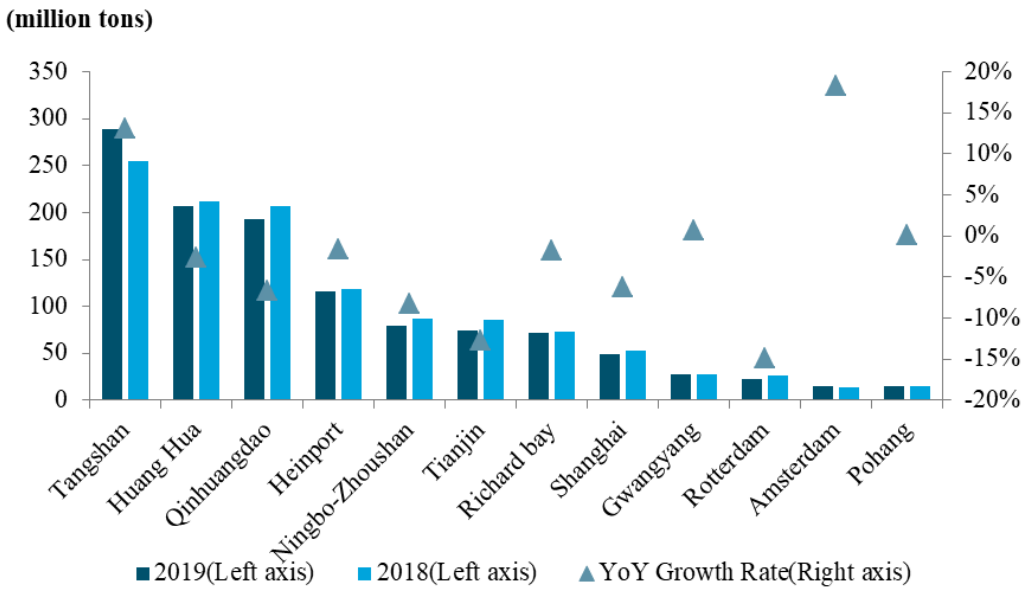


Source: Websites of various port authorities, sorted by SISI.

Figure 2-27 Iron Ore Throughput and Growth Rate of Global Major Ports (2018-2019)

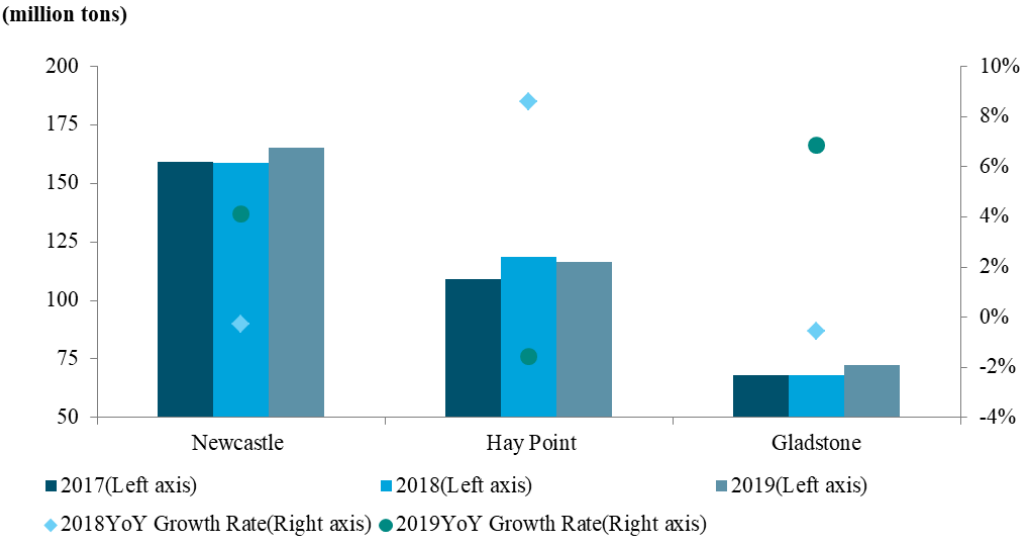
2.3.2 Development of global coal ports

Major coal ports in the world continued to witness declining of import and export trade in 2019. Among major coal handling ports in China, the throughputs of Qinhuangdao Port, Huanghua Port and Tianjin Port all decreased year-on-year due to factors such as the weak coal demand in the south, the impact of imported coal on the domestic market, and the increased share of clean energy. Benefiting from the increased shipping volume on the Mongolia-Hebei Line and Datong-Qinhuangdao Railway and QiananBei-Caofeidian Railway, Tangshan Port's coal throughput grew by 13.1% year-on-year to 290 million tons. Among the three largest coal exporting ports in Australia, the coal export volume of Port of Newcastle reached 170 million tons, an increase of 4.1% year-on-year, and that of Port of Gladstone was 72.55 million tons, a rise of 6.9%. The Port of Hay Point was hit by hurricanes. Coupled with China's coal restriction policy on Australian coal, the port witnessed its annual coal export volume falling by 1.6% year-on-year, 10.2 percentage points lower than last year's growth.



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

Figure 2-28 Coal Throughput and Growth Rate of Global Major Ports (2018-2019)



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

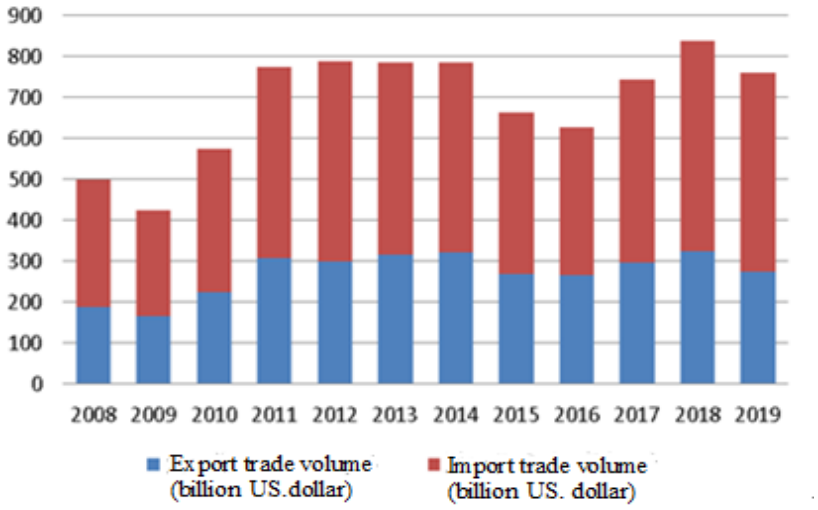
Figure 2-29 Coal Throughput and Growth Rate of Major Australian Ports (2017-2019)

Feature 3: Impact of Indian Shipping Policies on Port Development

India is located on world shipping arteries. Its east-west coastline extends 7,517 km, connecting the Middle East and Southeast Asia. India's west coast is located in the Arabian Sea, and its east coast faces the Bay of Bengal. Cargoes from East Asia to the United States, Europe and Africa need to be transited in India. There are 13 major ports in India, including six ones on the east coast and seven ones on the west coast . Its major ports, except Port of Mundra and Port of Kamarajar, are all under the jurisdiction of the national government. Apart from them, India also has 205 small and medium-sized ports under the jurisdiction of local governments, including 68 freight ports above a designated scale.

1. India's economic and trade fell off a cliff in 2019

The Indian economy has performed exceptionally well in recent years. However, with the global economic downturn, India's economy has fallen off a cliff in recent months. In the first half of 2019, India's GDP growth rate was 5.4%, down by 2.5% year-on-year.



Source: Trading Economics.

Note: Statistics of 2019 as of the first half of the year

Figure 1 Import and Export Trade Volume of Indian (2008-2019)

India's trade structure is dominated by cargoes required for infrastructure. From the perspective of imported and exported commodities, India's coal, iron ore, chromite, bauxite, mica, gypsum and other ore resources feature high export volumes due to the country's rich resource reserves. From the perspective of imported products, mineral products, mechanical and electrical products and precious metals and products are the top three categories of commodities imported by India. Despite its rich resources of coal, iron ore, chromite, bauxite and other minerals, India has a shortage of oil and natural gas, which is a short slab that restricts India's economic development. India imports a large amount of oil from economies such as Saudi Arabia and Iraq

every year, and the current government is augmenting infrastructure construction to further increase the demand for oil and natural gas.

Table 1 Comparison of India's TOP15 imports from the world in 2018

(Unit: million US dollars)

Product category	India's imports from the world in 2018	
	Amount（million US dollars）	percentage（%）
Mineral products	177117	34.6
electronics	95655	18.7
Precious metals and products	65116	12.7
Chemical Products	48712	9.5
Base metals and products	32962	6.4
Plastic, rubber	18969	3.7
Transportation Equipment	17760	3.5
Animal and vegetable oils	10196	2.0
Optics,watches,medical equipment	9888	1.9
Textiles and raw materials	7319	1.4
Plant products	6610	1.3
Cellulose pulp	5891	1.2
Furniture,toys,miscellaneous products	3149	0.6
Ceramics, glass	2946	0.6
Video, beverage, tobacco	2794	0.6
Xie Xue, umbrella and other light industrial products	—	—
Leather products; luggage	—	—
Other	6993	1.4
Total value	512077	100

Source: India Business Information Statistics.

'Potential risks' exist in India's economic and trade development. After India's high economic growth for several years, the decline in annual economic growth rates has exposed the current development barriers of India. While China is experiencing population aging, the Indian population, despite in a golden ratio of population structure, features a low education level, which restricts the rapid economic development. A large number of non-performing assets, as well as corruption and inefficiency are common. Its financial and fiscal policies lack flexibility and the credit from non-bank financial institutions is severely restricted. In addition, with the global trade clouded by international trade uncertainties, India's attempt to rely on exports to boost economy has a dim outlook. Unemployment and weak domestic consumption have made investors realize that most of Modi's reform measures are not well carried out, and some of the reforms that have been green-lighted have not even been initiated. The wealth gap, insufficient domestic demand, and underdeveloped infrastructure are still the stubborn problems hampering India's economic development.

2. Main shipping policies of India

To cope with the economic development issues faced by India, the Indian government has rolled out policies in various fields to stimulate economic development. Specifically, the policies in the shipping field primarily include encouraging domestic and foreign private market players to enter the port field, earmarking funds to support port construction, and lifting bans on foreign ships for conducting transshipment businesses in India.

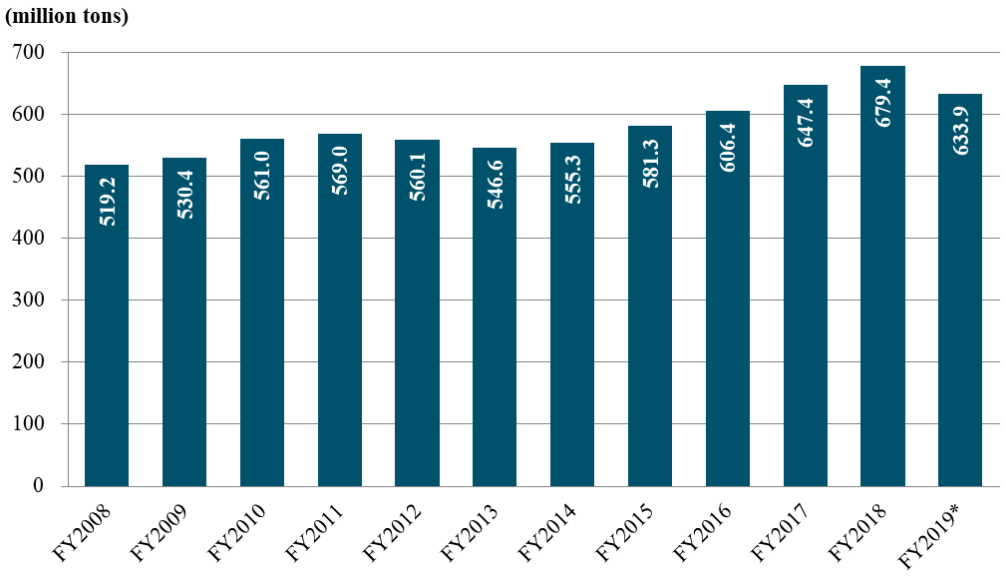
The Indian government continues to open up its shipping market to encourage domestic and foreign private market players to enter the port sector, and private entities are allowed to participate in port logistics services. Favorable policies to encourage private investment include: 1. Decentralization and tax holidays. The government allows as high as 100% foreign direct investment (FDI) in port construction and maintenance projects, and the companies involved in development, maintenance and operations of ports, inland shipping and inland ports can enjoy a 10-year tax holiday. 2. Price flexibility for capitalized operations of small and medium-sized ports. Small and medium-sized ports are allowed to set their own tariffs with reference to the guidance of the local maritime administrations. 3. The Model Concession Agreement (MCA) requires major ports to enter the bidding of selected projects during construction, operations and transformation, which has enhanced the transparency and standardization. After the government revised the MCA in March 2018, major ports have become friendlier to investments. 4. Major Port Authorities Bill allows future public-private partner operators to determine tariffs. With the implementation of this policy, port authorities will obtain a 40-year lease period for port-related land and a 20-year lease period for non-port-related enterprises. 5. The UNNATI plan initiated by the Indian government can identify areas of improvement for major ports. Under this plan, 116 schemes have been proposed, with 91 of them being implemented.

In addition, India's strategy of boosting economy with exports has prompted the government to support port construction from fiscal earmarking and policies. The 2019 fiscal budget showed that India's National Maritime Development Programme (NMDP) planned to invest US$118 million to build a total of 3.2 billion metric tons of port capacity to respond to the expected 2.5 billion metric tons of shipping demand in 2020. In terms of capital attraction, the government allows as high as 100% foreign direct investment (FDI) in ports. In terms of taxation, the Indian government has provided a 10-year tax holiday for companies that develop, maintain, and operate ports, inland waterways, and inland ports. In terms of port operational efficiency enhancement, India approved the measures of channel mechanization and deepening as well as pilotage. In May 2018, India's Ministry of Shipping announced allowing container ships that fly foreign flags to conduct transshipment businesses at Indian ports.

3. India's shipping policies yielded remarkable reform results

With Indian government's reform policies implemented, the net profits of major ports increased from US$178.4 million in 2013 to US$529 million in the fiscal year of 2018, and the operating profit ratio increased from 23% to 44%. The capacity of major ports is expected to rise to 1,477 million tons. The effective utilization of major Indian ports such as Jawaharlal Nehru Port (JNPT), Port of Kandla and Port of Kamarajar all exceeded the world average. The National Democratic Alliance (NDA) of India has initiated a series of infrastructure construction projects. The

Sagarmala scheme will promote the development of major ports and improve the facility construction of hinterland to achieve more efficient and low-cost rapid transportation. Compared with the fiscal year of 2012, the turnover period of major ports in the fiscal year of 2019 was reduced to 72 hours. In 2018, the employment of Indian seafarers and foreign vessels increased by 35%, and the supply of Indian seafarers ranked third in the global shipping industry.

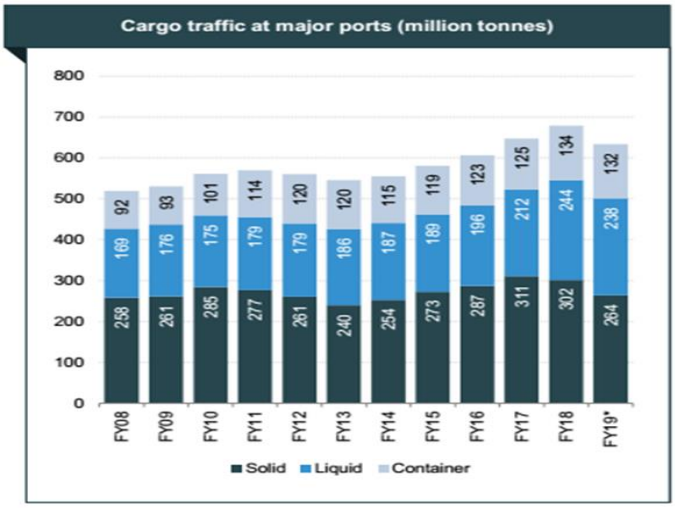


Note: * indicates projections.

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

Figure 2 Cargo Throughput of Major Indian Ports (FY2008-FY2019)

According to the Indian Ports Association (IPA), in the 2018-2019 fiscal year, the cargo throughput of 12 major ports in India increased by 2.90% to 699.04 million tons, accounting for 60% of the national total. The growth was primarily contributed by coal, fertilizers and container cargoes. The increasing crude oil imports also drove the surge in port throughput. India's original import volume reached 256.33 million metric tons in the fiscal year of 2018. As of the fiscal year of 2019, its crude oil imports reached 217.29 million metric tons. Gasoline, oil and lubricants were main contributors to major port throughput, namely by 36% in 2018.



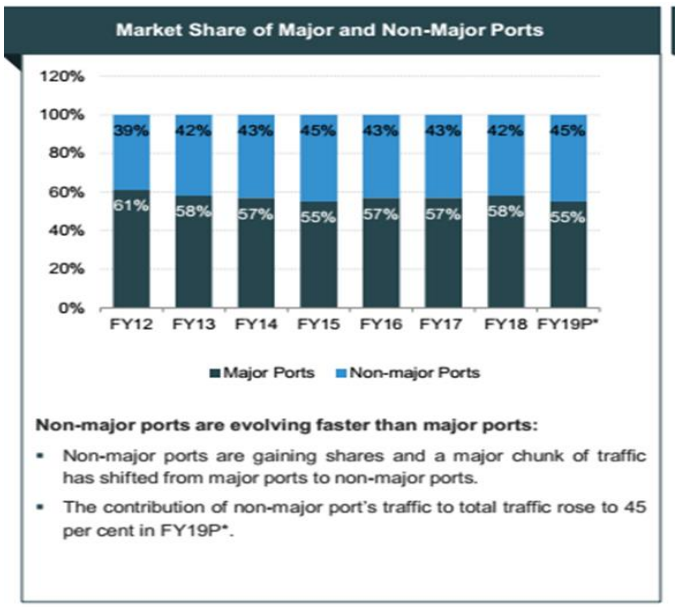
Note: * indicates projections.

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

Figure 3 Throughput of various cargo of major Indian ports (FY2008-FY2019)

4. Port integration promot port development

Indian Minister of Shipping Mandaviya said that India will implement port integration to promote port development, by strengthening the connections of 204 small ports and promoting further development of 12 large ports. Cargoes are transshipped from small ports to large ports which then export the cargoes overseas. The interaction between large and small ports will be further strengthened. This plan will boost inland river shipping, effectively reducing the pressure on highways and railways, while cutting shipping costs to promote further development of India's foreign trade.

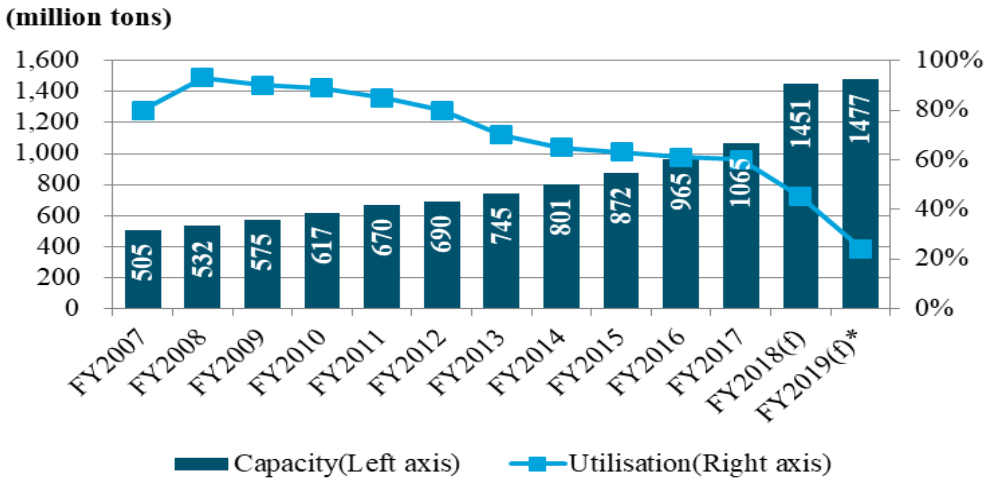


Note: * indicates projections.

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

Figure 4 Market Share of Major and Non-major Indian Ports (FY2012-FY2019)

From the trend of market share growth, the development of non-major ports is faster than that of major ports. Major cargoes are transferred from major ports to non-major ones, and the throughput contribution of non-major ports has reached 45% in the fiscal year of 2019. The Indian government's port investment strategy has resulted in an increase in port capacity, reduced performance efficiency of major ports and increased port congestion indexes. In 2018, the Port of Kandla operator even announced a port congestion surcharge of US$100 per TEU. Due to the frequent strikes by Indian port workers, some ports suffered serious backlogs of cargoes. The underdeveloped railways and highways in the hinterland of major ports, as well as the increased private sector participation in existing small ports have forced businesses to transfer to small and medium-sized ports.



Note: * indicates projections.

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

Figure 5 Capacity and Utilisation of Major Indian Ports (FY2007-FY2019)

5. Future trend of shipping and direction of port development

Facing the sluggish economic growth, the Modi government's dream of building a powerful country cannot become a reality as scheduled. But India's development is an undeniable general trend, and India's determination to invest in infrastructure construction is also imperative. The process of industrialization is bound to consume metals and energy. Under this general premise, the dry bulks and liquid bulks throughputs of Indian ports will increase in the future. India's coastal economic development will gradually become centralized in maritime clusters, dominated by marine tourism, shipbuilding and supporting services, marine services and marine products. The clusters should also include companies that provide services such as research, financing and technical assistance. According to the released plans and programs, India will first establish two maritime clusters in Gujarat and Tamil Nadu. Both clusters will be close to shipyards, major ports, steel mills, automotive and engineering industries, and universities and colleges. The two maritime clusters were established to cut down logistics costs and streamline service processes. The industrial clusters will also benefit from the "Make in India" program to stimulate local industries and attract investment.

Currently, Indian ports have problems including insufficient private participation and low port operating efficiency. Although the government has formulated policies, Indian ports still have a long way to go for development.

In the future, Indian ports can enhance efforts in the following three aspects:

First, reform the maritime department. Among the 13 major ports in India, only two are privately owned, and the rest are all state-owned. India has no restrictions on foreign investment in ports, but its seaports with superior geographic conditions and strong industrial support have been under the control of state-owned enterprises. In 2016, India issued the "Major Port Authorities Bill 2016" to allow for greater autonomy of port authorities in decision-making and reform of port management. However, the bill has remained pending due to opposition from the union. For India, its maritime sector needs much reform, which will largely depend on government support and participation of the private sector.

Second, enhance port operating efficiency. The long stay of cargoes at ports continues at most ports in India. To achieve seamless cargo shipping for the purpose of transaction cost reduction, large-scale mechanization, especially containerized shipping, is imperative. Indian customs must innovate and fully integrate its IT systems. In addition, improving infrastructure construction is also an important aspect of improving operating efficiency. Multimodal transport is a call of modern freight shipping, and seamless logistics is the essence of rapid foreign trade. Small and medium-sized ports and inland river shipping should be developed to support major ports, so as to shorten cargo stays at terminals and fully exert their roles are auxiliary ports.

Third, increase application of the latest technologies in port logistics. The blockchain, the Internet of Things, artificial intelligence and other technologies should be utilized to develop unique end-to-end port logistics solutions on a larger scale. Indian ports still need to pay much effort in this regard to catch up with the leading international ports.

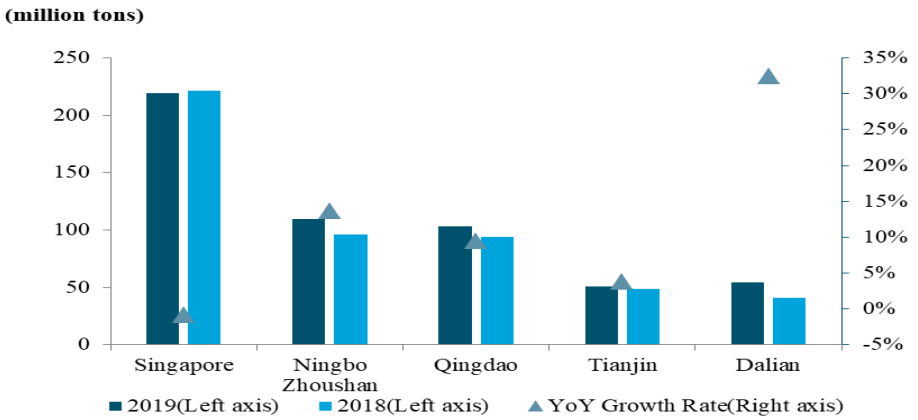
2.4 Overview of Liquid Bulks Throughput of Global Ports

In the first half of 2019, the international oil prices rose first and then declined with large fluctuations. The prices in the second half of the year continued the oscillation overall. The global crude oil supply and demand shifted from slight oversupply to a basic balance, and the seaborne trade volume of crude fell by 0.7% year-on-year.

2.4.1 Liquid bulks throughput of Asian ports rose

With the IMO sulfur restriction expected to take effect in 2020, the demand for low-sulfur oil was strong in 2019. Port of Singapore, as the world's largest offshore fueling hub, recorded as high as 5.48 million tons of ship-use low-sulfur oil sales a year, far higher than the 332,000 tons in 2018. Despite the slight fall in crude oil throughput, namely by 0.9% year-on-year to 219.45 million tons, the growth rate picked up compared with last year. China's crude oil import demand increased due to the high domestic refinery demand and the rising crude processing volume, and its crude oil import volume posted strong growth. As a result, China's ports imported a total of 510 million tons of crude oil in the year, an increase of 9.0% year-on-year. The increasing arriving volumes of

foreign-trade cargoes boosted a general increase in port throughput, as evidenced by Dalian Port and Ningbo Zhoushan Port, which recorded 32.4% and 13.6% of growth, respectively.

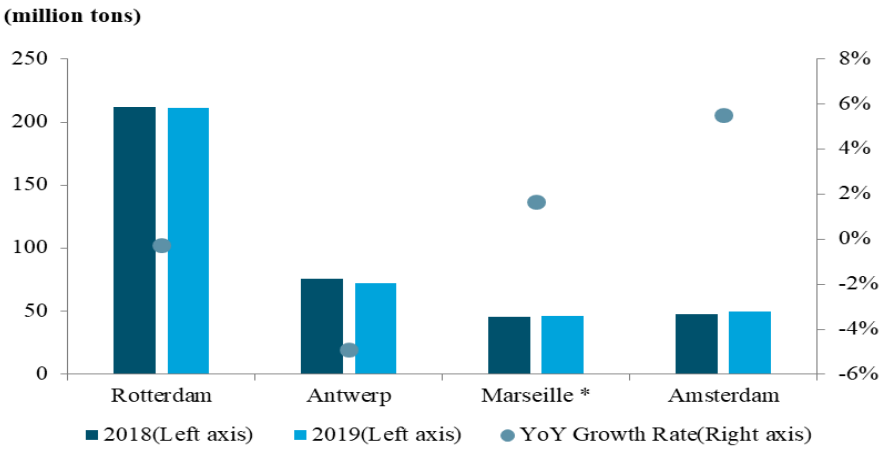


Source: Websites of various port authorities, sorted by SISI.

Figure 2-30 Crude Oil Throughput of Major Asian Ports (2018-2019)

2.4.2 Liquid bulks throughput growth of European ports slowed down

Impacted by decreased global fuel oil trade, the liquid bulks throughput of the Port of Rotterdam fell by 0.3% year-on-year to 210 million tons in 2019. Specifically, the crude oil throughput increased by 1.3%, and the port's LNG throughput rose driven by the increased natural gas production in the Atlantic. However, the mineral oil products throughput dipped due to the declining global fuel oil trade. The Port of Antwerp handled a total of 72.06 million tons of liquid bulks in the year, dropping by 4.9% year-on-year. The Port of Amsterdam transited a total of 50 million tons of liquid bulks in the year, an increase of 5.5% year-on-year.



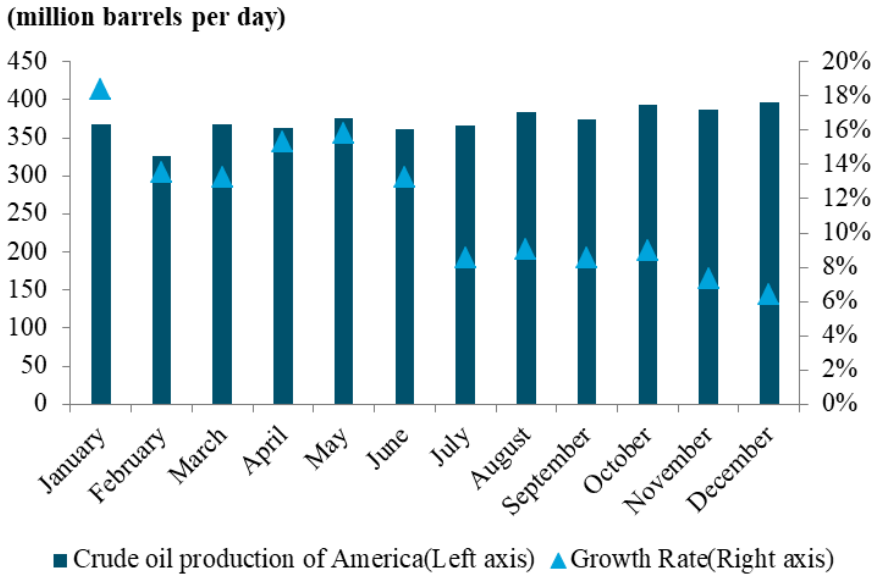
Note: * indicates projections.

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

Figure 2-31 Liquid Bulk Throughput of Major European Ports (2018-2019)

2.4.3 Liquid bulks throughput of North American ports dropped

The stricter capital constraints in 2019 resulted in the trimming of the drilling platforms of the largest shale oil field in the United States, which slowed the growth of the US crude oil production. Boosted by the steady increase in crude oil production, the US crude oil exports increased. Its export volumes of crude oil and petroleum products in this September were greater than the import volumes, marking the first month of the US as a net oil exporter in the past 70 years. Canada is the second-largest oil exporter of North American oil. Due to the oil price volatility, the surging oil inventories and the shortage of oil pipelines, the Canadian government has forced the production trimming measures on crude oil to avoid oil surplus due to blockage of pipelines. Its oil exports declined as a result.



Source: Energy information administration, sorted by SISI.

Figure 2-32 Crude Oil Production of America in 2019

III. Comments on Port Operation and Management in 2019

3.1 New Developments Trends of Port Logistics

With the increasing pressure on the maritime market, most port companies and terminal operators were faced with tremendous challenges in 2019 such as declining profit of terminal businesses and increased competition of existing businesses. To further attract cargo sources, expand profit sources and reduce the pressure of environmental pollution, many port companies have launched multi-party cooperation with logistics companies and information technology firms to create an ecosystem that covers all transport and shipping sectors to provide customers with comprehensive services.

3.1.1 Operation normalization of sea-railway intermodal transport

In recent years, the sea-railway intermodal transport logistics service model has developed rapidly, and the advantages of the model have also been recognized by most ports and logistics companies. When market environment and cargo source conditions are determined, ports developing the sea-railway intermodal transport can not only avoid the disadvantages and limitations of single-modal transport in terms of transport time, distance and cost, but also realize complementary advantages between waterway and railway transport modes to enhance transport efficiency. However, when the transport market environment is uncertain, the current development of sea-railway intermodal transport container trains are in a stage of line opening, without operation normalization, due to problems including the higher seaborne freight prices than seaborne shipping and the insufficient demand for returning cargo sources. Realizing operation normalization of sea-railway intermodal transport is essential for ports to coordinate the cargo collection, transportation and distribution modes, and for logistical service providers and cargo owners to arrange the logistics transportation mode.

From the development of sea-railway intermodal transport normalization, though large-scale construction of railways and supporting facilities is the basis for advancement of sea-railway intermodal transport, it is necessary to attract containerizeable cargo sources and streamline sea-railway intermodal transport procedures to achieve operation normalization in the real sense so that cargo owners, logistics companies, ports and other participants can truly enjoy the efficiency and profit guarantee brought by sea-railway intermodal transport. On the one hand, it is necessary to make full use of railways' cargo collection, transportation and distribution capacities as well as the returning capacity. We need to develop effective cargo sources in a targeted manner to increase the ratio of returning containers in sea-railway intermodal transport. On the other hand, ports should also pay attention to the connectivity of sea-railway intermodal transport and the capacity building of railway transfer channels. The renovation of container terminals and depots on railways should be stepped up, especially the supporting renovation of container handling operation zones. This way we can solve the "one kilometer in the middle" problem of sea-railway intermodal transport and improve the transshipment efficiency. In addition, ports can try to realize interconnection and interoperability of the land and port information and data through building shared sea-railway

intermodal transport information platforms, so as to create a more transparent supply-demand matching mechanism and reduce the uncertainty in cargo sources and liner services in the shipping market.

3.1.2 Cross-border multimodal transport development

With the continuous development of multimodal transport routes, the land-oriented service scope of port logistics has gradually expanded from the domestic hinterland of ports to the overseas hinterland. Cross-border multimodal transport has gradually become an important part of the global logistics network, and has provided a new multimodal transport mode for port logistics.

In cross-border multimodal transport, transport corridor is one of the main multimodal transport modes for connecting land and bridge corridors between cross-border areas. Building international cross-border transport corridors cannot only bring out the potential of cross-border transport, but also further facilitate cross-border transport of international cargoes, because of the unique geographical advantages, global connections and international integration characteristics of these transport corridors. **Building logistics channels based on trading channels is also one of the main modes of constructing cross-border multimodal transport channels.** In 2019, China released the General Plan on New Western Land-sea Corridor. The new western land-sea corridor takes Chongqing as the operational center, with Guangxi, Guizhou, Gansu, Qinghai and other western provinces as key nodes, and utilizes railways, highways, waterways and other transport modes to head southward passing through coastal and border ports such as Guangxi Beibu Gulf Port to Southeast Asian economies such as Singapore. The overall operating time has been significantly shortened compared to that by way of the eastern region. The establishment of the new western land-sea corridor not only reduces the cost and transport time at the port logistics level, but also promotes a new mode of inter-port cooperation.

However, cross-border multimodal transport not only involves the connection of multiple transport modes and corridor construction, but also involves multiple different subjects of liability and different legal boundaries. Therefore, promoting cross-border multimodal transport needs to further unify the responsible subjects and streamline documentation and procedures. Judging from the port logistics trends in recent years, the trend of multimodal transport cannot be halted and isolated and node-based transport modes will be replaced by chained and networked counterparts. In this context, **ports, as an important hub for gathering information from multiple parties, need to have public service awareness and a high level of customer service capabilities.** From the perspective of a global logistics supply chain service provider, it is necessary to promote various economic and trade entities to conduct trade activities more conveniently. To achieve this, it is necessary to promote development of goals with a networked organization model, actively break the limitations on ownership and space environment, and realize complementary effects with multiple transport modes. Meanwhile, **ports should also pay attention to the application of cutting-edge scientific and technological results in port logistics and promote business model innovation and technological model innovation with business needs.** They should elevate information technology levels, conduct R&D and application of logistics software, apply advanced information management systems and utilize other means to improve the construction level of port logistics

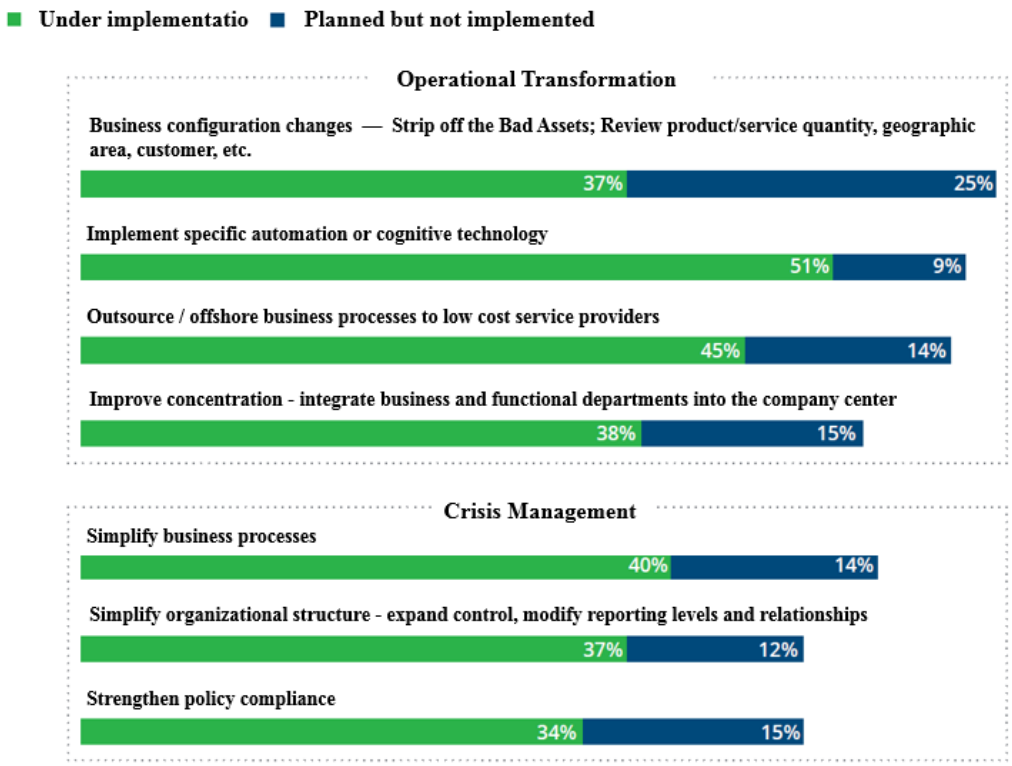
information platforms and the information-based level of port logistics activities, so as to connect multimodal transport modes in an efficient manner.

3.2 New Development Trends of Port Operation

3.2.1 Management strategies of port assets and investment risks

Port and terminal operators are asset-intensive companies, and their management over terminal assets directly affects the efficiency and effectiveness of business operations. Meanwhile, port and terminal operators usually have high one-time investments in terminal assets with a long return on investment. These investment projects not only occupy companies' funds for long, but also feature high asset professionalism, a large total amount of assets, and high costs for subsequent maintenance and renovation. Asset transactions between port and terminal operators in recent years have been dominated by asset mergers and equity mergers. In November 2019, China Merchants Port signed a memorandum of understanding with France's CMA CGM, intending to acquire 49% of the equity interest in 10 global terminals under the CMA CGM. This terminal asset transaction demonstrates the different asset investment and management strategies of China Merchants Port and CMA CGM.

In view of the increasing uncertainty, narrowing and sluggish profit margins will put pressure on port companies' asset management. Port companies' responses focus on three aspects: **reconfiguring asset portfolios, streamlining operations, and providing advanced customer experience in the digital age.** Meanwhile, the shrinking profits of the maritime industry have also forced many port companies to **transform operating methods, from the traditional cost-effective model to the "promoting transformation through conservation" operating model**, so as to improve the operating efficiency of port companies and reduce their strategic risks. According to Deloitte's global cost survey on executives who were directly involved in companies' cost management decisions, companies that are currently implementing operational transformation initiatives account for 37% to 51%, and companies that are implementing risk management initiatives account for 34% to 40%. Therefore, how to properly manage assets and reduce risks may be a strategic impetus for port companies to step over traditional boundaries and increase profits.



Source: Deloitte global cost survey 2019.

Figure 3-1 Combination of Operation Transformation and Risk Management

3.2.2 Marketing strategies of ports

Due to different industry characteristics and management systems, ports, as transport service providers, used to value production more than market, with relatively weak marketing efforts. However, with the continuous evolution and changes of the global trade model, ports, as important nodes in the logistics supply chain, are closely tied to upstream and downstream companies in the supply chain through logistic flows, information flows, capital flows and others. In a seaborne shipping market featuring fierce competition for cargo sources and shipping routes, ports urgently need to strengthen marketing capacities to improve and consolidate port businesses by expanding emerging businesses, answering to customers' needs, cultivating customer loyalty and using other means. The port logistics supply chain is no longer just a cost center. Customers even more hope that port companies can become their supply chain partners and provide one-stop logistical services to align the interests of both parties. In this context, many ports have jumped out of the traditional routines of marketing for shipping companies in marketing activities, and seek long-term and stable partnering models through extensive contact with cargo owners, governments, and all social sectors.

In terms of marketing, many ports expand their market connectivity by establishing port marketing associations. For example, Port of Busan attaches high importance to its container transit service marketing and actively establishes strategic partnerships with other ports. To promote its international transit services, Port of Busan has set up a specialized port marketing association to promote the international container logistics service of Port of Busan. Port of Hamburg established the Hamburg Port Marketing Association and set up offices in 11 cities

around the world specifically responsible for market research, external publicity, customer development, trade exhibitions and other activities in the port shipping and logistics industry.

In addition, with the logistics supply chain network and platform model evolving, **supply chain marketing alliance has gradually become an online marketing model of ports.** With the continuous evolution of e-commerce and online transactions, supply chain marketing alliances have gradually shifted from the marketing through alliances of physical ports and logistics companies to the marketing on affiliate networks. Ports and logistics service companies can leverage the website alliance services provided by professional alliance marketing agencies to expand their online and offline businesses, broaden sales space and channels. These are new attempts by ports and logistics companies in response to small batch and fragmented online businesses.

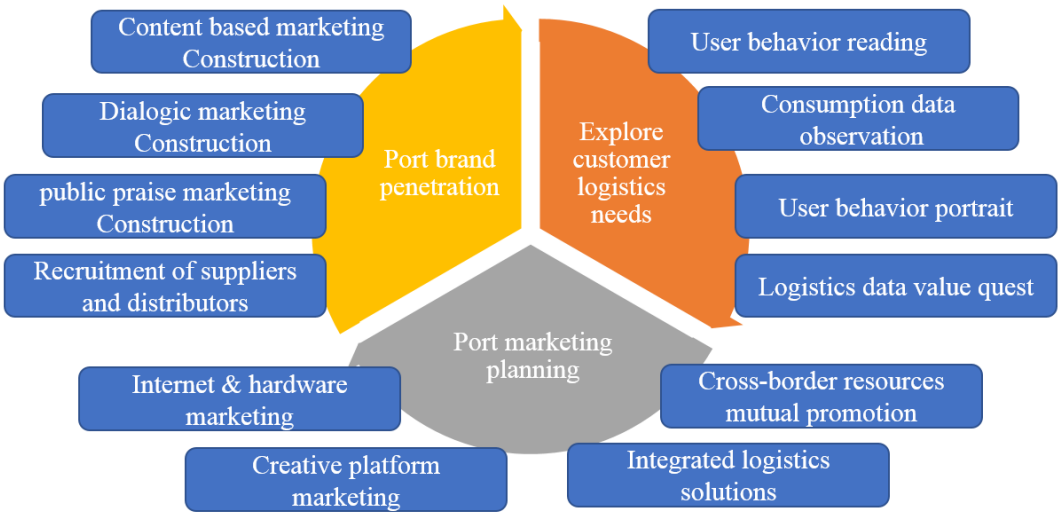


Figure 3-2 Port Marketing Strategy

In an era featuring large amounts of information, logistics supply chain, as a bond connecting ports, logistics companies and customers, continues to witness increasing customer bases, upgraded demand differentiation, and more difficult service management. All these developments have elevated the requirements on the capability and quality of port logistics services at all levels. Port companies should consider not only the source of profit margins, but also the prospects and ways of industry development, and improve the efficiency of company operation and management through innovating service economic models. In the face of a market featuring both international competition and regional monopoly, how port companies establish marketing alliances with logistics companies and internet companies that feature similar positioning but focus on different categories, so as to share information resources concerning customers may be a marketing strategic direction worth considering for ports to grow in the logistics supply chain. Meanwhile, port companies should put ports into the global logistics network on the basis of clear positioning, so as to understand market trends and the latest needs, explore market niches, and meet the basic logistical needs of customers with high efficiency and at low costs. Ultimately, they can excavate customers' potential logistics needs and create customer needs, and enhance customer value.

3.3 New Development Trends of Port Policy

3.3.1 Ports gradually promote shore power policies

In recent years, the shipping industry's attention to reducing pollution and greenhouse gas emissions has reached an unprecedented height. The IMO's sulfur restriction and carbon emission reduction targets have also created high challenges to the development of the port and shipping industry. Although the initial GHG emission reduction strategy proposed by IMO was primarily aimed at ships themselves, most of the carbon emission reduction measures for ships still need to be carried out on land, such as using shore power facilities and LNG among other clean energy sources. Port serves as a landing point of ships, and its shore power policies are closely related to ships' emission reduction. However, due to the differences in energy taxes and electricity prices, the construction and promotion of shore power at ports still face policy and institutional difficulties.

From the perspective of shore power policy, only a few governments in the world have issued mandatory regulations on use of shore power to reduce greenhouse gas emissions. Specifically, the ocean-going vessels at-berth regulation of California applies to the ports of San Diego, Long Beach, Los Angeles, Oakland, Hueneme and San Francisco, requiring fleet operators to reduce auxiliary engine emissions by 80% when ships berth at ports. When a ship is at a port, it can choose to turn off the auxiliary engine and connect to the grid-based shore power, or use alternative control technologies that can achieve equal emission reduction effects, such as distributed power generation or other ship-side or shore-side control technologies.

Although shore power is an important measure to achieve the IMO 2050 greenhouse gas emission reduction target and mandatory use of shore power will help promote shore power among ports, insufficiency in national legislation and tax exemption policies as well as the narrowing gap between the fuel oil and electricity costs still hinder the implementation of shore power on a global scale. The 2019 Environmental Report of the European Sea Ports Organization (ESPO) pointed out that due to the wide differences between the EU energy taxes and the taxes imposed by various economies on electricity prices, it is still very difficult for ports to commercialize the operations of shore power infrastructure. The Shore Power Technology Assessment at U.S. Ports pointed out that because shore power use by ships requires high costs for commissioning and purchasing electricity during berthing, it is unlikely for shippers to use shore power instead of ship-use light diesel oil given the current fuel oil prices. Therefore, the policies and regulations that only require ships to use shore power may find it difficult to actually promote the use of shore power at ports. Expanding ports' incentives for low-carbon and environmentally friendly vessels, and linking ports' incentives with greenhouse gas emissions may become a major direction of policies for ports to promote shore power.

3.3.2 UK freeport policy to be introduced in the Brexit background

In response to the impact of Brexit, the British government plans to set up 10 freeports after withdrawing from the EU to achieve free flows of cargoes. According to the British freeport consultation plan promulgated by the British government, the freeport construction will include

customs, taxation, planning, innovation and other related policies. If the British government can truly implement policies such as tax relief, infrastructure and innovation incentives in freeports, it can well solve the problems of customs clearance and tax payment brought by Brexit, while providing new development space for industrial economic development in the port areas.

With globalization and marketization evolving, building a free trade port (area) has become an important means for promoting globalization and facilitation of trade, and an effective way for countries and regions to get deeply engaged in global value chains as well. The existing internationally representative free trade ports (zones) are often located in countries and regions with significant geographical advantages and well-developed market systems. Their core element is freedom, and their essential feature is the free flows of cargoes, services, finance, and personnel. Different countries and regions have formed free trade ports with different characteristics and paths according to their own conditions and development strategic needs. The current global free trade ports (zones) present the following major trends based on their developments:

1. Diversified functions. In the early stage, free trade ports primarily served re-export trade. However, as the industrial economy progressed, free trade ports gradually began to develop various service functions related to logistics and trade, such as financial services, information services, data services, technology services, legal services and other business services. As the diversified development demands enhance, various types of free trade ports (zones) in the world are also exhibiting diversified characteristics.

2. International differentiation. The construction and development of free trade ports are results of international trade development under specific conditions, primarily for the purpose of achieving free and open institutions and areas. However, due to the developmental differences among countries and regions, free trade ports also show two differentiated trends of development: fall and rise. For developed economies that took the lead to establish free trade ports, their free trade ports no longer continue to enjoy policy dividends as the whole nation or more areas in the nation are opened up, and free trade ports are gradually declining. However, developing economies represented by China are seeing more and more free trade ports (zones) established and becoming more open. Therefore, though the establishment and development of free trade ports (zones) exhibit differentiated development in different countries and regions, it is undeniable that they are more open and broader overall.

IV. Comments on Global Terminal Operators in 2019

4.1 Overview of Global Terminal Operators Development

The shipping market fluctuated in 2019 and the downside pressure on production and operation of global terminal operators increased. Meanwhile, the continued investment in larger ships and the ever-changing shipping alliances also resulted in increased competition among global terminal operators for cargo supply. Global terminal operators sought to explore opportunities by adjusting their assets and expanding the scope of services to achieve profit growth.

4.1.1 Production capacity changes of global terminal operators

Global terminal operators controlled around 62% of the total terminal capacity in 2018, slightly higher than the 61% in 2017. According to Drewry's forecast, the terminal capacity share growth of global terminal operators will remain at 1.5% in the future, slightly lower than the industry's 1.9% growth. In general, due to factors such as overcapacity and increased investment risks, global terminal operators may increase cost management monitoring and adopt a more stringent and prudent investment strategy in 2019. Global terminal operators have limited space for capacity increase overall and the market shares may change only by small margins.

Table 4-1 Forecast Development of Container Port Capacity by Ownership

Year		2018	2019	2020	2021	2022	2023	Ave. Annual Growth
Global Operators	capacity	694.6	710.8	728.9	741.7	747.3	749.6	1.5%
	share	61.9%	61.7%	61.3%	61.1%	60.9%	60.9%	—
Private Sector	capacity	196.6	200.0	205.5	209.2	213.0	213.9	1.7%
	share	17.5%	17.4%	17.3%	17.2%	17.3%	17.4%	—
State Sector	capacity	210.2	217.5	227.7	234.4	238.3	238.3	2.5%
	share	18.7%	18.9%	19.2%	19.3%	19.4%	19.3%	—
Other	capacity	21.2	22.9	26.6	28.8	29.4	30.0	7.2%
	Share	1.9%	2.0%	2.2%	2.4%	2.4%	2.4%	—
Total (Million TEU)		1122.5	1151.2	1188.8	1214.0	1228.1	1231.8	1.9%

Source: Drewry, Global Container Terminal Operators Annual Report, sorted by SISI.

4.1.2 Market share changes of global terminal operators in various regions

The container throughput share of global terminal operators accounted for 65.3% of the global total in 2018, the share increasing by 1.1% compared with 2017. In terms of regional share, Europe, the Middle East and the Indian subcontinent were the regions with the highest terminal operator

throughput shares in the world, accounting for 76.3% and 73%, respectively. In addition, global terminal operators also seized a significant market share in Asia, namely 64.2%. The market share of global terminal operators in Africa rose by 1.8% year-on-year to 56.1%, based on the premise that public institutions accounted for nearly 40% there. The market share of global terminal operators in North America fell by 1.4% year-on-year to 58.2%.

Table 4-2 World Container Port Handling by Region and Ownership

Region	Throughput / ('000 teu)	Share of Throughput in 2018（%）			Global Operator Share Change
		Global Operators	Private Sector	State Sector	
North America	67518	58.2	20.7	21.1	↓1.4%
Europe	137031	76.3	16.4	7.3	↑5.6%
Asia	423077	64.2	10.5	25.4	↓0.5%
Middle East Indian Sub Continent	66682	73.0	11.4	15.6	↑1.5%
Latin America	47127	56.7	32.5	10.8	↑0.3%
Africa	25852	56.1	6.1	37.8	↑1.8%
Oceania	13119	33.6	56.6	9.9	↑2.9%
World	783630	65.3	14.5	20.3	↑1.1%

Source: Drewry, Global Container Terminal Operators Annual Report, sorted by SISI.

4.1.3 Profitability of global terminal operators

In 2018, except PSA International and EUROGATE Container Terminal, all major global terminal operators enjoyed increases in single-container revenues. EUROGATE Container Terminal was affected by the decline in port business volume, and its EBITDA margin fell. CK Hutchison, despite slight drop in business activities, maintained a high profit margin. The profit margin of COSCO Shipping Ports slightly decreased, but its business volume and revenue increased significantly. In addition, DP World enjoyed substantial revenue growth through acquisitions, but its EBITDA margin fell slightly because some of these acquisitions were not included in the scope of port businesses. In 2019, uncertainties such as the US-China trade frictions intensified trade tensions, and the growth slowdown in emerging markets also added to the uncertainties in market prospects. Coupled with liner alliances' pressure on the profitability of global terminal operators, it is expected that global terminal operators will face greater challenges in future profitability.

Table 4-3 Financial Performance of Selected Global Terminal Operators in 2018 ($ million)

Terminal operator	Revenue	Earnings	2017		2018	
			Revenue per teu/$	Earnings per teu/$	Revenue per teu/$	Earnings per teu/$
Eurogate	694	144	52.0	12.5	49.2	10.2
Hutchison Ports	4492	1710	51.6	19.0	53.1	20.2
ICTSI	1386	636	136.0	63.1	142.4	65.3

PSA	4086	2021	53.5	26.2	50.4	25.0
APMT	n.a.	n.a.	51.2	n.a.	8.9	n.a.
Cosco Shipping Ports	1000	319	27.0	8.7	29.9	9.5
DPW	5646	2808	129.6	67.7	153.6	76.4

Note：1）The earnings of all the terminal operators are EBITDA.

2）Revenue per teu and Earnings per teu are compared by equity throughput.

Source: Drewry, Global Container Terminal Operators Annual Report, sorted by SISI.

Feature 4: Resilience to Risks and Investment Analysis of Global Terminal Operators

The global economic and trade market was complex and changeable in 2019. Although global terminal operators maintained sound business capabilities, their investments and acquisitions slowed down compared with the previous two years due to terminal business growth slowdown and continued increase in capital pressure. As a result, they were faced with increasing risks.

I. Resilience to risks of global terminal operators

To cope with changes in the shipping market and industry landscape, global terminal operators are improving their resilience to risks and the capability of continuous operations primarily through improving capital structures, managing terminal asset ranges, and increasing asset investment in low-risk areas.

From a geographical perspective, investment risks in different regions of the world vary due to differences in economic development, political environment, and market conditions. Specifically, according to an investment-related risk assessment in various regions of the world conducted by the Organisation for Economic Co-operation and Development (OECD), North America has the lowest investment risk level, while Europe and Oceania also have relatively low investment risks. The investment risks of the Middle East and the Indian subcontinent and Latin America are higher, while Africa is the region with the highest investment risk. Emerging and mature economies in Asia are in the middle of the investment risk scale. As Drewry's risk indexes of global terminal operators' investment portfolios show, the resilience to risks of 21 global terminal operators is primarily related to their business distribution. Specifically, Bollor é Group recorded the highest risk index because its main businesses are located in West Africa. The four terminal operators of China Merchants Port, Hutchison Whampoa, DP World and AP Moller-Maersk also recorded high risk indexes due to business operations in Africa. PSA International enjoyed an improvement in risk status because of increased capacities in highly risky areas such as Dalian Port and Jawaharlal Nehru Port. Several other terminal operators such as Hyundai Group and Eurogate Group posted lower risk indexes in general because most of their terminals are located in low-risk areas. It is worth noting that the risk index of COSCO Shipping Ports followed a downward trend, primarily due to the addition of Orient Overseas (International) Limited's terminal in its investment portfolio and the increased investment in terminals in low-risk areas.

Table 1 Global Terminal Operators' Portfolio Risk Indexes in 2018

Operator	Risk index	Operator	Risk index	Operator	Risk index
K Line	1.00	SSA Marine	2.22	DP World	2.92
Hyundai	1.15	SAAM Puertos	2.35	Hutchison Ports	2.97
Eurogate	1.29	PSA	2.42	APMT	3.28
HHLA	1.68	Evergreen	2.50	CMA CGM	3.66
Yang Ming	1.71	TIL	2.55	China Merchants Ports	3.84

NYK	1.98	China Cosco Shipping	2.57	ICTSI	4.69
MOL	2.19	Yildirim/Yilport	2.64	Bollore	6.29
				Average	2.66

Note: weighted risk rating based on terminal capacity.

Source: Drewry, Global Container Terminal Operators Annual Report, sorted by SISI.

II. Analysis on investment strategies of global terminal operators

The investment strategies of global terminal operators can be analyzed from two aspects: one is the terminal operator's preference for investment in emerging markets or mature markets; the other is the terminal operator's preference for investment methods in the initiation of new businesses or M&A of existing businesses.

From the investment market perspective, global terminal operators are more interested in investing in emerging market investments over in mature markets. Specifically, the ports in mature markets are primarily the global transit hub ports in Europe, North America and Australia. Although some transit hub ports are geographically located in mature markets, they are classified as emerging markets because their sources of cargoes are primarily from emerging markets. Currently, relatively active ports in emerging markets include China Merchants Port, Bollore, ICTSI and SAAM Puertos. Other global terminal operators such as DP World, PSA International, Hutchison Whampoa and COSCO Shipping Ports are also active players in emerging markets. However, most of AP Moller-Maersk's businesses are in Europe, Japan and North America, and the company has relatively limited engagement in emerging markets.

From the perspective of investment methods, most terminal operators choose new construction investment rather than acquiring investment. To balance investment portfolios and alleviate financial pressure, terminal operators are mostly cautious about asset expansion. When suitable investment opportunities emerge, terminal operators will turn to merger and acquisition expansion. In addition to investment in traditional terminal assets, terminal operators have also invested in expanding logistics supply chain services in recent years.

From investment liquidity, some terminal operators have made large-scale overseas investments in recent years, with less demand for investment cancellation or reinvestment. The investment liquidity of terminal operators is mainly affected by market conditions and their own current funds. In 2019, CMA CGM invested in CEVA and sold 10 terminal assets it held. Its purchase of CEVA Logistics coincided with its large-scale investment plans, including its largest container ship order, stretching its current funds and leaving CMA CGM debt ridden. The capital strain forced CMA CGM to be divested of its terminal assets to enhance liquidity.

From preference of investment scope, some global terminal operators primarily make regional investments and are less involved in global investments outside the region. For example, the investment and development of Eurogate Group and HHLA are largely within the European region. This investment preference is often related to the terminal operator's home port development and its main routes. For example, China Merchants Group purchased 49.9% equity in Liaoning Port Group, the parent company of Dalian Port and Yingkou Port, through capital increase, to promote the integration of port resources in Liaoning. ICTSI acquired a 35% stake in its home port Manila North Harbour Port, Inc. (MNHPI) in 2017 to further improve home port operations.

III. Suggestions on anti-risk investment for terminal operators

Terminal operators' investment measures are closely related to their resilience to risks. Effective and reasonable investment of terminal operators can not only expand their market coverage and enhance their competitiveness in market, but also effectively respond to market risks through reasonable asset allocation. Therefore, in the current context of increasing market uncertainties, terminal operators are more cautious in investment decision-making and prefer terminals with greater development and profit potential, while reducing operational risks of terminals through cost control, cooperative operations and other means.

(1) Transform from new construction investment to expansion and upgrading investment. As the global port infrastructure continues to improve, opportunities for investing in new port construction are decreasing. Terminal asset investment will change from new construction expansion to existing asset upgrading. Some ports have outdated or old infrastructure equipment among other problems, which greatly affects the efficiency of port operations. Therefore, terminal operators can start from upgrading and renovating old terminals and obtain rights of terminal operations through investing in renovation and expansion projects.

(2) Transform from network layout to cost control. The investment focuses of terminal operators have shifted from project investment to cost control and to efficient use of their own assets, so as to reduce business risks.

(3) Transform from individual investment to cooperative investment. As market uncertainties grow, international terminal operators should gradually introduce other terminal operators or investment groups, to exchange part of their terminal equity for high-quality terminal resources or cooperative investment in terminal projects with strong development potential.

(4) Transform from port businesses to full industrial chain services. Current terminal operators are changing from the traditional internal growth mode to the innovative extended growth mode. Major terminal operators are also providing efficient and high-quality services to global customers by building port supply chain platforms to achieve multi-faceted development and profitability.

4.2 Business Performance of Global Terminal Operators

4.2.1 COSCO Shipping Ports in sound operations

In 2019, COSCO Shipping Ports recorded a container throughput of 123.8 million TEUs in the year, a year-on-year increase of 5.5%, and an equity throughput of 39.7 million TEUs, a year-on-year rise of 7.0%. Although its previous high-speed growth has ceased, COSCO Shipping Ports has been actively leveraging the synergy of its parent company and the Ocean Alliance to strengthen control and management over port businesses, recording a rapid increase in equity throughput in the year. In addition, COSCO Shipping Ports has accelerated the expansion of its terminal businesses and sold terminal assets with smaller contribution to throughput and profitability to further streamline its terminal portfolios for higher overall quality of the portfolios.

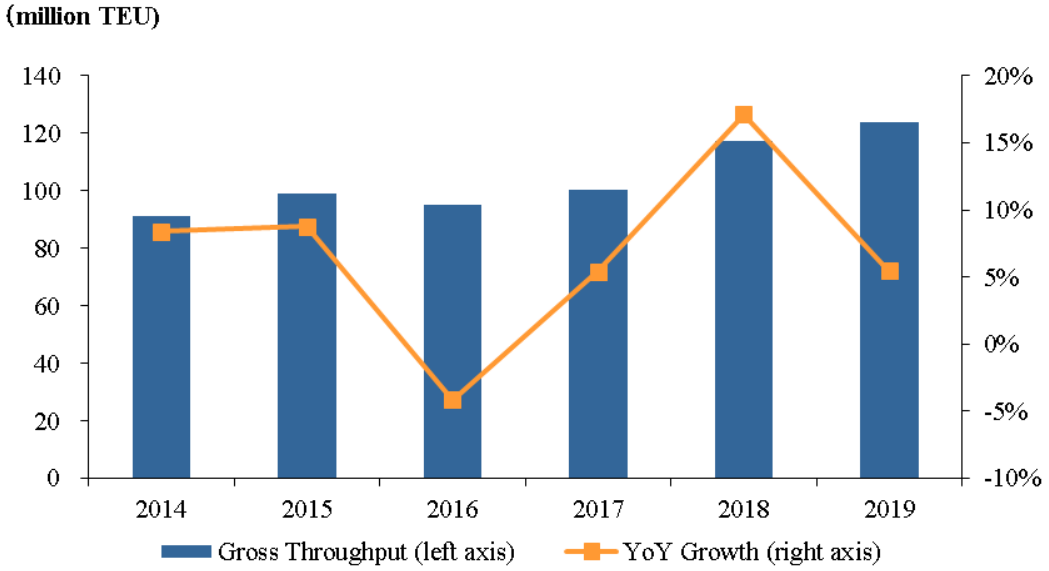


Figure 4-1 Cross Throughput and Growth Rate of COSCO Shipping Port in 2014 -2019

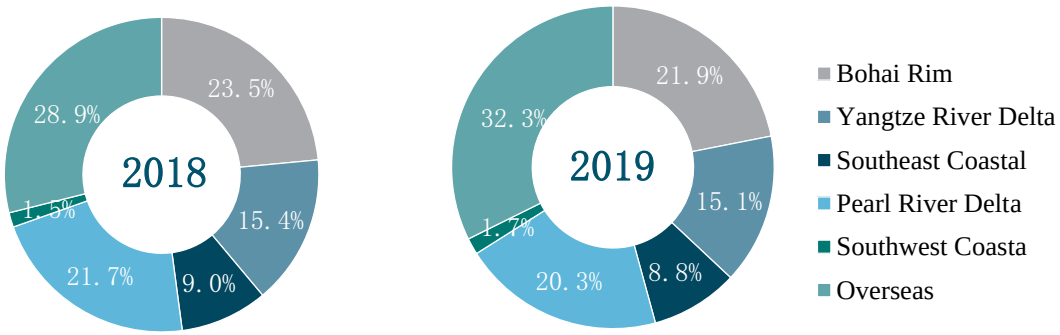


Figure 4-2 Proportion of Equity Throughput of COSCO Shipping Port by Region in 2019 and 2018

4.2.2 Business growth of China Merchants Port slowed down

In 2019, China Merchants Port recorded a container throughput of 111.7 million TEUs in the year, a year-on-year increase of 2.4%, and an equity throughput of 41.7 million TEUs, a year-on-year rise of 1.9%. Although the throughput growth of China Merchants Port slowed down due to the weak global economy and increasing regional uncertainties, the company responded to the internal and external economic and trade complexity by speeding up home port construction and expanding the layout of overseas terminals to enhance its professional capabilities and risk prevention. As a result, the company's business performance was overall stable.

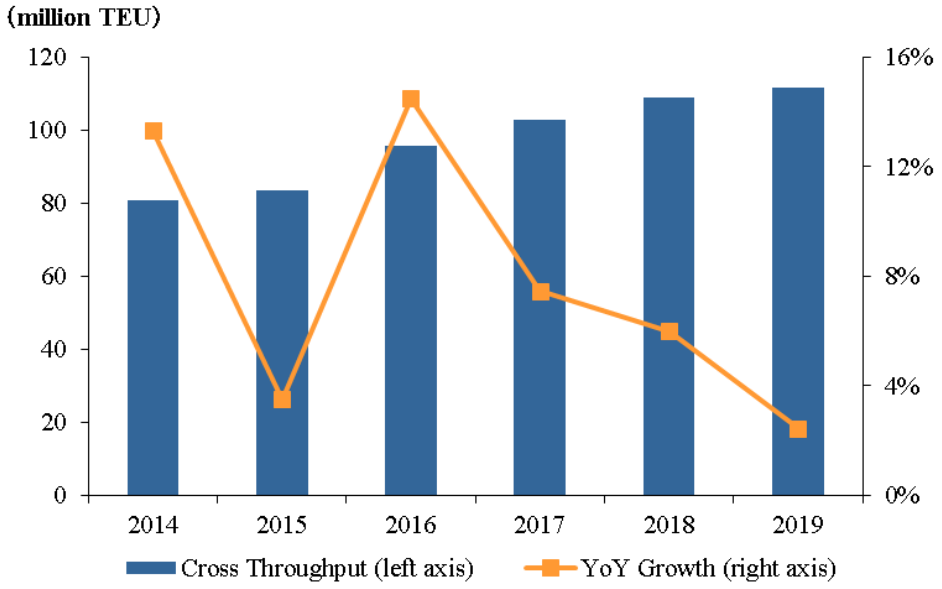


Figure 4-3 Cross Throughput and Growth Rate of China Merchants Port in 2014 -2019

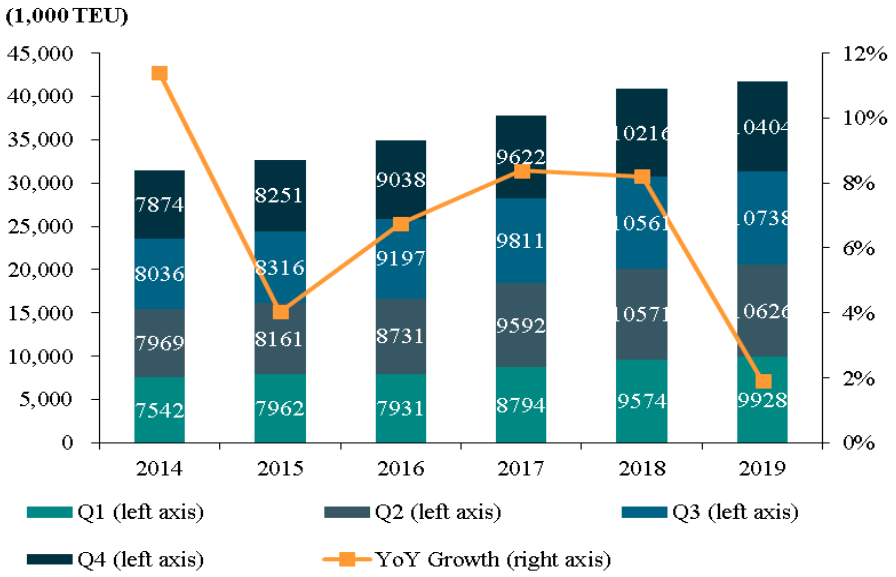


Figure 4-4 Quarterly Equity Throughput of China Merchants Port in 2014 -2019

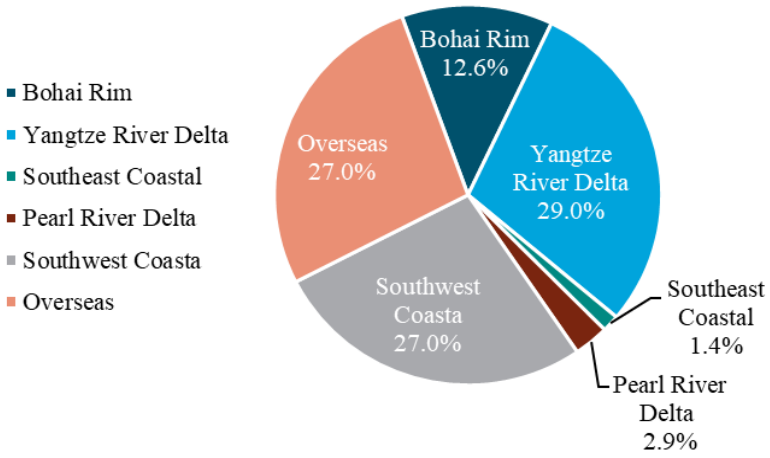
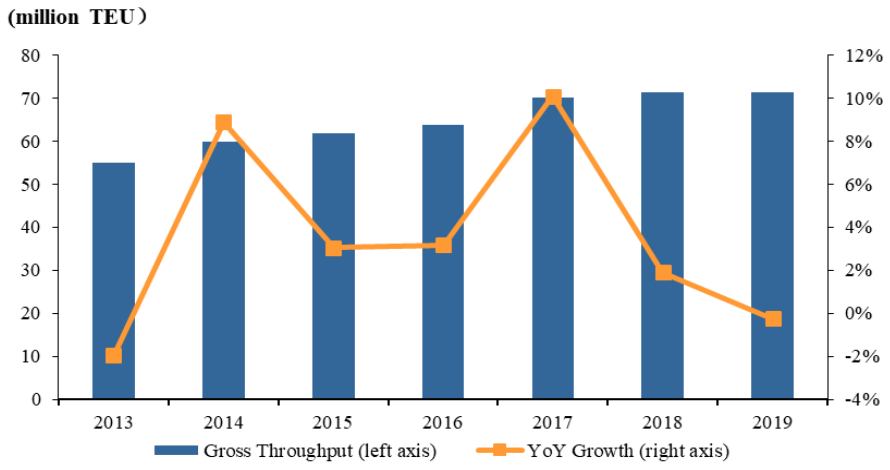


Figure 4-5 Proportion of Equity Throughput of China Merchants Port Holdings by region in 2019

The port recorded an annual revenue of HK$8.89 billion in the year. Affected by the sale of group's Shenzhen Chiwan Wharf Holdings equity last year, the annual revenue marked a year-on-year decrease of 12.4%. The profit attributable to equity holders of the company was HK$8.36 billion, a year-on-year increase of 15.4%. Meanwhile, the recurring profit of China Merchants Port fell by 3.1% year-on-year to HK$4.16 billion due to the decreased share of profits of associates.

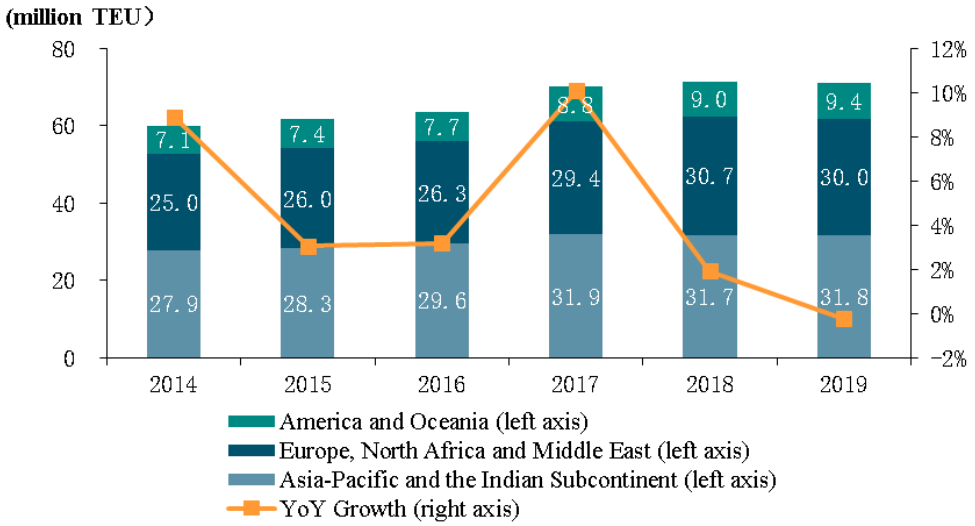
4.2.3 DP World profits declined

In 2019, DP World recorded 71.3 million TEUs of container throughput, a year-on-year decline of 0.2%. Due to the market uncertainty caused by geopolitical situations, coupled with the group's adjustment in its terminal business strategies, low-margin cargoes fell, and the group recorded negative growth for the first time in the past five years. However, DP World has accelerated its pace of acquisitions, strengthened cost management and invested more rigorously and prudently to maintain profitability by focusing on high-margin cargoes.



Source: Website of DP world, sorted by SISI.

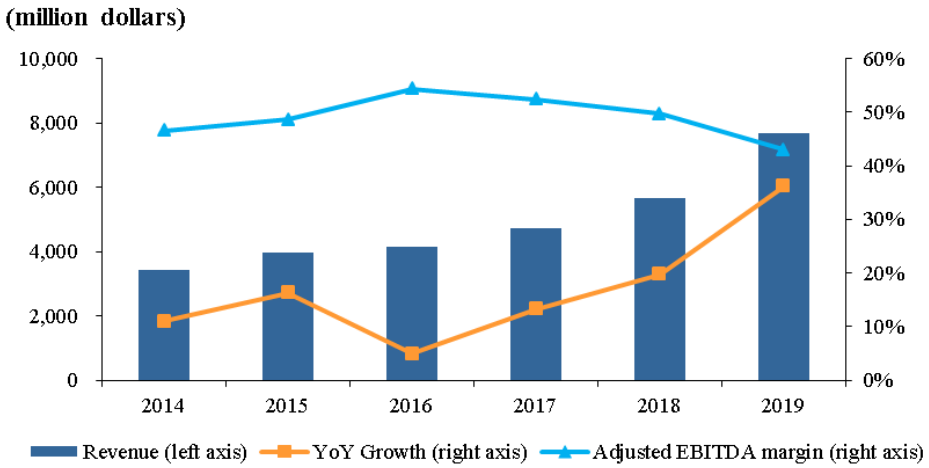
Figure 4-6 Gross Throughput and Growth Rate of DP World in 2013-2019



Source: Website of DP world, sorted by SISI.

Figure 4-7 Container Throughput and Growth Rate of DP World by Region in 2014-2019

In terms of profitability, DP World recorded a significant rise of 36.1% year-on-year in operating income in 2019, to US$7.7 billion, driven by the acquisition of the pan-Europe logistics platform P&O Ferries, the marine logistics operator Topaz Energy & Marine, and two terminals in Chile, as well as the acquisition of Peru's integrated logistics provider CAM and European container shipping company Unifeeder last year. The group's net profit attributable to its parent company's owners was US$1.2 billion, down by 8.7% year-on-year. The group's earnings before interest, tax, depreciation, and amortization (EBITDA) were US$3.3 billion, up by 17.7% year-on-year. The annual EBITDA margin was 43.0%, down by 6.7 percentage points.



Source: Website of DP world, sorted by SISI.

Figure 4-8 Operation Performence of DP World in 2014-2019

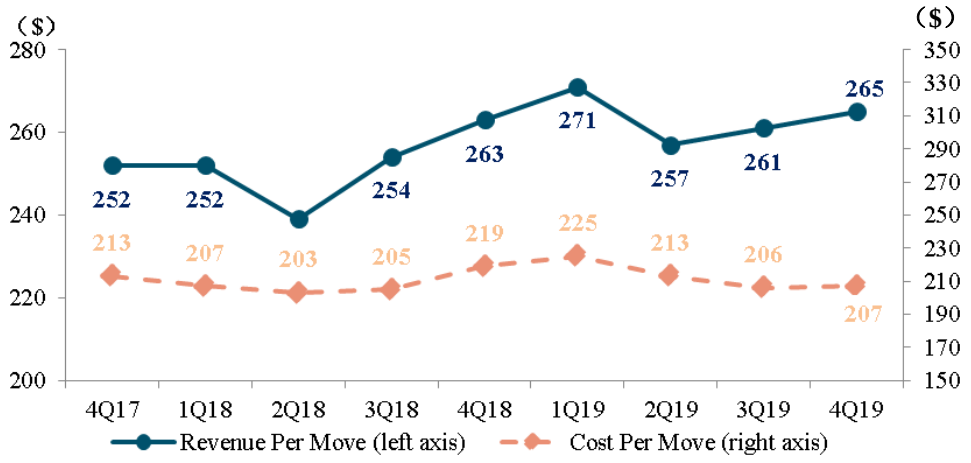
4.2.4 AP Moller-Maersk profits increased

In 2019, despite the sluggish market environment, AP Mueller-Maersk achieved increased profitability and cash flow by reducing the amount of interest-bearing debt and further deleveraging. The group's operating income reached US$38.9 billion, though slightly lower than last year's US$39.3 billion, recording a free cash flow of US$6.9 billion, a year-on-year rise of 35.3%. Specifically, terminal and tugboat business, as one of the group's high-profit business segments, recorded an annual operating income of US$3.9 billion, an increase of 3.2% year-on-year. The company's EBITDA rose by 11% year-on-year to US$1.1 billion, with the EBITDA margin standing at 28.4%. The rise in terminal and tugboat business performance was largely due to the increased cargo volume at the Moin Terminal in Costa Rica, the increased stockpiling income and the reduced sales and administrative expenses.

Table 4-4 Revenue and Earnings before Interest, Tax, Depreciation and EBITDA Ratio of A.P. Moller-Maersk in 2018-2019

	Revenue /million dollars			EBITDA margins		
	2019	2018	Growth	2019	2018	Growth
Ocean	28418	283.7	0.2%	15.3%	13.3%	2.0%
Logistics & Services	5965	6082	-1.8%	4.0%	3.1%	0.9%
Terminals & Towage	3894	3772	2.9%	28.4%	26.5%	1.9%
Manufacturing & Others	2172	2787	-22.2%	9.4%	5.8%	3.6%
Unallocated activities, eliminations, etc.	-1559	-1750	10.9%	12.4%	7.8%	4.6
Total	38890	39257	-0.9%	14.7%	12.7%	2.0%

Source: Website of Maersk, sorted by SISI.



Source: Website of Maersk, sorted by SISI.

Figure 4-9 Revenue Per Move and Cost Per Move of A.P. Moller-Maersk in 2017.Q4-2019.Q4

In terms of terminal business, AP Moller-Maersk recorded a consolidated statement throughput of 11.8 million containers in the year, a year-on-year increase of 3.9%. Specifically, the company recorded a throughput on consolidated statement of 5.4 million containers in the Americas region,

partly because of the increased throughput of Costa Rica's Moin Terminal and the increased customers in Los Angeles, as well as the synergy brought by the business integration of AP Moller-Maersk and Hamburg Süd. Propped by the steady economic growth in Africa and the Middle East, the regional throughput on consolidated statement rose by 4.6% year-on-year to 1.9 million containers. In Europe, because the group sold the Izmir Container Terminal at the end of last year and the business volume in Barcelona declined, the region's throughput on consolidated statement reached 2.5 million TEUs, a year-on-year decrease of 6.1%. In the Asian region, the company's withdrawal from the Port of Kobe and the decline in business volume in Mumbai, India, the region's consolidated statement throughput fell by 9.7% year-on-year to 2 million containers.

Table 4-5 Financially Consolidated Volume of A.P. Moller-Maersk in 2018 and 2019

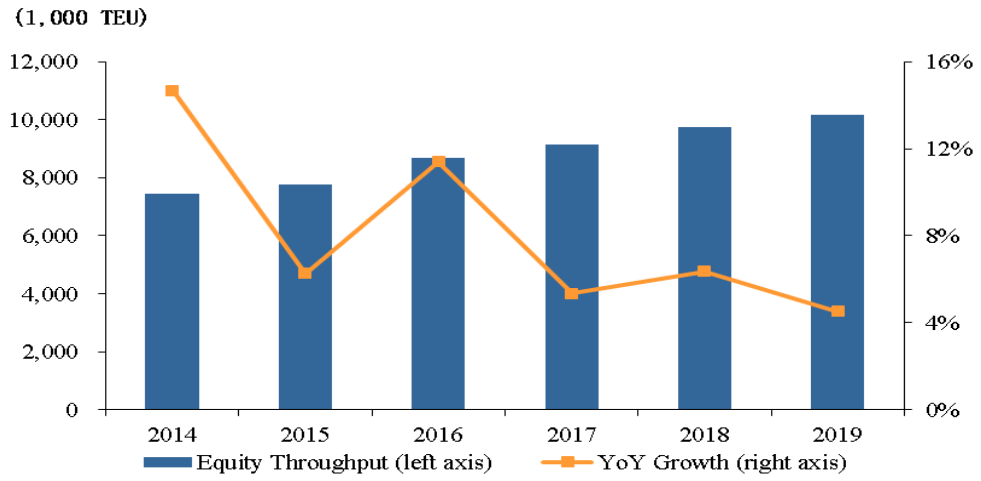
(Unit: Million Moves)

Region	2019	2018	YoY Growth
Americas	5.4	4.7	15.7%
Europe,Russia and Baltics	2.5	2.7	6.1%
Asia	2.0	2.2	-9.7%
Africa and Middle East	1.9	1.8	4.6%
Total	11.8	11.4	3.9%

Source: Website of Maersk, sorted by SISI.

4.2.5 ICTSI businesses progressed steadily

In 2019, ICTSI recorded an equity container throughput of 10.2 million TEUs, a year-on-year increase of 4.5%. The company's port business revenue reached US$1.5 billion, a rise of 6.9% year-on-year. In general, the Philippines' international production and operation continued to maintain a stable and improving trend in the year. Despite the slower growth of throughput compared with the previous year, the company enjoyed significantly increasing profitability through strict cost control and increased market share. Its net profit reached US$260 million.



Source: Website of ICTSI, sorted by SISI.

Figure 4-10 Equity Throughput and Growth Rate of ICTSI in 2014-2019

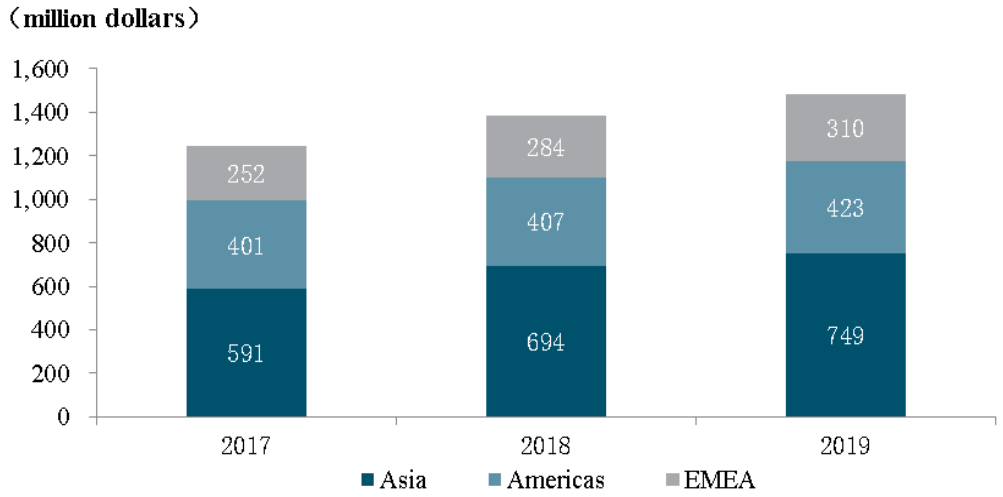
Table 4-6 Equity Throughput of ICTSI by Region in 2017- 2019

(Unit: 1,000TEU)

	2017	2018	2019
Asia	4815	5237	5403
Americas	2855	2935	2979
EMEA	1481	1563	1794
Total	9153	9736	10178

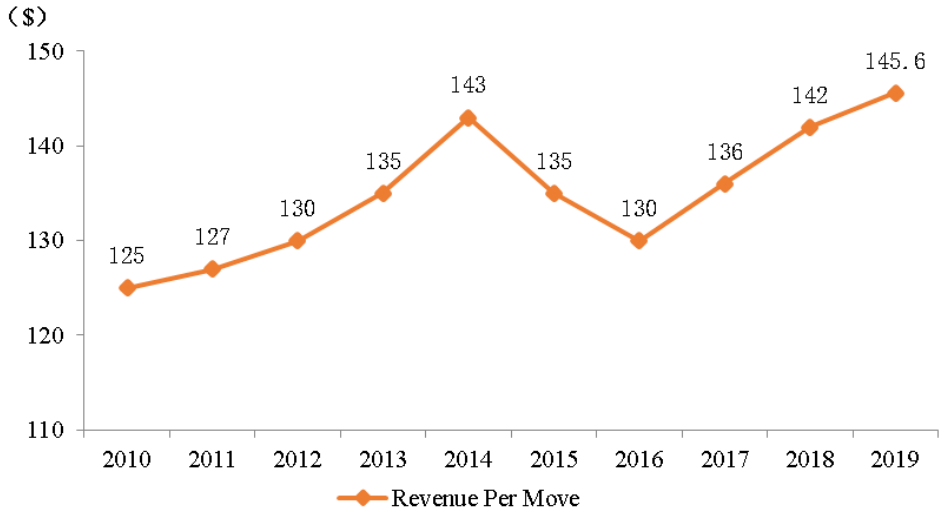
Source: Website of ICTSI, sorted by SISI.

In terms of profitability, ICTSI's annual revenue in 2019 increased by 6.9% year-on-year to US$1.48 billion in 2019, with the single-container income standing at US$145.6, and the annual earnings before interest, taxes, depreciation and amortization (EBITDA) was US$830 million, a rise of 9.9%. In addition, benefiting from the company's continuous monitoring of cost optimization investment measures, its consolidated cash operating expenses recorded US$464.2 million, an increase of only 2.7% year-on-year. The strong revenue growth and the lower cash operating expenses have brought the company's EBITDA margin to 56%, a rise of 1.5 percentage points from last year.



Source: Website of ICTSI, sorted by SISI.

Figure 4-11 Revenue of ICTSI by Region in 2017-2019

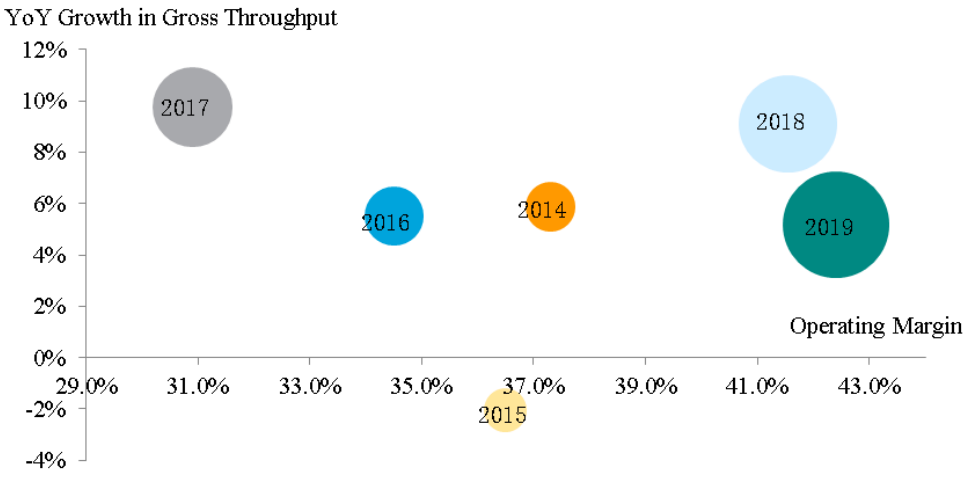


Source: Website of ICTSI, sorted by SISI.

Figure 4-12 Revenue Per Move of ICTSI in 2010-2019

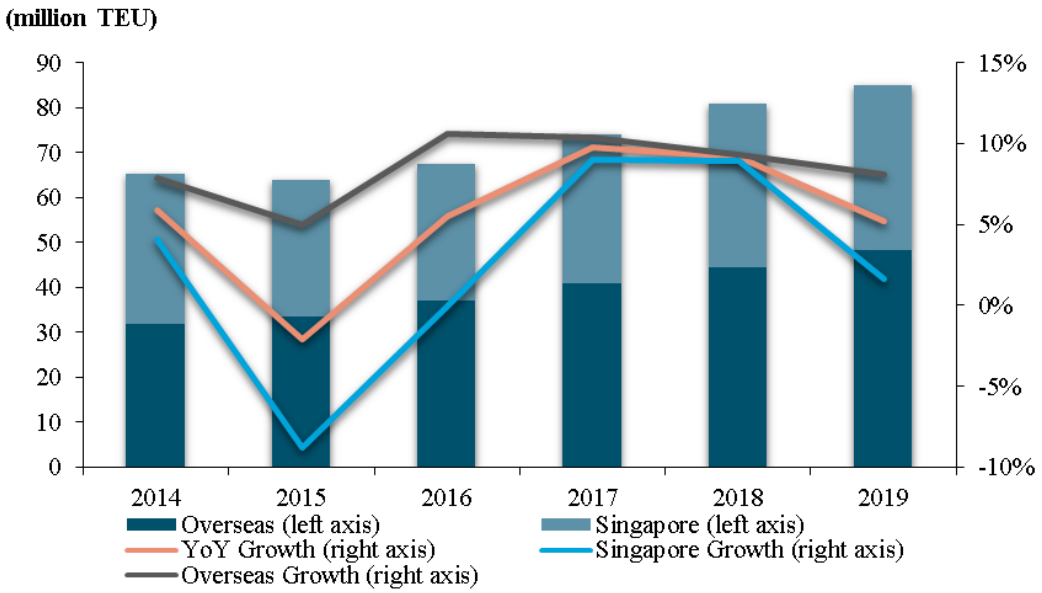
4.2.6 PSA International posted sound business performance

In 2019, PSA International sped up its upgrading to a new type of port with integrated digital systems while developing its own port businesses, and maintained sound production and operations. PSA International completed a total container throughput of 85.2 million TEUs in the year, a year-on-year increase of 5.2%. Specifically, the group recorded a total overseas container throughput of 48.3 million TEUs in the year, a year-on-year rise of 8.1%, and a total domestic container throughput of 36.9 million TEUs, a year-on-year increase of 1.6%. In terms of profitability, the group continued to invest in terminal assets to improve productivity, and led industry transformation to provide customers with high-quality freight solutions, which resulted in its stable performance in the year. In 2019, the group recorded an operating income of 4.08 billion yuan, with the profit margin at 42.4%.



Source: Website of PSA, sorted by SISI.

Figure 4-13 Gross Throughput Growth Rate and Operating Margin of PSA in 2014-2019

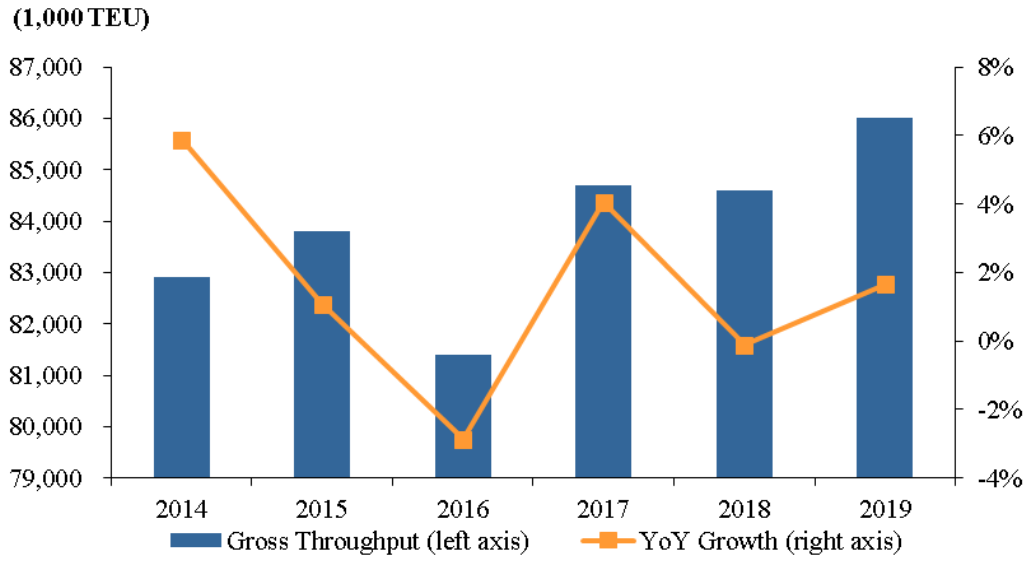


Source: Website of PSA, sorted by SISI.

Figure 4-14 Gross Throughput and Growth Rate of PSA by Region in 2014-2019

4.2.7 CK Hutchison businesses grow at a low rate

In 2019, the port and related services segments of CK Hutchison recorded a container throughput 86 million TEUs, up by 1.7% year-on-year. The increased uncertainties from trade tensions and the reduced cargo transshipment demand in Asia resulted in continued slow production growth of the company's port and related business segments.



Source: Website of Hutchison Ports, sorted by SISI.

Figure 4-15 Cross Throughput and Growth Rate of Hutchison Ports in 2014 -2019

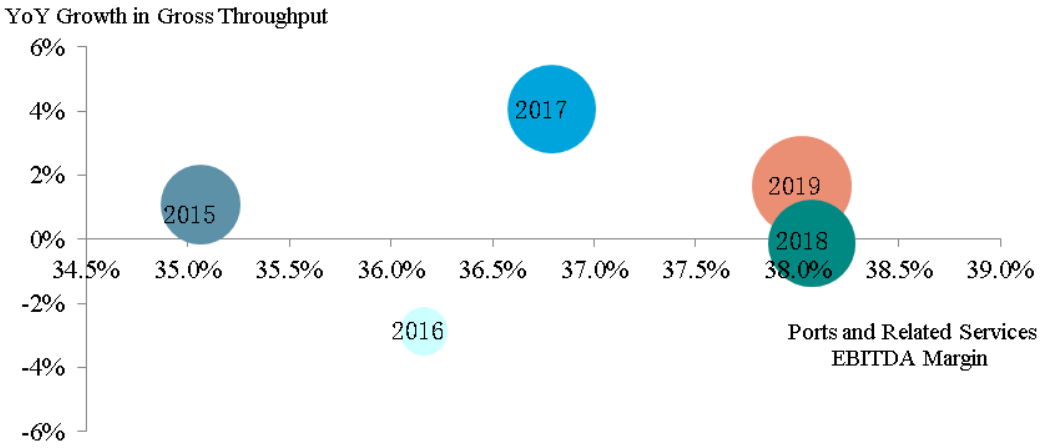
Table 4-7 Gross Throughput and Growth Rate of Hutchison Ports by Region in 2018- 2019

(Unit: 1,000TEU)

Region	2019	2018	同比增长
HPH Trust	235	243	-3.3%
Mainland China and Other Hong Kong	135	135	-2.2%
Europe	162	158	2.5%
Asia, Australia and Others	328	307	7.0%
Total	846	860	1.7%

Source: Website of Hutchison Ports, sorted by SISI.

In terms of profitability, despite the throughput increase, the operating income of port and related service sectors remained flat year-on-year because of depreciation of major currencies such as pound and euro. The company's strict cost control and franchise rights extension of part of its ports have reduced depreciation and amortization. The company's segment operating income was HK$35.4 billion, an increase of 0.7% year-on-year; its EBITDA rose by 0.1% year-on-year to HK$13.4billion, accounting for 12% of the company's total profit.



Source: Website of Hutchison Ports, sorted by SISI.

Figure 4-16 Gross Throughput Growth and Ports and Related Services EBITDA Margin of Hutchison Ports in 2015 -2019

V. Comments on Terminal Investment and Construction in 2019

Under the trend of large ships and diversified international cooperation, the world's ports have experienced a number of construction booms in the past few years. New or expanded port capacity is about to be released, and it may take years of trade growth to absorb in the future. Particularly, global trade only grew by 1 percentage in 2019, leading to a surge of the port construction risks.However, judging from the actual investment and construction of global ports in 2019, most countries remain relatively enthusiastic, driven by regional economic and trade.

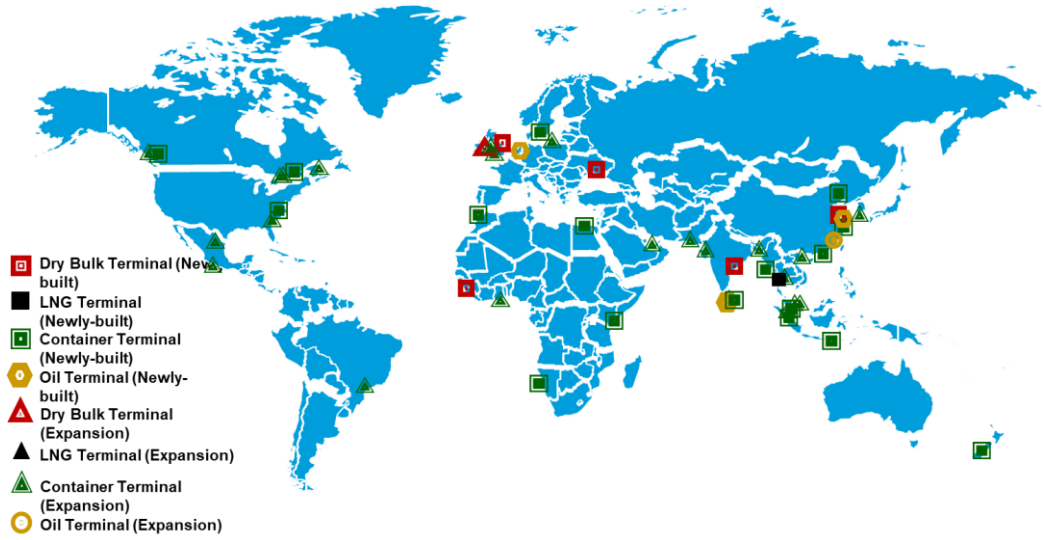


Figure 5-1 Distribution of Major Terminals Construction in 2019

5.1 Construction of Container Terminal

5.1.1 Asia

1. Southeast Asian ports continued to enjoy high enthusiasm for development

With the expanded scale of international industrial transfer and the deepening of China-proposed Belt and Road Initiative, Southeast Asia is becoming a hot spot of global investment. In particular, its special location on the main Eurasian trunk routes has explained the continued port construction heat in Southeast Asia. Among them, Singapore and Indonesia post the highest enthusiasm for investment and development. To further alleviate port-city contradiction and continue to vie to be the world's largest container port, Port of Singapore officially launched the construction of the Tuas Port Area in 2019. It is expected that the total investment will exceed S$20 billion (approximately US$14 billion), and the area is expected to handle 65 million TEUs of containers a year. In addition, the two new berths of COSCO-PSA Terminal (CPT) in Singapore also officially launched the signing ceremony in 2019, further enhancing the capacity of the original three container berths to 4.85 million TEUs. The Indonesian government is unwilling to lag behind in port construction. It continues to promote the Masterplan for Acceleration and Expansion of Indonesia's Economic

Development (MP3EI) and encourages private investment in basic industries such as ports to make up for the shortage in local capital, technology and management experience among other port construction restraints. In addition to Singapore and Indonesia, Malaysia, Vietnam, Thailand, Myanmar and other Southeast Asian economies have also augmented investment in port infrastructure. In 2019, the Malaysian government led the port area expansion of Port of Kuantan, the largest port in south of East China Sea. In addition, the Malaysian government also provided great support to the construction of Port of Tanjung Pelepas, hoping it can gain an upper hand in the competition against Port of Singapore. In contrast, Vietnamese ports' expansion seems more urgent. With the international industrial transfer in recent years which has boosted Vietnam's trade growth, the ports that originally only accommodated small ships have become more embarrassing. Therefore, the Vietnamese government approved the investments in No. 3 and No. 4 international container berths at Port of Haiphong, with investments valued around US$300 million in total. The total length of the berth shoreline is about 750 meters, and the berths can accommodate fully-loaded 100,000-DWT ships. In addition, the Myanmar government is also actively pushing construction of port facilities. However, it primarily did this through upgrading port facilities by attracting foreign investment from China, Japan, India, etc.

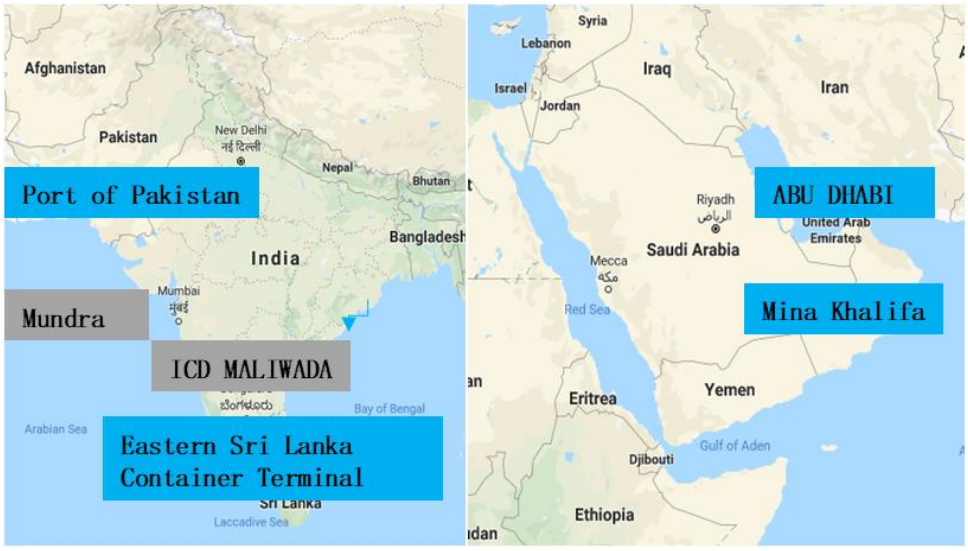
Note：“ ”Under construction；“ ”Proposed construction；“ ”Completed.

Figure 5-2 Overview of Container Terminal Construction in Southeast Asia

2. Port construction in South Asia and West Asia progressed steadily

Although enthusiasm for port construction is less than that in Southeast Asia, South Asia still maintained relatively stable intensity of investment. South Asian economies, especially India, have formulated support plans and subsidy programs to support the development of local ports. In particular, measures such as tax incentives have increased the attraction to overseas funds, contributing to the stable port construction in recent years. In 2019, the Adani Group of India spent US$832 million to expand the Port of Mundra at the northern end of India's west coast to enhance

the port's cargo capacity. Meanwhile, the group plans to build a new 24-hour operating container port,consisting of nine large container berths in Vadhavan, 140 kilometers to the north of Mumbai, aiming to build the port into one of the top 10 largest container hub ports in the world. To further promote the construction of the Port of Colombo, Sri Lanka has also actively introduced investments from economies such as Japan and India to jointly promote the construction of the eastern container terminal at the South Port of Colombo. The development of Pakistani ports was more rapid. With the support of CK Hutchison in 2019, Pakistani ports received US$240 million to expand the ports. After the project is completed, the port capacity is expected to grow to 3.2 million TEUs. Compared with South Asia, the construction of ports in West Asia has relatively slowed down due to geopolitical tensions and weak imports/exports situation. Specifically, the Abu Dhabi Port Authority of the United Arab Emirates plans to invest another 3.8 billion dirhams (about US$1.04 billion) to expand Khalifa Port to meet increased trade demand in the future. After the expansion, the port throughput will increase from the current 2.5 million TEUs to 5 million TEUs.



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

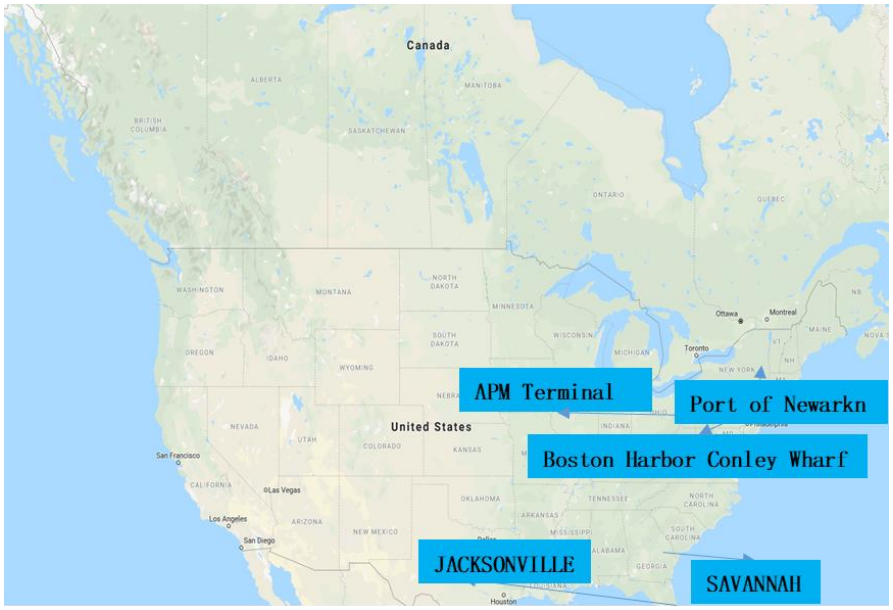
Figure 5-3 Overview of Container Terminal Construction in South and West Asia

5.1.2 North America

1. Ports in eastern US continued to expand rapidly

In 2019, affected by the expansion of the Panama Canal, more large container ships began directly calling at the more prosperous ports in eastern US. This, coupled with other factors, has contributed to the surging demand for port construction in eastern US. The Port of New York-New Jersey invested US$500 million to upgrade and transform the Port Newark Container Terminal (PNCT), while striving to accelerate the port expansion and transformation. Meanwhile, AP Moller-Maersk terminal operators in the Port Elizabeth area invested US$200 million for upgrading port facilities. On completion, the PNCT in the United States will have six super Post-Panamax cranes which will double the terminal capacity to 2.4 million TEUs, capable of berthing and handling two 14,000-TEU container ships at the same time. In addition, the Boston Harbor in Western US was also undergoing port upgrading preparations, planning to spend US$215 million to build a new

container berth (with three cranes), and invest another US$103 million in the second phase to build another container berth and additional storage space for freezers. The Boston Harbor also received a grant of US$20 million from the federal government for upgrading the container terminals at the port and building dedicated highways. Currently, the Boston Harbor is carrying out a dredging project costing US$350 million. The project will deepen the entrance channel from 45 feet (about 13.7 meters) to 51 feet (about 15.5 meters) and deepen the main channel to 47 feet (about 14.3 meters) to further elevate the harbor's competitiveness. The Port of Jacksonville in Florida, also on the East Coast, invested even more in terminal upgrading and channel dredging. In 2019, the US government allocated approximately US$240 million for infrastructure construction and equipment upgrades at the Port of Jacksonville. As a result, the annual processing capacity of the port facility was further elevated to 700,000 TEUs. After the upgrading, the terminal is able to handle two Panamax carriers at the same time. To better handle the new Panamax carriers of 14,000 TEUs, almost the whole Eastern US area was overwhelmed by the wave of terminal upgrading and channel dredging. Specifically, the Port of Savannah's expansion project costing US$970 million and the Port of Charleston's renovation project costing US$560 million are still ongoing. The Port of Philadelphia's channel will be deepened to 45 feet (about 13.7 meters), the Port of New Orleans, to 50 feet (about 15.2 meters), and the Port of Virginia, to 55 feet (about 16.8 meters).



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

Figure 5-4 Overview of North American Container Terminal Construction

2. Port construction enthusiasm in Canada continued to rise

With the continuing growth of international trade and cargo volumes at ports, Canadian ports maintained a positive construction trend in 2019. Specifically, Port of Halifax focused on large-scale expansion of the container terminals in the south of the port. After the expansion, the port will be able to handle ships of 14,000 TEUs and 15,000 TEUs at the same time. In addition, the throughput of the Port of Montreal in Canada embraced a relatively sharp increase in 2019. For this reason, the Viau Terminal of the port also ushered in a new construction stage. The project will further increase the existing terminal capacity to 600,000 TEUs. The Port of Quebec in eastern

Canada was also preparing to build a new container terminal. In 2019, the Quebec Port Authority signed a long-term commercial agreement with CK Hutchison and the Canadian National Railway to build a new container terminal called Laurentia. According to the agreement, CK Hutchison will build the terminal in Quebec City into a cargo port with the best environment and the most advanced technology, which will also serve as the gateway of CK Hutchison to the east coast of North America. The west coast of Canada featured a cooperative development model. Although the Port of Vancouver and Port of Prince Rupert are 500 kilometers away along the coastline, the two have partnered to strengthen infrastructure construction such as near-sea routes and terminals, connecting railways and roads. The partnership is expected to bring another 4 million TEUs of trade demand to the two ports.

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

Figure 5-5 Overview of Canadian Port Construction

5.1.3 Europe

European economic and trade development continued to suffer pressure in 2019, and the Brexit issue continued to ferment, which has led European economies, including the United Kingdom, to face downward pressure on economy. For this reason, the United Kingdom first launched port construction plans to fuel economic and trade growth through port infrastructure construction. European nations also continued to promote port facility construction on the basis of TEN-T and other comprehensive transportation networks.

1. Brexit crisis accelerated port construction in the UK

In 2019, the Brexit process has produced continuous impacts on both economy and trade sectors, and the economic and trade pattern in the European region will also be subject to a significant impact. To this end, the British government announced plans to establish as many as 10 free trade ports in the country, with taxes reduced and customs regulations adjusted to encourage import and export trade of cargoes.

Table 5-1 Details of UK Port Construction in 2019

Port	Type of construction	Construction Overview
Southampton Harbor	Expansion	Southampton Port will invest 4.3 million pounds to expand the port infrastructure and terminal facilities to ensure that Southampton Port can continue to welcome the world's largest container ship and maintain smooth trade.
Port immingham	Expansion	The project is an upgrade of £33 million to the Immingham Container Terminal. This upgrade will increase the terminal's space, improve the layout and add new equipment, including new electric tire gantry cranes shipped from China.
Port Tilbury	New	A new Pier 2 will be built in Port Tilbury. The construction of the port terminal includes new rail and road connections, deep water terminal and pontoon, and the construction cost will exceed 200 million pounds. This is the core of the Tilbury Port 1 billion investment plan, and it is expected that the freight volume of the entire terminal will double (from 16 million tons to 32 million tons) in the next 10 years.

Source: collated by Shanghai International Shipping Research Center.

2. European ports continued to enjoy a strong momentum in expansion

Although the expansion of most European ports slowed down, the growth was far from subsiding. In 2019, the ICTSI planned to expand the Croatian container terminal. After getting the approval from the Port of Rijeka Authority, the first phase of the project will cover the expansion of a 130-meter terminal on Berths 1 and 2; the second phase will cover the dredging at the 438-meter terminal to further deepen the channel to 16.5 meters. Upon completion, the Croatian container terminal will become the first port in the northern Adriatic Sea capable of berthing 20,000 TEU ships. In addition, the Port of Gothenburg in Sweden invested 1 billion Swedish kronor (about US$100 million) to build a new large terminal. The terminal marks the largest port development project at the port in 40 years, and will further consolidate the Port of Gothenburg's status as a logistical capital in North Europe. Meanwhile, Port of Gdynia in Poland also implemented the largest infrastructure construction plan, including rebuilding the 1.5-km terminal shoreline and dredging port channels.

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

Figure 5-6 Overview of European Container Construction

5.1.4 Africa

The commodity trade growth in the African region in 2019 expanded the demand for shipping at African ports and for related shipping infrastructure networks. To adapt to the future surge in import and export trade demand, Africa may continue to maintain the port construction boom. Specifically, Port of Mombasa, a main trade gateway of East Africa, urgently needed to upgrade the current port. In 2019, the Kenya Port Authority (KPA) spent 20 billion shillings (about US$193 million) to modernize four berths to handle both container and non-container cargoes at the same time. Meanwhile, the KPA will also invest 55 billion shillings (about US$530 million) to build a new port in Lamu on the northern coastline. In addition, ports in Morocco also cooperated with AP Moller-Maersk to operate the APM Terminals Medprot Tangier container terminal. The terminal is 1,200 meters long and 16 to 18 meters deep, and is capable of berthing and handling super-large container ships. The new terminal will bring the port's annual throughput to 9 million TEUs, which will help improve Morocco's shipping network. Meanwhile, the terminal is also the first automated container terminal in Africa. The new container terminal in Walvis Bay, Namibia in the same area was also officially completed. The completion of the new terminal increased the container handling capacity from 350,000 TEUs to 750,000 TEUs per year, improving the handling capacity of the Port of Walvis Bay.

5.2 Construction of LNG Terminal

In view of the increasingly stringent environmental protection policies around the world, the demand for clean energy is becoming more urgent. The sulfur restriction targeting the global shipping industry will take effect starting from 2020, and ports around the world will all invest in LNG and other clean energy terminals, vying to become a regional marine energy replenishment center. Although currently LNG-powered ships only take a small share, and even new LNG-powered ships are not entirely LNG-powered, ships that have not installed desulfurization equipment will be prohibited from carrying non-compliant fuel oil starting from March 2020 according to the International Maritime Organization (IMO) regulations. This will further reduce the demand for general fuel oil and bring opportunities for further promotion of clean energy such as LNG. Therefore, the construction of LNG ports also saw a boom in 2019.

5.2.1 Sulfur restriction accelerated LNG terminal construction in China

In October 2019, the Maritime Safety Administration of China issued the Implementation Plan for Global Marine Fuel Oil Sulfur Restriction in 2020, which stipulated stopping the use of desulfurizers. As a result, low-sulfur fuel oil or alternative energy sources such as LNG and methanol will become the best alternatives. Based on the current market structure, LNG will become the most promising alternative fuel for inland water shipping in China. With LNG's cleanness and other environmentally friendly characteristics, it is expected that the potential demand for marine LNG fuel in the Yangtze River Delta region alone will reach 500,000 tons. Meanwhile, Zhejiang Pilot Free Trade Zone established Zhoushan as the LNG refueling service center in the Yangtze River Delta region, focusing on LNG imports, storage, distribution, shipping and refueling businesses. In particular, Zhoushan will build Baiquan, Liuheng, Qushannan and Xiaoyangshan LNG receiving stations. LNG receiving stations in other parts of China will also be put into production one after another.

Table 5-2 LNG Receiving Stations under Construction in China in 2019

Name	Scale	Processing power	production time
Tianjin floating LNG	Entered into trial operation in December 2014, a floating storage gasification unit (FSRU), two 30,000 cubic meters of LNG storage tanks, one 160,000 cubic meters of storage tanks, 266,000 cubic meters of LNG cargo ship berthing and discharging dock, 30 tank The vehicle loading skid can hold up to 600 vehicles within 24 hours. The second phase plans to build four 200,000 m3 LNG storage tanks.	2.2 million tons / year	2021
Shanghai Ocean Harbor LNG	Three 160,000-square-meter LNG storage tanks, 82-115 thousand cubic-meter LNG terminals, and two new 200,000 cubic-meter LNG storage tanks in the second	3 million tons / year	2020

	phase		
LNG, Ningbo, Zhejiang	Three 160,000 cubic meters of LNG storage tanks; 266,000 cubic meters of LNG terminals, and the expansion of three 160,000 cubic meters of LNG storage tanks in the second phase.	3 million tons / year	2021
Tangshan LNG	Sixteen 160,000 cubic meters of storage tanks, one 80,000-270,000 cubic meter LNG carrier special dock, and three new LNG storage tanks in the third phase.	6.5 million tons / year	2020
Rudong LNG	An 80-266,000 cubic meter LNG carrier dock, a work ship dock, three 160,000 cubic meter storage tanks, and one 200,000 cubic meter storage tank. Two 200,000 m3 LNG storage tanks were added in the third phase.	6.5 million tons / year	2021
Tianjin LNG	A pier of 326,600 cubic meters, 4 160,000 cubic meters of LNG storage tanks, 5 new 220,000 cubic meters of LNG storage tanks in the second phase.	6 million tons / year	2021
Jiangsu Nantong Qidong LNG	A 150,000 cubic meter LNG carrier wharf, a work ship wharf, two 50,000 cubic meter storage tanks, one 160,000 cubic meter storage tank, and supporting facilities, a new 160,000 cubic meter LNG storage in the third phase tank.	1.15 million tons / year	2019
Zhoushan LNG	Two 150,000 cubic meters of storage tanks, one unloading dock for reliable berthing of 80,000 to 266,000 cubic meters of LNG ships, one multi-functional dock (including two LNG loading berths, and can take into account unloading operations), A ro-ro ship terminal (including two 30-car ro-ro ship berths), and equipped with 14 tank truck skids, IFV gasification facility, high-pressure outer cabin, cold energy power generation and other supporting technologies and auxiliary facilities, the second phase of construction Two 160,000 m^3 storage tanks, the receiving capacity expanded to 5 million tons / year.	3 million tons / year	2021

Source: collated by Shanghai International Shipping Research Center.

5.2.2 LNG investment and construction boomed in North America

North America once again set off a wave of global LNG project approvals in 2019. According to the statistics of new projects announced and planned, North America will see new small LNG liquefaction terminals from 2019 to 2023, with their capacity expected to account for 47% of the increased total LNG capacity globally. In the next four years, the capacity of new small LNG liquefaction projects in North America will reach 7.88 million tons/year. According to the latest report about North American LNG projects, there are currently three terminals in the US Gulf of Mexico planning to build LNG berths. For this reason, North America has also set an annual record

for LNG project approval. In addition, there are two other projects in the US Gulf Coast area following, namely the fourth liquefaction chain of Freeport and the Driftwood LNG project.

5.2.3 Southeast Asia speeded up LNG terminal construction

With the rapid development of economic and increasing population in recent years, the demand for energy in Southeast Asia is also urgent. However, economies in Southeast Asia have limited resources, and they need to rely on the import trade to meet the rapidly growing LNG consumption demand. According to the data released by the International Energy Agency (IEA), Southeast Asia's demand for natural gas is strong, and the area is expected to become a net importer of natural gas after 2020.

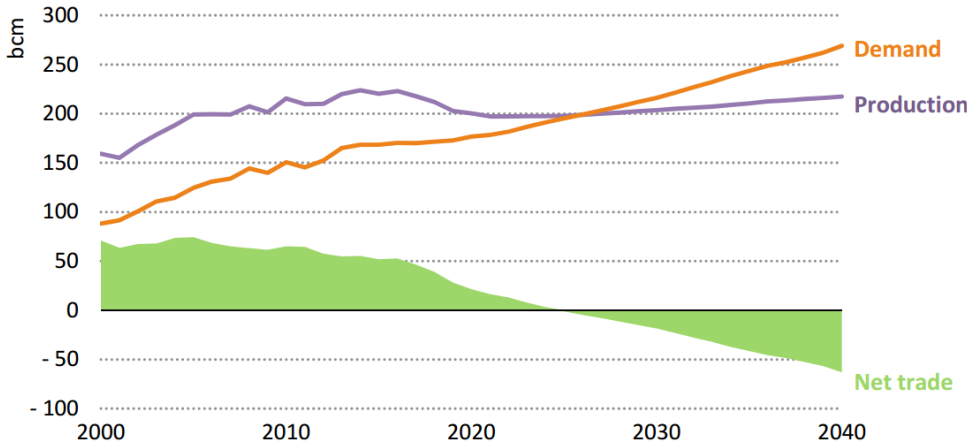


Figure 5-7 Southeast Asia 2000-2040 Natural Gas Supply and Demand Forecast

Southeast Asia has also responded positively to this trend by constantly accelerating the construction of local LNG terminals. In 2019, Thailand invested US$1.3 billion to start an LNG port construction project, which will be jointly developed by Gulf Energy Development PCL and Thai National Petroleum Corporation (PTT). It is expected that the initial annual capacity of the port will be 5 million tons. Meanwhile, India is also actively promoting the construction of domestic LNG terminals. It is expected that India will build 17 new LNG terminals from 2019 to 2023. In addition, the Indonesian Bangtang LNG tank terminal has also been officially contracted. After the project is completed, LNG will be tanked and shipped in containers to various islands to relieve the natural gas supply pressure for island residents in northeast Indonesia.

5.3 Construction of Dry Bulk Terminal

With the global trade and investment slowdown, the international dry bulks market has become volatile, and many unstable factors have led to the slowdown of bulk terminal construction in 2019.

5.3.1 Europe actively expanded grain terminal capacity

Port of Tilbury Grain Terminal is an important port in southeastern UK for handling grain imports from all over the world. The terminal has more than 200 rear silos in the landside areas to provide

support to the flour markets in the southeastern and central regions of the country. In 2019, the Port of Tilbury completed the expansion of major storage, and the new warehouses are able to handle another 16,000 tons of wheat imports. The terminal is one of the largest grain terminals in the UK so far. With new warehouses entering operation, the terminal's storage capacity will be further increased to 136,000 tons. In addition, Ukraine's Port of Chornomorsk also invested about 3 billion Ukrainian hryvnia (about US$120 million) in 2019 to upgrade port facilities, which primarily involved building a grain terminal. This project will elevate the annual transshipment volume of Ukrainian agricultural products to 7 million tons.

5.3.2 India speeded up liquid bulk terminal construction

With India's domestic economy developing, its domestic demands for liquefied petroleum gas, edible oil, molasses and chemicals are also rising. To meet the growing domestic consumer demands, India's Jawaharlal Nehru Port Trust (JNPT) plans to build a new liquid bulk terminal to provide more loading and unloading ports for transporting bulk energy materials. Currently, the liquid bulk handling capacity of Jawaharlal Nehru Port in India is 6.5 million tons per year, and the newly added liquid bulk terminal will further increase the capacity by 4.5 million tons, which will greatly meet the future demands for energy supplies.

VI. Comments on Port Technology and Information in 2019

With the continuous advancement and development of informatization in 2019, global ports continued to head for intelligence and digitization. Driven by big data, 5G technology, blockchain technology, and cloud computing technology, port construction highlights technological innovation more with the pace of information construction accelerated. Smart port construction has become a new engine for the development of the industry. According to the Marketsand Markets report, the intelligent port market has developed rapidly in recent years. It is estimated that the global smart port market will be worth US$1.7 billion in 2019 and will grow to US$5.3 billion in 2024, with the compound annual growth rate as high as 25%, and the growth rate may increase year by year. During the forecast period, the Asia-Pacific will become the largest intelligent port market.

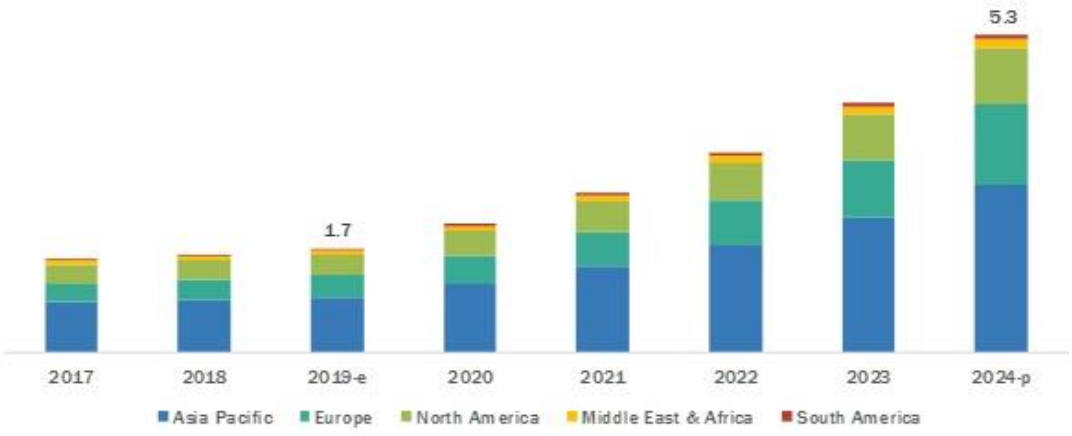


Figure 6-1 Smart Ports Market Scale by Region (USD Billion)

According to the definition given by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) in the Digitalization and Port Productivity report, smart port refers to a green one that utilizes the fourth-generation technologies such as automation, AI (artificial intelligence), IoT (Internet of Things), and ICT (Information and Communication Technology) to achieve automated and autonomous optimization of logistics processes and efficient utilization of energy sources. Compared with existing ports, such ports can improve port production efficiency and reduce pollution through unmanned automated port facilities, intelligent operating systems and related facilities.

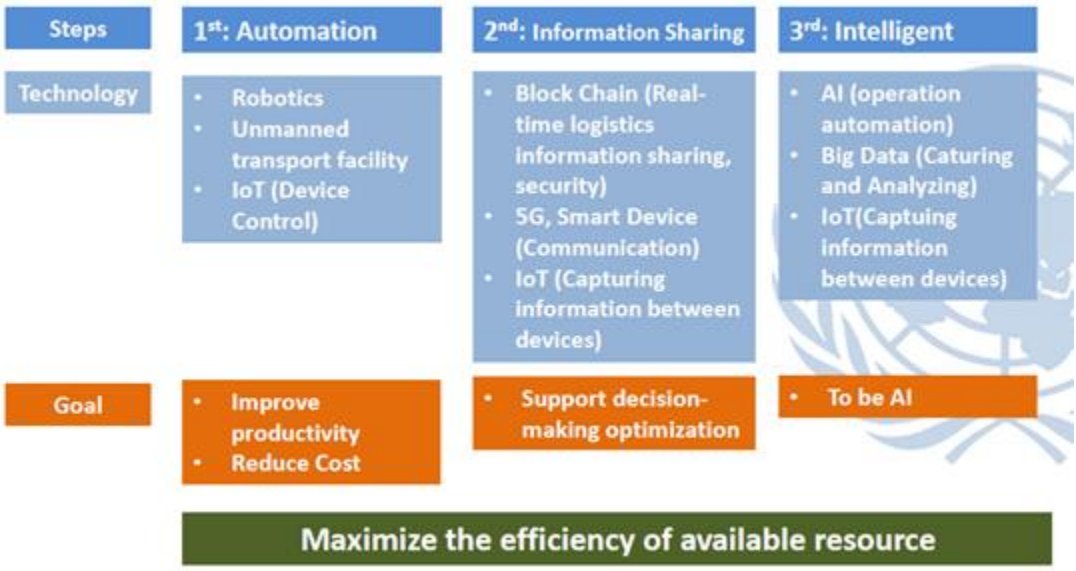


Figure 6-2 APEC's Definition of Smart Port

6.1 Digitalized Development of Ports

6.1.1 Connotation of port digitalization

As a new concept, digital port has no authoritative definition in the industry yet. This report believes that digital port refers to the integration of computer, Internet of Things, artificial intelligence and other technologies into traditional port production and management, and constant integration of external data to the port's own digital platform on the basis of all-round digital control and feedback of port production to form a digital copy of the real port. Ultimately, the real port and the digital virtual port will coexist. Slightly different from port informatization, the data in digitization only covers the necessary elements and by-products involved in the informatization process. The basis and starting point are existing businesses of the port. Port digitization is the next stage of informatization, and its data does not rely on existing businesses. Its circulation, processing and utilization can become separate value-added projects.

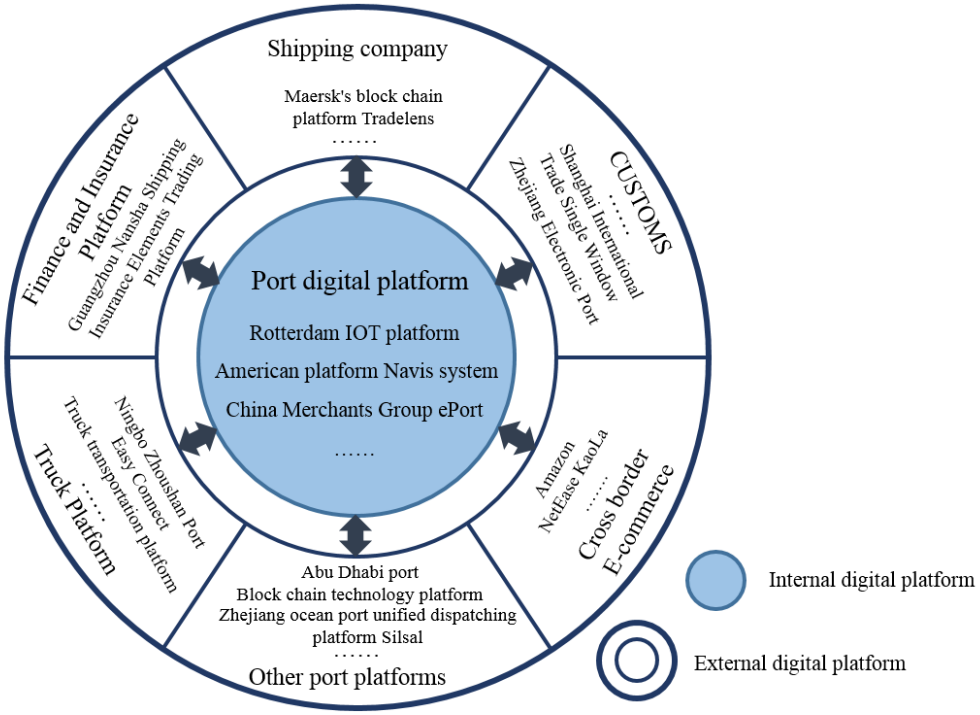


Figure 6-3 Examples of Port Digital Platform

Digitization of a port can be divided into three stages: the primary stage when the port can use its internal digital dispatching platform to supervise, control and provide feedback to traditional businesses to improve the port's production and energy efficiency; the intermediate stage when the port realizes all-round sensing of port shipping elements and processes of non-physical port businesses become fully digitalized; the advanced stage when a complete digital network copy of the supply chain is established through integration of upstream and downstream data flows in the supply chain, and additional value-added data services are provided.

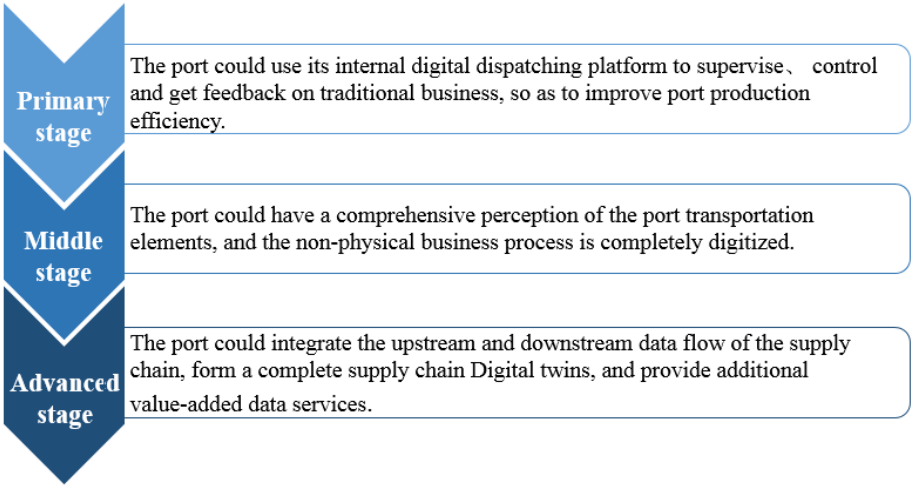


Figure 6-4 Three Stages of Port Digitalization

6.1.2 Development status quo of global port digitalization

Currently most ports are still in their infancy in terms of the digitization process, and their platform functions focus on the supervision, control and real-time feedback of traditional port operations. A port digital system can be divided into two categories. One is developed by terminal operators, such as the CMPort of CMHI, the TOPS of Shanghai International Port Group, the n-TOS of Ningbo-Zhoushan Port, and the ITOP of Dalian Port. Such platforms are highly targeted and customized to businesses of the companies. Due to the extensive business experience accumulated by terminal operators, such platforms feature short periods of early commissioning and testing, and can be applied to ports quickly. But they have shortcomings in interface versatility and scalability. The other category is provided by third-party suppliers, such as the Navis system of the US NAVIS, the Tideworks system of the US Tideworks, and the COSMOS system of Belgium. Such platforms feature high universality, standardized external data interfaces, and better compatibility with new automated ports. In terms of actual port application, most ports that use third-party platforms only purchase the core digital modules of these products. Although the early-stage cost is low, with the increased port operation requirements and the upgrading of port digital platforms, the secondary development cost has increased. Besides, users only have partial access to the platform data structure, so ports will be restricted to varying degrees in terms of digital application and development.

Table 6-1 Major Port Production Scheduling Platform and Functional Characteristics

Terminal operator / Third-party port software provider	Production scheduling digital platform	Characteristic
CMPort	CMPort System	It consists of Container Terminal Operating System (CTOS), Bulk Cargo Terminal Operating System (BTOS), Dry Terminal Operating System (DTOS), Container Freight Station System (CFSS).In addition to a complete digital solution to the wharf work,modular design makes the platform more flexible and scalable.
SIPG	TOPS System	It consists of Vessel Stowage System (VSS), Vessel Planning System(VPS),Electronic Data Interchange(EDI), Vessel monitoring System(VMS), Yard Monitoring System(YMS)and Tractor Paging SUB-System(TPS). Its advantage is that it has a graphical loading tool, with the function of interacting with external data flow; the disadvantage is it lacks the function of rolling over prompt function,the management personnel cannot judge whether the instruction of the digital platform will lead to rolling over the container.
NZPG	n-TOS System	It is characterized by a unified management and control platform, which can realize the six unification of business model, EDI business processing, logistics information network information service, reservation service, indicator caliber and

		basic code. At the same time, it has intelligent algorithm, which can pre input data and forecast according to the advance booking in the future, the number of operation containeres entering and leaving the wharf gate will be analyzed independently, the rationality of site arrangement will be analyzed, and the personnel planning and arrangement of the storage yard will be assisted.
PDA	ITOP System	It can realize intelligent planning of berths, real-time monitoring of loading and unloading, moving and other operations. The operation interface of field bridge, quayside bridge and trailer is graphical; it has external data interface, and has been connected with the "one port connection" system.
NAVIS	Navis System	Designed by the third-party port software provider, the data mostly uses general interface, and is the only digital terminal operating system in the world that supports visualization and operation on multiple devices; supports graphical crane sequencing, berth scheduling and crane shift batch management; customizable berth scheduling program; the graphical interface can provide 360 degree real-time view, and record lifting in real time Scheduling and monitoring of aircraft, vessle and berths.
Tideworks	Tideworks System	The platform supports real-time filtering and sorting of data, and consolidation of all cargo data, such as cargo type, cargo damage and dangerous cargo information. It integrates financial and accounting systems, and supports electronic data exchange for external data interaction.
COSMOS	COMOS System	It integrates eight functions of vessle plan, site plan, equipment control, container information, station management, electronic data exchange, billing module and gate system; it can automatically allocate the best yard location for containers, with independent video identification of container number and vehicle; external data can be exchanged through electronic data exchange module.

Benefiting from the continuous development of the Internet of Things, big data and blockchain technologies, the digitalization process of the world's ports continues to accelerate. First, the real-time port data flows enabled by the Internet of Things technology makes it possible for ports to realize all-sensing of shipping elements. Second, big data and blockchain technologies have promoted the full-process logistical digitization, and the invention of digital applications such as electronic bills of lading and electronic files saves documents and papers, speeds up port workflows and promotes green ports while paving a feasible way to future port data sharing with the increasingly standardized port data.

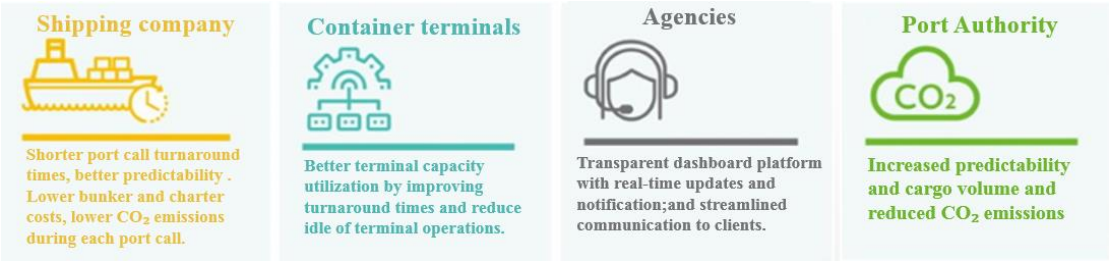


Figure 6-5 Advantages of Port Digitalization

6.1.3 Trend of port digitalization

1. Blockchain technology to address data integration in the advanced digitalization stage

With the increasing demand for external data access by ports, how to share data in a safe, equal, and real-time manner has become a major pain point. The blockchain technology featuring "decentralized", "transaction record authenticity verifiable", "encrypted network" and others begins to enter the horizon of port practitioners. As an open digital ledger technology, blockchain enables participants to record and extract detailed information about transactions, and has broad development prospects and technical superiority.

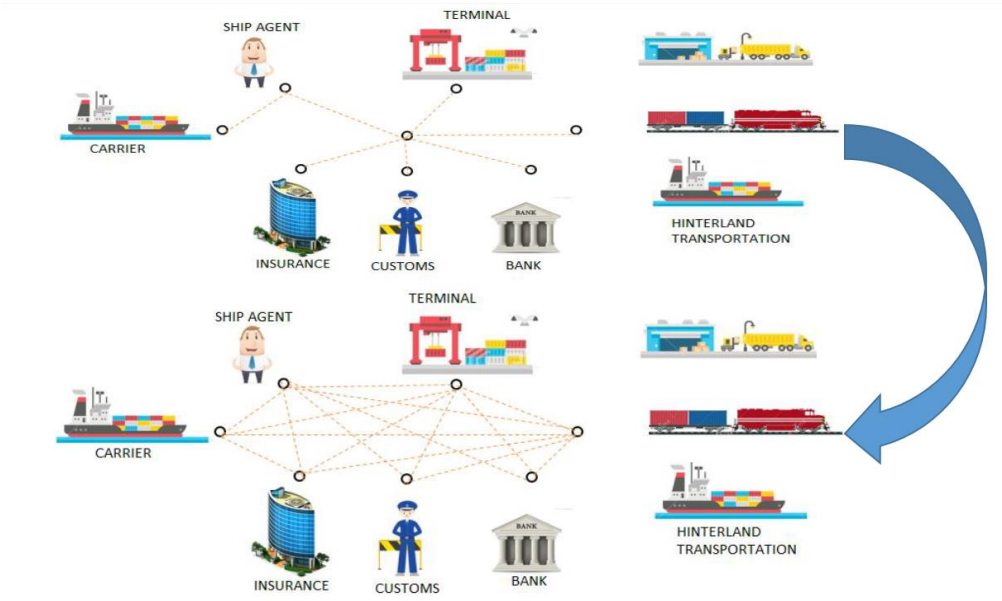


Figure 6-6 Overview of Block Chain Technology

In view of the fact that the blockchain technology can effectively solve ports' pain points in integrating upstream and downstream data flows in the supply chain, some port and shipping companies began piloting the technology in some scenarios in 2018. Successful cases include the Tradelens blockchain platform jointly launched by shipping giants Maersk and IBM, and Silsal blockchain application platform jointly launched by Port of Abu Dhabi and Mediterranean Shipping. However, due to the industry's cautious attitude toward such emerging technologies and companies'

considerations for their own benefits, as well as IT platform providers' different standards for blockchain building, the blockchain applications in that stage were still standalone, without a complete chain in place. In 2019, with the accelerated integration of the blockchain technology and the port industry, the blockchain platforms of ports around the world began to expand their coverage. Vying for the say over data standards, the blockchain platforms of various ports were in fierce competition, struggling to attract partners. For example, Global Shipping Business Network (GSBN), a blockchain consortium led by COSCO Shipping and benchmarked against Tradelens, has pooled together multiple port operators including DP World, CK Hutchison, PSA International, and Shanghai International Port Group since it was first developed.

To further unleash the potential of port and shipping blockchain platforms, it is obviously not the optimal solution to compete for seizing the remaining market alone. The Shanghai International Shipping Institute Center believes that exploring how to connect data on different platforms under different chain-construction standards is the future trend. The 'supply chain + blockchain' platform Deliver, which went into operation in July 2019, was jointly established by the Port of Rotterdam, the Dutch bank ABN AMRO and Samsung SDS. It is worth noting that all three used different blockchain building solutions, Samsung SDS used its own NexLeger blockchain, the Dutch customs clearance system was based on Hyperledger Fabric chain-building technology, and the blockchain system of the Port of Rotterdam in the Netherlands was based on Ethereum.

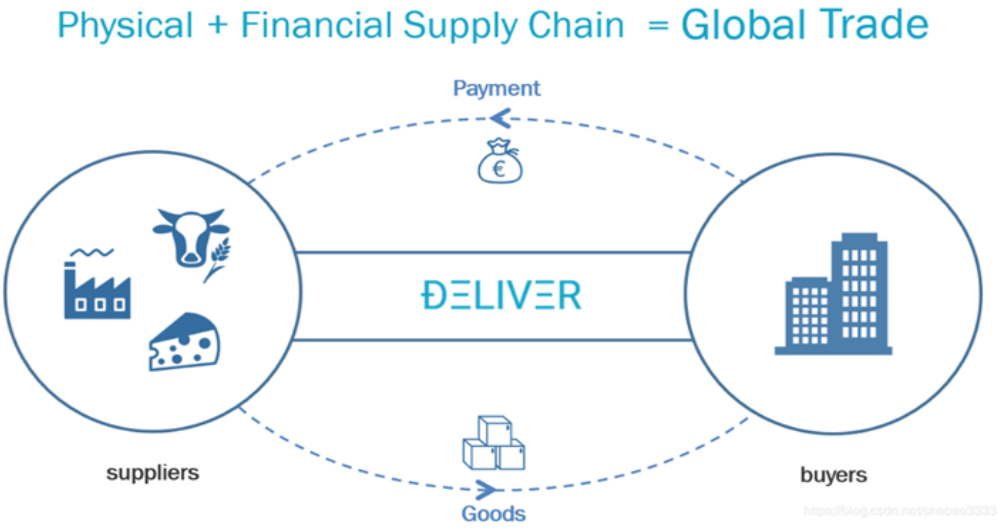


Figure 6-7 Rotterdam Port Blockchain Platform "DELIVER"

2. 'Digital copy' is to become a new trend of port digitization

With the world's manufacturing center shifting to Asia, the world trade center has also shifted from the older Europe and United States regions to the emerging Asia-Pacific. European ports can no longer rival Asia-Pacific counterparts such as Shanghai and Singapore in terms of throughput. Meanwhile, facing a plateaued mature market, how to improve efficiency and protect market share among ports have become the core of their competition, and striving to create "smarter" ports has become the trend of European ports. As an older major port in Europe, the Port of Rotterdam always steps ahead in the digitization process, and has begun to trial integration of upstream and downstream data flows in the supply chain. In September 2019, the Rotterdam Port Authority announced that as part of the port's "Digital Twin" port program, a smart data collection container

called "Container 42" has begun its two-year data collection work. By simulating the digital information of cargoes throughout the supply chain, the Port of Rotterdam is building a digital port model, that is, the "digital twin" port. When the model is officially launched after testing, the Port of Rotterdam can improve its own supply link through digital simulation, cut costs and improve efficiency. Moreover, the digital twin port can also act as an independent digital value-added service and provide services such as fleet planning, and decision-making simulation to ship companies, port machinery manufacturers, maritime research institutions and other organizations. Such emerging application that utilizes the Internet of Things and big data technology has broad prospects in theory. The bold attempt of the Port of Rotterdam may gain an upper hand in the port digitization wave.

6.2 Port Intelligentization

To build a smart port, full sensing of related logistical elements in port areas alone is far from enough. How to efficiently process the collected data flows and optimize the logistics process autonomously is currently a major task of port intelligence. There are currently two major obstacles to the port industry's intelligent transition. First, port environment is usually harsh, and in such an environment, traditional communication technologies are not capable of supporting stable and low-latency transmission of related data instructions. Second, to make ports "autonomous", some ports are currently trying to fully integrate the intelligent control center in the cloud computing center, which will not only increase the early-stage investment of ports, but also add to the difficulty of port cloud computing center coding because of the diversity of port terminals. The emergence of the 5G technology and the MEC edge cloud computing technology may change the current predicament at the levels of data transmission and intelligent computing, respectively.

6.2.1 5G technology solves pain points of port data transmission

The 5G technology, namely ‘the 5th generation’ technology, is the latest cellular mobile communication technology. Compared with the traditional 4G technology, 5G's performance advantages are reflected in its "high data rate", "low latency", and large-scale device connections.

In terms of data transmission, key business systems such as gantry cranes, container trucks, and video surveillance have traditionally used optical cables, industrial Wi-Fi and other communication methods for transmission in the current port environment. On the one hand, the optical cable communication solutions cost higher for cable laying, exposing optical cables to a shorter service life due to highly frequent wear and movement and more difficult maintenance. On the other hand, some automated machines such as Automatic Guided Vehicles (AGVs) are impossible to use wired means of communication due to site and machine restrictions. The industrial Wi-Fi network communication solutions have poor anti-interference performance and low bandwidth. The network may fail in the case of severe weather. The 5G communication technology features high bandwidth, low latency, and high stability, making it a good solution to this pain point to ensure real-time data transmission.

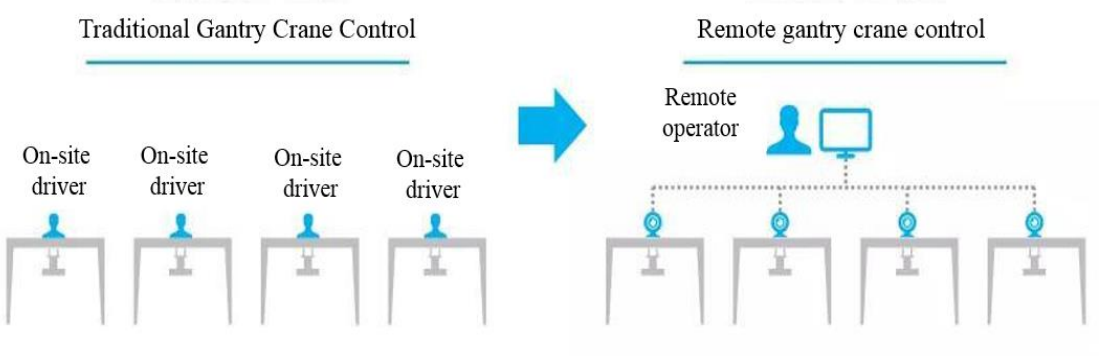


Figure 6-8 Operation Data Transmission of Gantry Crane Under 5G Technology

To achieve autonomous intelligent identification of smart ports, AI, machine vision and other related functions will be used in future scenarios such as intelligent monitoring of port personnel, container truck/container monitoring and identification, and AGV guidance and control. Implementing these functions is based on the low-latency transmission of high-definition videos. The large-scale device connections support of the 5G technology can also handle a large number of high-definition cameras. According to the "5G Smart Port White Paper" of Huawei, the current 5G R15 version can basically support AGV guidance and control, as well as remote control of rubber-tired gantry cranes. With the increase of 5G uplink capacity, the introduction of low latency and high reliability features, such applications will deliver more advanced functions.

Figure 6-9 Smart Port Application

6.2.2 MEC technology solves pain points of port intelligent computing

In terms of intelligent processing, taking the world's advanced Shanghai Yangshan Phase IV Terminal and Qingdao Port's fully automated terminal Phase II as examples, the frontend operation links that truly achieve computerised intelligent control are mostly about rail-mounted gantry cranes and horizontal cargo moving by AGVs. Quay cranes, however, restricted by ship type, container type, operation sequence and others, cannot meet this requirement given the current cloud computing technologies and algorithms, so they are still manually controlled remotely. To solve this problem and realize intelligent services of smart ports in the true sense, it is necessary to introduce the so-called edge cloud computing technology. The edge cloud computing is a cloud computing

platform built on the edge infrastructure, relying on the core and edge computing capabilities of the cloud computing technologies.

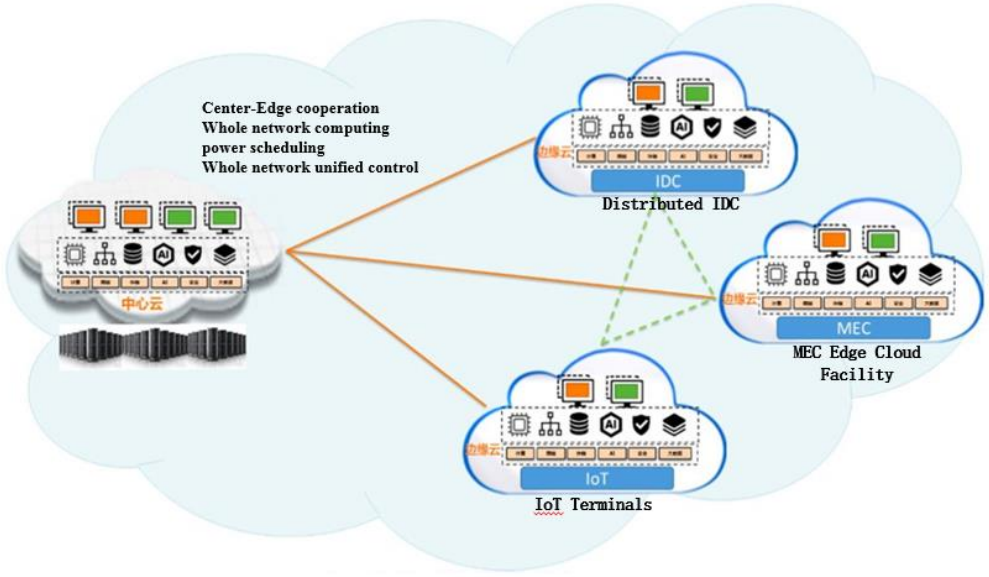


Figure 6-10 Edge Cloud Computing Technology

Compared with traditional central cloud computing, 'central cloud + edge cloud' computing boasts the advantages of low latency, self-organization, definable, schedulable, high security, and open standards. Meanwhile, building edge computing nodes allows port companies to expand the Internet of Things networks as needed, which helps ease the contradiction between the high initial investment in Internet of Things construction and the slow benefits of digital application in the port digitization process. These natural advantages create a sound prospect of the edge cloud computing technology in smart port construction. In December 2019, Qingdao Port, China Mobile and Huawei jointly completed the deployment of the '5G + MEC' (edge computing) solution. Gantry cranes are connected to the 5G network covering the Qianwan Port Area of Qingdao Port to achieve remote control of quay cranes through '5G + MEC' in the port environment, marking a successful exploration for improving port intelligence in the next step.

As an emerging technology, the application of edge cloud computing in smart ports is still in its infancy. But in the foreseeable future, the real-time videos recorded by the high-definition cameras on the gantry cranes will be quickly transmitted to the edge cloud computing center near the job site through the 5G network. With artificial intelligence technologies such as AI machine vision, the edge cloud computing center can identify and locate containers in a very short time and issue instructions to complete quay cranes loading/unloading of containers from ships to AGVs autonomously without human intervention. In summary, '5G + MEC' technology will further improve the data processing capabilities of terminals such as port cranes, vehicles, and gates, and realizing port intelligence is no longer just a fantasy.

6.2.3 Port commanding and dispatching intelligentization

As the "brain" of ports' operation dispatching, the port commanding and dispatching center needs to take into account the coordinated commanding of three major aspects, namely ship pilotage, port utility ship dispatching and planning, and port production, featuring systematic and complicated work. With the increasing requirements of port supply chains on various processes, traditional port dispatching centers which rely solely on manual commanding no longer meet the needs of efficient dispatching and information sharing. As a large number of ports continue to promote the construction of intelligent port dispatching platform systems, some results have already been achieved. According to the statistical report released by Ningbo-Zhoushan Port in March 2019, since the port launched the "Zhejiang Unified Dispatching Platform for Seaports" in 2018, Zhejiang Province has achieved unified declaration, processing, releases and queries of ship dispatching information for coastal ports across the province's jurisdiction scope. During the report period, the average ship-hour efficiency of container ships on trunk routes increased to 116.34 M/H, an increase of 6.76% year-on-year; the average waiting time of trunk route ships for operation and for unberthing reduced to 1.77 hours, a decrease of 0.39 hours year-on-year.

Leveraging data analysis technologies and modular designs, the sharing and collaboration of information flows in different dimensions of ports have been further optimized. Ports' autonomous judgment capability has been improved, and "computer coordinated dispatching, personnel assisted commanding" has become an emerging business format. For example, the US marine industry R&D giant Navis launched the "Navis Smart" intelligent application in March 2019. The application is built on the "Compass" visual workflow management module and the "N4 Ops Monitoring" monitoring module. Specifically, the "Compass" workflow management module can provide port planners with a port-to-port view and a complete visible port planning task list during ship transportation planning to ensure personnel priority relations and reduce idle time of resources. The other module "Monitoring" can provide real-time business intelligence analysis through port operation monitoring. For another example, Tianjin Port launched an intelligent dispatching and commanding system in May of the same year. The system integrates 10 application modules such as production dispatching management and standardized index analysis. It offers intelligent data analysis on related data flows such as global ship AIS, freight vehicle GPS, and real-time port production elements, to optimize "one-click ship dispatching" and full-process supervision of production. The system realizes coordination, intelligence and visualization of port production dispatching management, further elevating the "autonomous" judgment capability of ports.

6.2.4 Unmanned driving technology empowered port shipping intelligentization

As an important part of horizontal cargo moving at ports, how to further realize unmanned intelligentization of port transportation vehicles has also been a hot topic in the industry in recent years. In the current stage, with the extensive application of AGVs in automated container terminals, unmanned transportation within ports has gradually become a mature practice. However, as another important process in port logistics, short-distance transshipment of containers between logistics

hubs outside ports is still manually conducted by container truck drivers. The maturing driverless technology in recent years has brought new solutions to intelligent port transportation. According to the classification standard of the Society of Automotive Engineers (SAE) for driverless vehicles in January 2014, driverless vehicles can be divided into six levels, L0 to L5, from fully manual to fully autoumated.

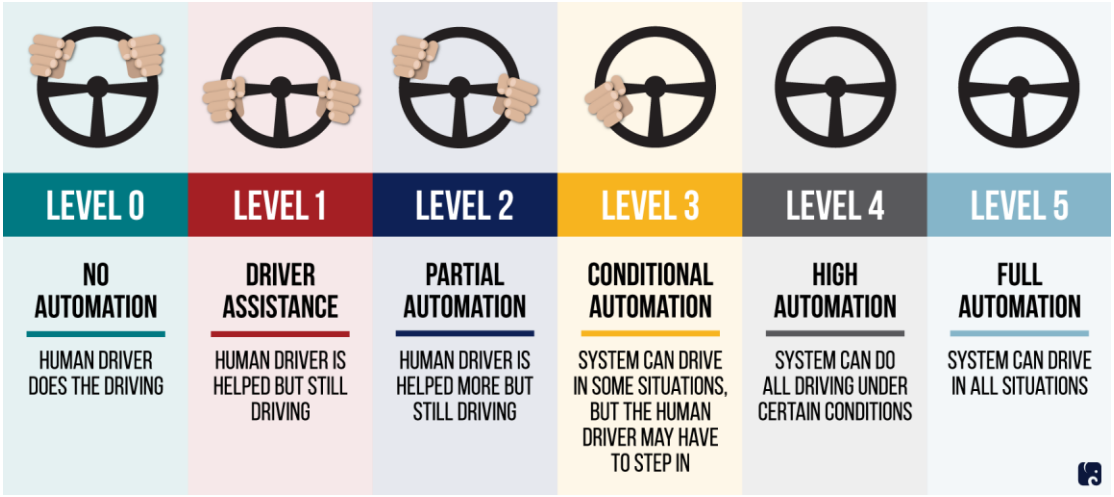


Figure 6-11 Levels of Driving Automation

In the in-port transportation scenario, with AGVs been widely used in automated ports, some of their limitations gradually emerge. First, the current commonly used AGVs in the industry are mainly guided using the photoelectric or electromagnetic technologies. The former is prone to ambient weather disturbances such as rain, snow, and haze, featuring low guiding stability, while the latter uses electromagnetic induction potential differences to locate vehicles, with slightly lower guidance accuracy. Second, AGVs using either guidance method are still costly in the early stage, making it difficult to transform traditional terminals. Finally, both guidance methods are essentially manually planned in advance and vehicles operate as pre-programmed, lacking intelligent decision-making to some extent. Unmanned driving technology demonstrates its own inherent advantages in view of the three pain points above. First, multiple ranging radars and visual cameras can accurately locate vehicles, and the intelligent system can help correct vehicle position deviation to ensure accurate guidance. Second, the renovation cost of unmanned container trucks is much cheaper than that of the whole AGV system, by about the price of a traditional container truck. This cost advantage makes unmanned driving technology more suitable for transformation and upgrading of traditional terminals. Finally, in the event of an emergency, AGVs can only be stopped as a response, but unmanned container trucks can quickly respond to avoid obstacles automatically. Looking to the future, the unmanned driving technology will promote the reform of port transportation both outside and inside ports, to further empower port transportation.

VII. Comments on Green Port Development in 2019

7.1 Connotation and Prospects of Green Ecological Ports

Compared with traditional ports, green ecological ports mark a sustainable port mode that can meet environmental requirements and secure sound economic benefits as well. It requires ports to meet the needs of economic and trade development in the hinterland while minimizing the impact of port construction and operations on the environment and ecology, so as to reduce consumption of resources and energy, mitigate the impact on climate changes, rationalize the irrationality of resource allocation, and achieve a balance between environmental impact of economic activities and economic benefits.

Figure 7-1 Schematic Diagram of Green Ecological Port

To achieve green, low-carbon and sustainable development of port operations, applying the next-generation information technologies such as cloud computing, big data, Internet of Things, and blockchain to drive green ecological port development through building smart ports may become a new development trend. The Port Authority of Bari in Italy built the ISMAEL platform based on the Internet of Things, collecting environmental data (such as air and water pollutants), weather conditions, and truck and ship traffic data through a sensor network to analyze the data and help with decision-making. The Port of Rotterdam Authority worked with IBM in the digital transformation of the port. Sensors were installed on the port's terminal walls, bollards and roads to cover the entire port area stretching 42 kilometers from Rotterdam city to the North Sea. These sensors will collect tidal as well as hydrological and meteorological data such as water flow, temperature, wind speed and direction, water level, berth availability and visibility. The data is further analyzed through IBM's cloud-based Internet of Things technology and converted into information useful for decision-making at the Port of Rotterdam, so as to shorten the waiting time of ships, determining the best timing for ships to get berthed, and load and unload cargoes. This helps increase the number of available berths and contribute to the sustainable development of the port.

7.2 Status Quo of Green Ecological Port Construction Globally

Global ports have made great achievements in environmental and ecological protection. In addition to introducing the green ecology and environmental protection concepts in planning, it is also essential for government departments to formulate relevant standards and detailed green emission reduction plans.

1. Stress on port environment planning

Port planning shall not just seek economic benefits, but it should also comprehensively consider the environmental and social factors among others. Green ecology concept should be incorporated into port planning to achieve a win-win situation in economic development and environmental protection in port development. Take the Port of Tokyo as an example. The Tokyo Bay area has formulated its basic plans five times since 1959, to specify the positioning of the city's functions, with special attention paid to environmental protection, resource conservation, and disaster prevention among other aspects. During the port area construction, the surrounding areas are also renovated and developed, including building marine parks, coastal landscapes and green space to create a high-quality port area with a pleasant environment and ecological harmony. Currently, a total of 38 marine parks have been built around the port area of Tokyo for the leisure and entertainment of urban residents.

2. Formulate port emission reduction plan

Take Port of New York-New Jersey in the United States as an example. The port authority is committed to sustainable port development. As the first US port to implement the Paris Agreement, the Port of New York-New Jersey has developed a greenhouse gas (GHG) emission reduction plan, promising to reduce greenhouse gas emissions by 35% by 2025 and by 80% by 2050. To promote shipping decarbonization and reduce greenhouse gas emissions, the British government released the Clean Maritime Plan, which required that all new ships ordered in and after 2025 for navigation in the UK waters shall be designed with zero-emission technologies. In the 2019 Green New Deal Pathway released by the Port of Los Angeles, it plans to reduce greenhouse gas emissions by 50% by 2025 and achieve zero greenhouse gas emissions by 2050.

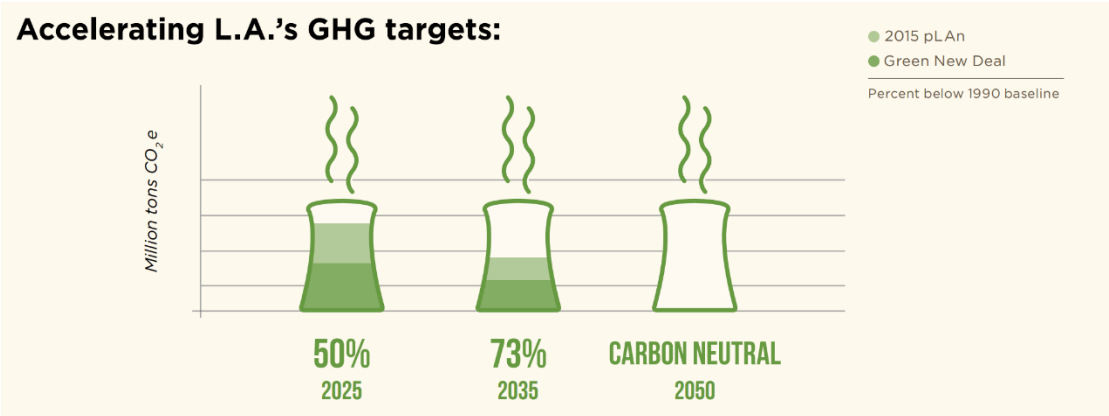


Figure 7-2 GHG Reduction Targets for the Port of Los Angeles

3. Promote zero-emission for shipping

The air pollution and greenhouse gases generated by the shipping industry are primarily from port operations (onshore emissions) and ship operations (offshore emissions). To reduce the harm of shipping emissions to the environment, many European economies have reached a consensus to implement a zero-emission plan for shipping. The Maritime 2050 released by the British government believed that promoting a zero-emission shipping plan can start from the use of alternative fuels, emission treatment technology and fuel efficiency enhancement.

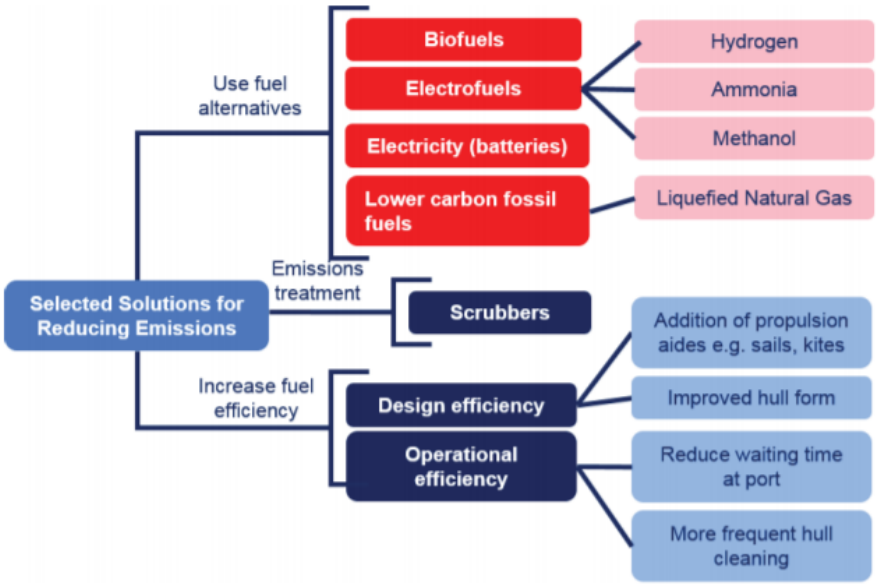


Figure 7-3 Zero-emission plans for shipping

To further achieve the decarbonization goal, the shipping industry is accelerating technical R&D to develop zero-emission power or fuel for transportation purposes. In November 2019, the Norwegian shipyard Havyard Group and the Swedish fuel cell component manufacturer PowerCell co-developed a zero-emission fuel cell system, which will be installed on a ship of the HavilaKystruten shipping company and serve the routes from Bergen to Kirkenes.

Table 7-1 The Power or Fuel for Zero-emission Transportation

Type	Power/Fuel	Detail
Alternative fuel	Biofuel fuel	Different biomass sources (e.g. crops, waste).
	Hydrogen fuel	Replace fuel oil with hydrogen.
	Ammonia fuel	It can be used as a fuel itself or as a carrier of hydrogen.
Power	Hybrid power	The diesel engine as the power source, provides the power for the motor
	All-electric power	No diesel engines, powered entirely by batteries.
	Solar power	Using the space on the deck, photovoltaic cells convert solar energy into electricity.
	Shore power	When the ship is in port, the auxiliary power system is operated by shore power supply

7.3 Green Port Developing Measures

7.3.1 Formulate policies to promote multi-party cooperation

1. Formulate policies

In October 2019, the European Sea Ports Organization (ESPO) announced the top 10 environmental priorities for EU ports at the GreenPort Congress in Oslo, Norway. Specifically, air quality was listed as the primary environmental consideration for three consecutive years, becoming a key determinant of public acceptance of port activities in the next few years. Energy consumption and climate change followed closely, and 80% of European ports will consider the impacts on the climate and energy when developing new infrastructure projects. In response to the changes in air quality, energy consumption and climate change, governments and relevant organizations in various economies formulated a series of policies and measures in 2019.

Figure 7-4 Top 10 Environmental Priorities of European Ports in 2019

The discharge of sulfur dioxide, nitrogen oxides, and particulate matters when ships enter and leave ports and berth at ports can severely harm the air quality at ports. To improve the port air quality, the IMO proposed new requirements on some new ships in its Initial IMO Strategy on Reduction of GHG Emissions from Ships in May 2019. The emission reduction target for container ships of 200,000 DWT and above will be increased from 30% in 2025 to 50%. The target requirement takes effect from 2022. To reduce the impact of traditional energy consumption on the port environment, the IMO adopted the MEPC.323 (74) resolution, which aims to promote the regulatory, technical, operational and economic actions of the port sector, such as development of onshore power supply (from renewable energy), provision of alternative low-carbon and zero-carbon fuels, and incentives that encourage sustainable low-carbon transportation and optimize docking measures at ports. In

addition to the air pollutants generated by port and ship operations, the large amounts of greenhouse gas emissions are gradually affecting global climate change. In December 2019, the European Commission promulgated the comprehensive environmental policy European Green Deal, announcing to reduce carbon emissions by 55% by 2030, that is, a 10% rise over the currently agreed target, and promising to achieve net zero-carbon emissions by 2050. The deal has provided clear targets for European ports and logistics transportation to achieve low-carbon transportation in Europe.

2. Promote 'port-company' and 'port-port' cooperation

In terms of green ecological port development, the exchanges of information management, energy technology and other issues through port-port or port-company cooperation is an important means to promote green and sustainable development of ports and achieve mutual benefit. Inter-port cooperation has become more common and frequent to tackle environmental and ecological problems. In November 2019, the Port of Los Angeles and the Port of Malmo in Copenhagen signed a five-year cooperation agreement. The key cooperation areas identified in the agreement included development of sustainable energy sources, promotion of green terminal equipment and technologies and active engagement in global environmental protection. In the same month, 10 ports in the Nordic region agreed to cooperate to cope with environmental challenges related to the UN Sustainable Development Goals. Each port will share its own technological innovations to improve the ecosystem, and is committed to developing alternative energy sources and air pollution emission reduction technologies. In December, the Port of Antwerp signed a cooperation agreement with eight companies in the field of chemical energy to research and develop CCS application, which aims to recycle and store greenhouse gases to further reduce greenhouse gas emissions.

In addition, building international cooperation platforms has become a new way to promote green ecological ports. The International Association of Ports and Harbors (IAPH) and PortXL signed an agreement to establish an innovative investment platform for the World Ports Sustainability Program (WPSP). On this platform, participating ports and companies can conduct pilots and cooperation with each other.

7.3.2 Technological innovation leads green port development

1. Develop green and sustainable energy sources

To mitigate the impact on the marine environment and climate, Port of Stockholm in Sweden announced a plan to use solar power in each berth in place of onshore power supply generated by fossil fuels in August 2019. The British terminal operator Associated British Ports (ABP) invested £12 million in ocean cruise terminal at the Port of Southampton in the UK to build 2,000 solar panels to increase the existing solar output. After the project was completed, amount of electricity generated by the solar panels will exceed the electricity consumption of the terminal.

In the Americas, the New York State Energy Research and Development Authority (NYSERDA), the Empire State Development (ESD) and the New York State Department of Transportation (DOT) reached an agreement to support the offshore wind power industry, which is expected to bring the offshore wind power capacity to 9,000 MW by 2035.

2. Develop carbon capture and storage technology

Carbon capture and storage technology (CCS) can capture carbon dioxide produced during coal combustion, natural gas power generation and production of other industrial facilities, and transport it through pipelines or ships for safe and permanent storage in oil fields, gas fields or deep seabeds, so that the carbon dioxide can be prevented from entering the atmosphere to cause climate change. As a means to significantly reduce industrial greenhouse gas emissions, many ports in Europe are stepping up R&D efforts of carbon capture and storage technologies and applying them to port production to reduce port emissions. The Port of Rotterdam Authority, Gasunie and EBN announced a CCUS (Carbon Capture, Utilization and Storage) project in May 2019. It is expected that the project can capture up to 5 million tons of greenhouse gases annually at the Port of Rotterdam area. The gases will be transported through a 21-km pipeline to the storage location at an exhausted gas field deep in the North Sea.

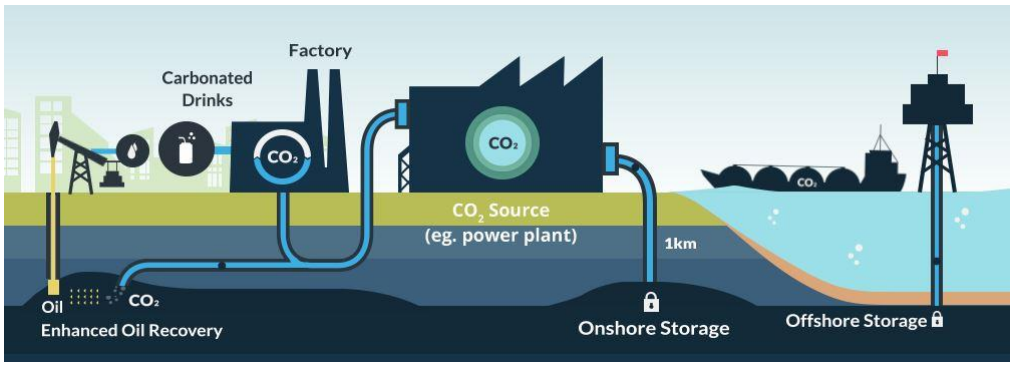


Figure 7-5 Schematic Diagram of CCS Technology

3. Promote scrubber installation on ships

The upcoming new IMO sulfur restriction regulations force shipowners and shipping companies to invest a lot to meet the requirements. Using compliant marine diesel means a higher cost. Marine LNG fuel is currently only available at specific ports, and for specific ships. Therefore, installing scrubbers has become the most economical solution to sulfur restrictions. Currently, the global peak of desulfurization scrubber installation has arrived. DNV GL expected that 2,083 sets of scrubber systems will be installed on ships worldwide by the end of 2019, with an average of nearly 6 scrubbers installed per day. By then, more than 3,000 ships will have scrubbers to comply with the new IMO sulfur restriction in 2020.

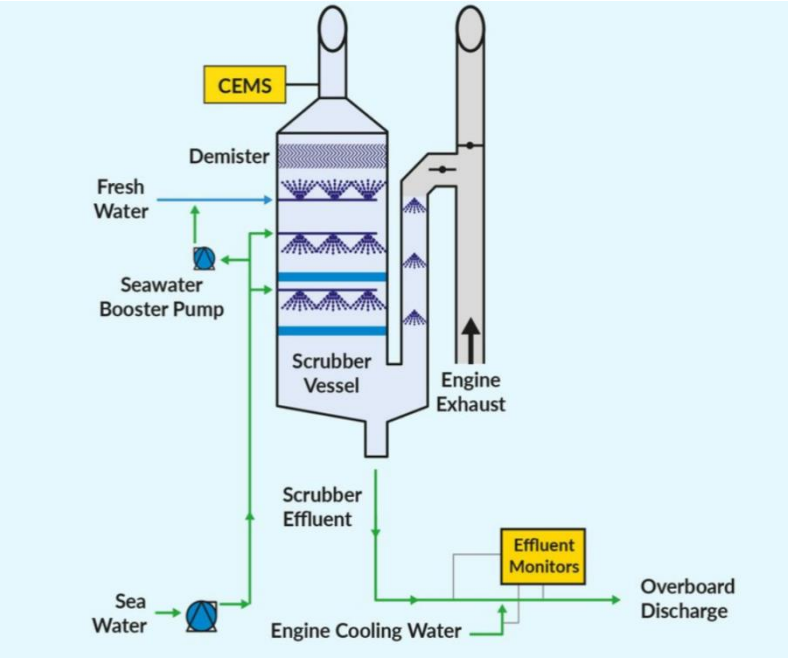


Figure 7-6 Flow Chart of Ship Scrubber Tower

7.3.3 Establish and improve ships and ports emission inventories

As a practical guide for assessing emissions, the ship and port emission inventories provide the port and maritime authorities with the development of targeted emission reduction strategies, which is the basis for the development of port emission reduction strategies. Although the IMO International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI regulations on air pollution and energy efficiency targeted ships, all emission sources need to be considered to reduce port emissions, including cargo handling equipment, trucks, and ships.

Table 7-2 Emission Source Sorted By Energy Type

Source type	Emissions source category	Energy types
Mobile	Vessels	fuel oil, diesel, NG, methanol
	Cargo handling equipment	diesel, NG, propane，electricity
	Locomotive	diesel, NG, electricity
Stationary	Manufacturing facilities	electricity, renewable, diesel
	Administrative offices	electricity, renewable, diesel
	Power plant	coal, NG, diesel, renewable

When formulating the port emission inventory, the fuel method and power are generally used for estimatingproduction equipment such as the port area machinery. The IVE Model is used to estimate the pollution emissions of cargo collection, distribution and transportation vehicles to the port area. There are two research methods for formulating a ship emission inventory. One is the "top-down" fuel estimation method, which is to calculate the fuel oil volume sold by fuel suppliers, or the actually consumed fuel oil volume by main engine, auxiliary engines, and boilers on the ship, so that a ship emission inventory can be estimated using the emission factor of fuel oil consumption. The

other is the "bottom-up" estimation method, which uses AIS to record data to accurately obtain ship activity data and the corresponding technical parameters pf equipment. This method is used so that a ship emission inventory can be estimated based on basic parameters such as ship type, deadweight, engine power, and ship speed using the emission factor of ship energy consumption.

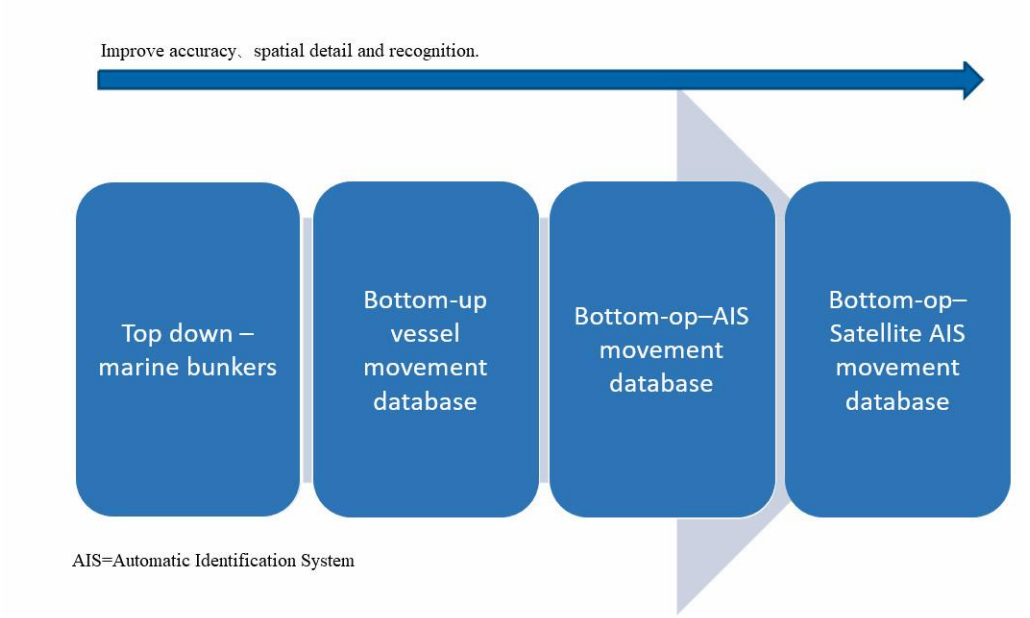


Figure 7-7 Top-down Fuel Estimation Method to Bottom-up AIS Estimation Method

Ship and port emission inventories provide a structured framework to offer guidance for national policies and regulatory frameworks related to preventing air pollution and reducing greenhouse gas emissions from ships. The Hong Kong Environmental Protection Department (EPD) compiles the Hong Kong Air Pollutant Emission Inventory annually to analyze the quantity of local air pollutant emissions and their major emission sources. The emission sources are divided into seven categories including water transportation for supporting the formulation of effective air quality management strategies in Hong Kong. The Port of Long Beach uses the latest data and methods every year to study the air emissions from relevant sources at the port, so as to track and improve air quality and reduce the impact on the surrounding communities.

7.4 Social Impact of Green Ecological Ports

For most green ecological ports in the world, their construction is still in the energy conservation and emission reduction, as well as pollution source control. They still have a long way to go in terms of driving urban development through building green ecological ports and promoting benign social effects. In addition to the requirements for developing the circular economy, building and protecting the ecological environment, and degrading and handling pollutants, leading green ecological ports have started to strengthen port-city synergy to extend port services to the city hinterland and promote urban green ecology. In 2019, the Port of London Authority launched a Thames River cleaning campaign to prevent plastic waste from harming the environment of inland rivers and the ocean. The Port of London Authority worked with non-governmental organizations to invest in waste water collection equipment, such as floating waste collectors. The Port of Long Beach in Los

Angeles plans to earmark funds to the communities around the port to improve community sanitation and infrastructure, and build parks and green space. The Port of Long Beach has allocated US$25.8 million for improving the community environment, and has pledged to provide a total of nearly US$65 million of investment.

In addition, various port authorities have also attached importance to the social effects of green ecological port area development and highly valued biodiversity protection. Take the Port of Gothenburg in Sweden as an example. The Torslandaviken wetlands near the Port of Gothenburg have been a burial site for Swedish industrial and manufacturing waste in the 1970s. In recent years, the Port of Gothenburg Authority has been working to restore the local environment to that before the burying days to attract more birds. The Torslandaviken restoration project has started, and the macrophylla used to improve the marine ecological environment has also entered the operational evaluation stage, and will soon start transplantation. Meanwhile, the Port of Townsville in Australia finalized the Great Barrier Reef ecological protection plan targeting the Cleveland Bay and its surrounding areas while releasing the master plan, to ensure that the creatures in the area are free from damage produced by port activities. The Port of Napier in New Zealand used limestone rocks of the revetment walls to develop artificial reefs for maintaining marine habitats.

VIII. Comments on Comprehensive Services Time Efficiency of Global Container Ports in 2019

8.1 Connotation of Comprehensive Service Time Efficiency at Container Ports

For port operators, improving the efficiency of port services is one of the important means to enhance the comprehensive competitiveness of ports. Especially in the case of dense regional ports and prominent competition, better port service efficiency will attract more ship calls, so as to win out in competition. It can be said that port service efficiency is crucial to port development.

For ship companies, port service efficiency is reflected in the efficiency of services provided by the port after the ship enters the port boundary. In the past, port service efficiency was often understood as the service efficiency of port operators. The efficiency was determined by port companies. The indicators to measure the service efficiency of port companies are generally expressed in standalone efficiency and ship-time efficiency. The standalone efficiency reflects the hourly operating efficiency of each quay crane, and the ship-hour efficiency reflects the operating efficiency of quay cranes for completing the operations of each ship. The above operational efficiencies only reflect the loading and unloading production efficiency of the berths at a terminal, and do not reflect the comprehensive service efficiency of the entire port to serve ships. After a ship enters a port, the ship generally undergoes the following service processes: pilotage, tugging, anchored waiting, port inspection, and loading and unloading operations. Therefore, it is obviously unreasonable to evaluate the comprehensive service efficiency of a port only by the berth production efficiency. Instead, the efficiencies of all processes including pilotage, tugging, anchored waiting, port inspection, and loading and unloading operations should be included.

To this end, the Port Development Institute under the Shanghai International Shipping Institute tracked the spatiotemporal dynamics of ships based on a large amount of AIS ship trajectory data, and took a look at the comprehensive efficiency of ship arrival tugs, pilotage, anchored waiting, and port services, so as to rank the global top 20 container ports in an objective manner.

8.2 Method of Evaluating Comprehensive Service Time Efficiency at Container Ports

Container port service efficiency evaluation primarily calculates the auxiliary operation time at the container port and the loading and unloading operation time at terminal. When evaluating the service efficiency of container ports, the Shanghai International Shipping Institute primarily selected the auxiliary operation time at port and the terminal operation time of container ships for measurement. Therefore, the specific implementation idea can be divided into five steps: (1) Delineate the port areas and terminal areas at a container port; (2) Screen port entry/departure events and terminal entry/departure events of container ships; (3) Calculate ships' operation time at port,

terminal and berth operation time and auxiliary operation time; (4) De-noise the data results; (5) Perform statistical analysis on the processed data.

8.3 General Analysis of Comprehensive Service Efficiency of Global Container Ports in 2019

(1) Chinese ship arrivals at ports increase steadily in 2019

The global economic and trade situation was depressed in 2019. The throughput growth of the world's top 20 container ports slowed down. According to data released by Drewry, the global container port throughput was expected to hit 806 million TEUs in 2019, an increase of 2.6% year-on-year, a drop of 2.3 percentage points compared with 2018. As a result, the throughput growth of the world's top 20 container ports slightly slowed down compared with 2018. Specifically, China's container ports benefited from the boosted domestic demand and recorded an annual container throughput of 260 million TEUs, a stable increase of 4.4% year-on-year. The growth rates of Qingdao Port (8.8%) and Ningbo-Zhoushan Port (4.5%) among other ports were also strong. As a result, based on the numbers of ship arrivals at the world's top 20 container ports as shown in the AIS ship trajectory data, the number of ship arrivals at China's ports steadily increased. Ship arrivals at the Port of Dubai (-5.6%), the Port of Los Angeles (-1.3%), Port of Hong Kong (China) (-6.3%) and other ports declined.

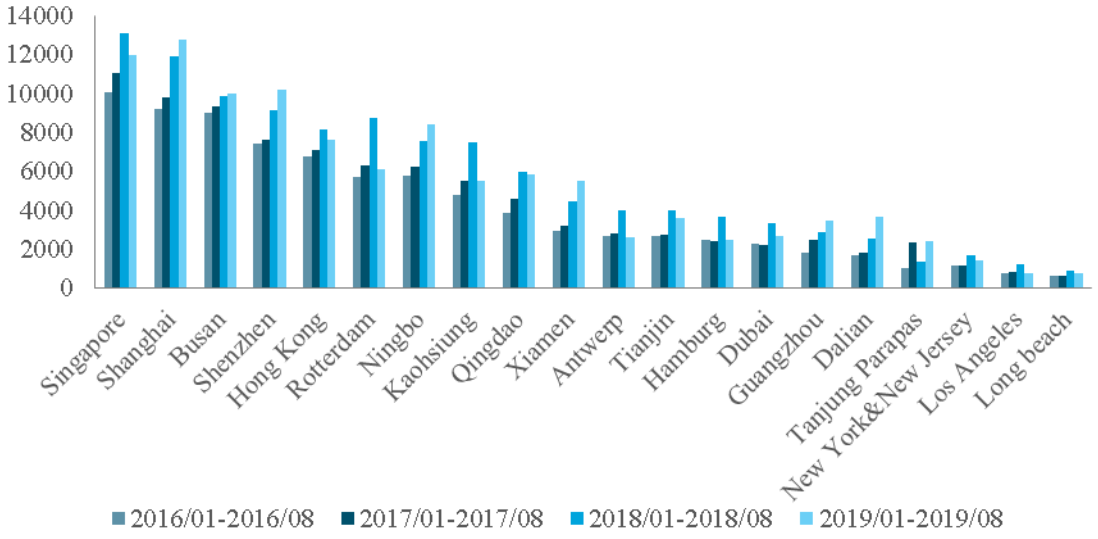


Figure 8-1 Number of Ship Arrivals at Global Ports in 2016 to 2019

(2) Container ship upsizing trend evident on the global scale

Based on the AIS ship arrival data, the arrival frequencies of the top 20 container ports (ships of above 12,000 TEUs) increased significantly in 2019, and the proportion of such ships in all ship arrivals also rose markedly. In 2016, the share of arrived ships of 12,000 TEUs or above at the top 20 container ports was only about 9%, while this figure grew to 13% in 2019. According to Clarksons statistics, as of the end of November 2019, the shipping capacity of ships of 12,000 TEUs or above accounted for 28% of the total shipping capacity, an increase of 5.4 percentage points from that at

the end of 2018 (against a rise of mere 2.8 percentage points in 2018). Due to the overall slower-than-expected growth of cargo volume in the market, liner companies continued to implement the ship upsizing strategy in order to reduce operating costs.

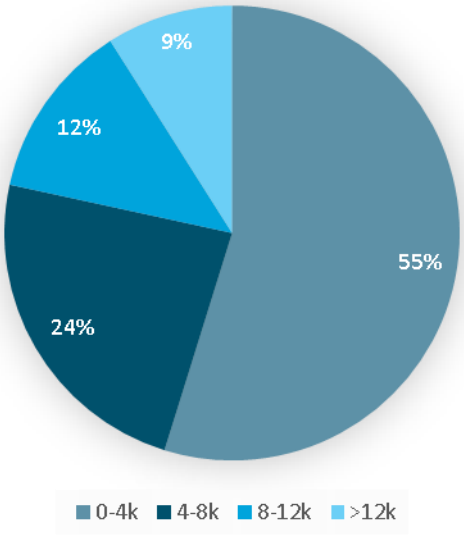


Figure 8-2 Ship structure of container ships arriving at the world's 20 largest container ports in 2016

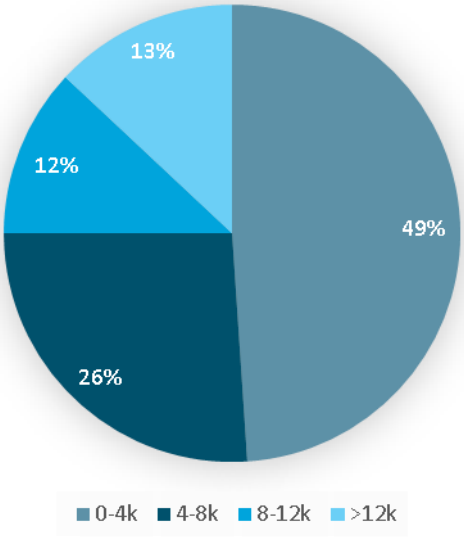


Figure 8-3 Ship structure of container ships arriving at the world's 20 largest container ports in 2019

(3) Ship detention time increases slightly

According to the AIS ship trajectory data, the ship arrival time of the world's top 20 container ports increased slightly in 2019. The at-berth operation time of the global top 20 container ports was about 24.5 hours, a slight rise from the 24 hours last year. The auxiliary operation time was 2.3 hours, running flat with the previous year. According to JOC's analysis of port productivity data, the stay duration of container ships at ports in the first half of 2019 was still on a rise. The data was provided by seven container liner companies that ranked among the top 10 in the world. Ships of 5,000 TEUs or above stayed at the ports for about 26 hours on average, which was consistent with our statistics based on AIS ship trajectory data. According to statistics, 81.5% of ships' stays at ports were spent

on loading and unloading containers, and terminal loading and unloading primarily depend on the number of quay cranes deployed and the container handling efficiency of each quay crane. Overall, the numbers of quay cranes and the container handling efficiency of each quay crane of world's major container ports all improved in 2019. However, such improvements still cannot meet the increased container volumes at ports, resulting in slightly longer stays of ships at ports. In addition, the handling capacity of depots will also limit the overall efficiency and production capacity of terminals.

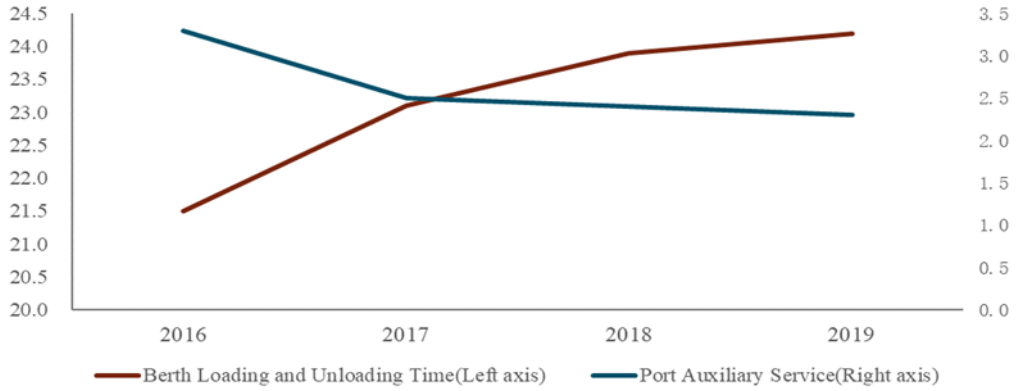


Figure 8-4 Berth Loading and Unloading Time and Auxiliary Service Time of Global Top 20 Container Ports (2016 – 2019)

8.4 Analysis of Global Container Ports in 2019 by Breakdown Indicators

I. Structural analysis of ships arriving at global top 20 container ports

(1) Shanghai becomes the busiest port in the world

In 2019, based on the sample data of the Shanghai International Shipping Institute ports and shipping database, the number of ship arrivals at Shanghai Port has surpassed that of Singapore Port, making Shanghai Port the port with the largest number of ship arrivals in the world. In 2019, the container throughput of Shanghai Port reached 43.3 million TEUs, ranking first in the world for 10 consecutive years, and its container volume growth remained stable. Due to strong freight demand, the number of ship arrivals at Shanghai Port was also on a rise year by year. Data for January to September 2019 showed that the number of ship arrivals at Shanghai Port has surpassed that at Port of Singapore, and the port has become the busiest in the world.

(2) Ships of 0-4,000 TEUs account for a higher share at hub ports

It can be clearly seen from the structures of arriving container ships in the world that Shanghai, Singapore, Hong Kong, Busan, Rotterdam, Dubai, Dalian, Xiamen and other hub ports featured a higher share of ships of 0-4,000 TEUs. Specifically, Shanghai, Singapore, Hong Kong, Busan and other ports are international hub ports, forming hub-and-spoke transportation networks with the ports of neighboring countries and regions. The cargo sources from neighboring countries and regions are transported to the hub ports by small and medium-sized ships, and then transported to the destinations in larger ships. As a result, the share of smaller ships is higher at hub ports overall,

namely around 50%. Ports such as Dalian, Rotterdam, and Kaohsiung are regional hub ports that primarily serve cargo transportation in surrounding areas, with a higher frequency of calls by small container ships on near-sea routes. Ships of 0-4,000 TEUs accounted for a larger proportion, or more than 50%.

(3) Ships of 800-12,000 TEUs at US ports increase significantly

According to AIS ship statistics, from January to September 2019, the number of ships of 800-12,000 TEUs at the US ports increased significantly year-on-year, and ship arrivals at the three major ports of Los Angeles, Long Beach, New York and New Jersey rose by around 20% to 30%. This is primarily because after the expansion of the Panama Canal, the maximum nominal capacity of container throughput is about 13,000 TEUs, more than doubling that of the past. After the expansion, large Asian ships (of above 8,000 TEUs) can directly arrive at eastern US ports. The container ship structure on the Asia-Pacific route was adjusted to some extent. Due to the restrictions of the Panama Canal, the ships of 12,000 TEUs or above that arrived at the Port of New York-New Jersey accounted for a small proportion in all ship types, far lower than the average.

(4) Large container ship arrivals at ports of Shanghai, Ningbo, Shenzhen and others increase significantly

The global container shipping market was generally weak in 2019. To gain a better competitive advantage, liner companies continued to promote the ship upsizing process. According to Clarksons, as of the end of November, the share of ships of 12,000 TEUs or above in the total shipping capacity was 28%, an increase of 5.4 percentage points from that in 2018. A more evident manifestation was that the frequency of large ship arrivals at ports of Shanghai, Ningbo, Shenzhen and other large global container ports increased significantly. Take Shanghai as an example. According to the data sample, there were only more than 1,000 ships of 12,000 TEUs or above arriving at Shanghai Port in 2018. From January to September 2019, the ships of this size arriving at Hong Kong Port were nearly 2,000.

II. Rankings of global top 20 container ports in terms of operating efficiency

Ports serve ship companies, and ship companies' service experience at ports can be summarized into two aspects: time and cost, and ship companies are even more sensitive when it comes to time. The service efficiency at ports can be determined by a ship's stay at the port. Port services for ships can be generally divided into two categories, that is, the handling services and the auxiliary services. The auxiliary services include tugging fees, pilotage dues, waiting for berth, and port inspections. Therefore, the efficiency analysis on port services to ships should put stress on statistics of the time efficiency of handling services and auxiliary services (see Table 8-1).

Table 8-1 Efficiency Ranking of the World's Top 20 Container Ports

Ranking	Total ranking	Operation time at berth ranking	Auxiliary services ranking
1	Hong Kong	Xiamen	Los Angeles
2	Xiamen	Hong Kong	Kaohsiung
3	Ningbo	Ningbo	Long beach
4	Shanghai	Shanghai	Busan
5	Dalian	Guangzhou	Dalian
6	Shenzhen	Shenzhen	Hong Kong
7	Kaohsiung	Dalian	Ningbo
8	Guangzhou	Qingdao	Dubai
9	Qingdao	Kaohsiung	Xiamen
10	Busan	Busan	Shanghai
11	Tanjung Parapas	Tanjung Parapas	Shenzhen
12	Singapore	Singapore	Qingdao
13	Tianjin	Tianjin	Rotterdam
14	Rotterdam	Rotterdam	Tanjung Parapas
15	Dubai	Antwerp	Singapore
16	Antwerp	Dubai	New York&New Jersey
17	New York&New Jersey	New York&New Jersey	Antwerp
18	Hamburg	Hamburg	Guangzhou
19	Long beach	Long beach	Hamburg
20	Los Angeles	Los Angeles	Tianjin

The above rankings show the following three characteristics: **(1) Port operating efficiency in Asia was generally higher than that in Europe and the US.** Specifically, China's ports ranked among the top. China's port handling technologies and operation levels have led the world in the past years, and the berth rankings in terms of handling efficiency are a favorable proof. Compared with the Chinese region, the efficiency of berth operations at US ports was generally low, largely because European and American economies are protected by the labor system, and their terminal operations are generally longer. **(2) Intelligence elevates terminal operating efficiency steadily.** In the berth rankings by operating efficiency, Xiamen, Shanghai, Qingdao and other ports that have achieved automated operations ranked among the top. The completion and operation of the fully automated terminals of Shanghai Yangshan Port and Xiamen Yuanhai have basically realized computerized

control of most terminal functions such as terminal handling and depot operations from the central control room, which had greatly elevated the terminals' comprehensive operating efficiency. **(3) Ultra-large hub ports face capacity strains.** Shanghai, Shenzhen, Singapore and Tianjin ports, though equally matched with other ports in terms of auxiliary service duration, have no superiority in terms of rankings. 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 delay the entry of large ships. But overall, the time difference is marginal compared with other ports.

IX. Development Trend of Global Ports in 2020

9.1 Global Economic and Trade Growth May Slump

In 2020, with the global outbreak of the coronavirus (COVID-19), global ports will undoubtedly face even bigger challenges and even experience negative growth as the international trade scale shrinks.

In addition to the international trade war, Brexit, regional economic sanctions, and geopolitical conflicts that have continued from the past few years, the global port industry will face surging shipping costs under low-sulfur fuel restriction, infectious diseases affecting trade demand and other new challenges in 2020. Although, according to the latest forecast issued by the International Monetary Fund (IMF) in January 2020, the global economic growth rate in 2020 will rise from 2.9% in 2019 to 3.3%, and the growth rate of international trade volume will also increase from 1.0% to 2.9%. This data is already lower than the data released in October 2019. According to the "convention" of the IMF for being optimistic in predictions, and the failure to fully consider the impact of the COVID-19 pandemic on global economic and trade development, it is expected that the economic growth in 2020 will be far less than the expected, and the global trade volume growth will find it difficult to recover.

9.2 Global Ports May Face Slower Growth

The global economic landscape is likely to face stagnation or decline in 2020, and the world seaborne trade scale may maintain a slight fall. Since 2017, the cargo throughput growth of global major portshas been on a decline from 5.2% to 2.9% in 2018 and further to 1.7% in 2019. Given this context, it is expected that the cargo throughput of major ports in the world may fall on a large scale in 2020. Meanwhile, the global port container throughput also declined all the way from 6.4% in 2017 and 4.9% in 2018 to 2.3%. It is expected that the global port container throughput may stop growth affected by the global pandemic outbreaks and the weak economic growth momentum in 2020. The impact of the COVID-19 prevention and route adjustment will be more severe for Eurasian routes and the Pacific routes. The economic growth of developed economies in Europe and Americas is expected to be rather weak in 2020, due to the global pandemic. In particular, the trade volume of the US may decline further, which signals a depressed production prospect of global ports in 2020.

➢ Asian ports may face negative growth, American ports continue to decline

There was no bigger impact to the global ports in 2020 than the COVID-19 pandemic. Production of China's ports will be severely hit at least in February and March, which may drag down the annual growth rate of Chinese port throughput by at least 2 to 3 percentage points. China's ports enjoy absolutely large shares in Asia in terms of cargo throughput, and the 14-day observation period for COVID-19 infection diagnosis will also have a serious impact on the shipping schedules of near-sea routes in the Asian region. As a result, Asian ports are likely to face a slight decline in 2020. (The pandemic in Asia was basically brought under control in the second quarter.) Meanwhile, according to available port data, the throughput of American ports fell to negative growth in 2019. In the future,

as the demand for energy and ore resources cargoes continues to fall, port throughput will also continue to decline.

➢ European ports plunge again, Australian ports' growth stalls

Unlike the ports in the US and Asia regions which face severe production situations, European ports are troubled by both the global pandemic outbreaks and the decreased exports of Asian finished products and the Brexit event. The originally relatively stable economy may once again be bogged down. The growth of European ports in the past three years was second only to Asian ports, showing a relatively stable momentum. Due to the pandemic and the continued contraction of European manufacturing, the international import and export trade demand may pick up in the short term. But in the year of 2020, the throughput growth in the region will remain weak, and European ports may once again fall into negative growth. In addition, though Australian ports have maintained a favorable growth trend in the past years, considering the declined demand for energy materials such as ore and coal in emerging markets including China in 2020, and the impacts of natural weather such as fire in ports in Australia, the production of Australian ports in 2020 may fall back to the "zero growth" range.

➢ Container trade continues to fall, European and American ports struggle to sustain

In the past three years, the container throughput growth of global ports has been declining quarter by quarter, from the 7.7% in the first quarter of 2017 to the 1.6% in the fourth quarter of 2019, implying the relative sluggish development of the international container trade in recent years. Affected by the pandemic, the international demand for commodity trade may decline in the short term. However, against the background of economic globalization, complementary industries and labor resources will still be the focus of attention of production companies, and the international commodity trade represented by containers will continue a strong growth momentum. In summary, the global container throughput of ports in 2020 will fall to some extent under the global pandemic spread, the weak consumer market and the policy interventions of various economies, but its overall momentum may outperform other cargo types. Specifically, due to the large amount of labor-intensive and low-value-added commodity import demands in Europe and the United States, the regions will remain major contributors to international container throughput growth, if without the impact of the pandemic. However, the consumption demand in the European and US markets will fall based on the current pandemic spread. By contrast, the Asian containers market that just recovered from the pandemic is more resistant to risks. In addition, Latin America, Africa and other economically underdeveloped regions have insufficient consumer demand in the market. Coupled with the relatively underdeveloped port logistics and other infrastructure, their commodity import and export trade will be hindered and may face negative growth. On the other hand, Australian ports may see declines due to lower demands for staple commodity trade resources. Meanwhile, with frustrated exports of ores, coal and other materials, Australia's domestic economy as well as its market consumption capacity and enthusiasm have been inhibited, and may face continuous negative growth.

9.3 Port Investment Market Will Stay Depressed in Short Term

Port construction is a major infrastructure investment project, and various economies are relatively cautious for such projects. In particular, after the outbreak of the global financial crisis in 2008, there has been a global-scale port construction boom, in a bid to boost domestic demand and spur economic development. Later, driven by the Panama Canal expansion and the international ship upsizing wave, large, medium-sized and small ports have also, in response to the changes of the shipping market, sped up their expansions and transformation to handle larger ships and meet the higher port handling efficiency requirements from ship companies. In recent years, various economies have gradually shifted their port investment to the construction of supporting facilities and rear parks and cargo collection, distribution and transportation channels. However, with the COVID-19 pandemic outbreaks worldwide, industrial shutdowns and logistics obstructions occur from time to time, and the investments in infrastructure including ports and terminals may head into a "short-term downturn".

➢ Asian port construction relatively stable

The Asian port construction boom was seen in mainland China after the financial crisis, but now the boom is shifting to other Asian economies. Despite the global pandemic which threw all economies' port investment to a short-term downturn, Asian port construction boom will remain relatively stable compared with other regions in the world. To boost the international shipping industry and its ports' statuses as shipping hubs in Northeast Asia, the Korean government invested heavily in reconstruction and expansion of domestic ports. Meanwhile, it focuses on supporting the construction of international hub ports such as Busan, by not only speeding up the reconstruction of Busan North Port, but also studying building the second new port of Busan, so as to expand Korea's seaborne trade channels and build a world-class regional transshipment center. On the other hand, ports in Southeast Asia such as Singapore, Indonesia, and the Philippines have also ushered in investment and construction booms, primarily because the outbreak of the US-China trade frictions have accelerated the transfers of some international companies' factories to Southeast Asian economies that have lower labor costs. Since the logistics facilities at the ports in these economies are relatively insufficient, they may further push forward port facility construction in the future.

➢ A new round of port construction in eastern US will be put on hold

The US ports and railways among other infrastructure were built in early years. As a result, their operating efficiency has been slightly falling behind. After the Panama Canal expansion, ships became bigger in size and a batch of ports in eastern US already planned expansion at that time. However, these expansions were slowed down given the insufficient cargo volume. Currently, the US trade on the Pacific routes may inevitably fall into trouble due to the US customs tariff policies, and the North America-Europe trade urgently needs to be strengthened, so that the US government supports the construction efforts of port companies, especially those of the ports in eastern US that focus on the Europe-US trade. It is expected that terminal operators will still be preferred for future construction through invited cooperation and development, to strengthen ports in the eastern region. Developers will gain the operating benefits through the landlord mode. However, such development is expected to be focused on Panamax and ultra-Panamax ports. However, due to the raging global

pandemic, it is expected that these facility construction plans in the US will be shelved in the short term, and likely to be postponed to the next year depending on the situation of the pandemic control.

➢ China's port construction pace is to gradually slow down

China has been both a major international seaborne trader and a major port investor and constructor in previous years. However, the rapid development in recent years has resulted in not only the continuous investments for years in port facilities in coastal areas and inland rivers, leaving lower demands for new port construction and traditional port expansion, but also China's increasing caution in port investment coupled with the declining international trade. In recent years, China's investment values in waterway transportation infrastructure have also been on a decline, and it is paying more attention to the integration of port resources in various regions, especially in areas with excess capacity. China is focusing on strengthening the use of resources such as terminal shoreline and port-front land, and is starting to pay attention to the output and operating benefits per unit land and per unit shoreline. Therefore, China's port facilities construction pace may slow down in the future.

➢ Automated terminal development demand may grow

The COVID-19 epidemic broke out in mainland China at the end of 2019. During the epidemic, China's port logistics was suspended by the government out of concerns of epidemic spread, and port workers and container truck drivers could not return to work on time. This has produced an impact on the international trade. In view of the outbreaks of infectious diseases in the past years, it is expected that automated terminal technology that reduces manual operations will be increasingly favored by port companies and local governments in the future. Construction of fully automated or semi-automated terminals or automation technology transformation will gradually become evident trends, especially in China, Japan, Korea and other economies that were severely affected by the pandemic. In addition, with the automation technology applications maturing and the modern communication technologies such as 5G developing, it is estimated that the future costs for purchasing and operating automated port facilities will continue to fall, which will also provide strong support for the popularization of automated terminals.

9.4 Integration Wave Reappears among Global Terminal Operators

➢ Terminal operators sell off assets to promote integration.

With the merger and adjustment between international shipping alliances, shipping alliances' say over upstream and downstream industrial chains is increasing, leading to decreasing operating benefits of terminal operators. Likewise, the competition between international shipping alliances has also intensified, and the building of new large ships, the investment in warehousing facilities, and the extension of onshore logistics have all cost large amounts of funds of shipping companies. As a result, global terminal operators with a shipping company background have to sell off assets to repay their group companies' investment loans or make up the operating funds. Taking 2019 as an example, France's CMA CGM signed an agreement with China Merchants Port to sell all its stocks

in 10 container terminals in Asia, Europe, the Middle East and the Caribbean regions to repay its loan for purchasing the logistics operator CEVA Logistics. In view of this, as port revenues are under stress from both the shipping alliance landscape and shipping groups' lack of funds, more terminal operators will sell assets or merge companies. Just like the mergers of shipping alliances, the more than 20 current global terminal operators may face a reshuffle.

Data Sources and References

1. **IMF**
2. **World Economic Outlook Database**
3. **Drewry website**
4. **Clarkson website**
5. **Alphaliner website**
6. **Ministry of Transport of the People's Republic of China**
7. **Hong Kong Port Authority website**
8. **Singapore Port Authority website**
9. **Rotterdam Port Authority website**
10. **EU organization statistics websites**
11. **China Ports website**
12. **www.snet.com**
13. **Asia-Pacific Economic Cooperation**
14. **COSCO Shipping Ports Limited website**
15. **www.simic.com**
16. **A.P. Moller-Maersk Group**
17. **The Journal of Commerce**
18. **Lloyd's List**
19. **Shipping watch**
20. **Port Strategy Magazine**
21. **Port Technology Magazine**
22. **Port Management Magazine**
23. **Container Management Magazine**
24. **Websites of Various Port Authorities**
25. **Websites of Various Terminal Operators**

Global Port Development Report (2019) Preparation Committee

Chief Editor: Zhen Hong (Professor)

Members: Yin Ming (Professor)

Li Gang (Associate Professor)

Zhang Jieshu (Professor)

Zhao Nan (Director of Port Department)

Xie Wenqing (Assistant Director of Port Department)

Working Group on Global Port Development

Leader: Zhao Nan

Deputy head: Xie Wenqing

Members: Zhang Jing, Chen Weijie

Wu Wenjuan, Mao Zirui

Li Qiongjie, Qin Yuanhao

Zhu zhaofeng, Xu Yiwen

Shanghai International Shipping Institute

Shanghai International Shipping Institute Port Development Institute

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

Contact: Lu Weiling

Email: luweiling@sisi-smu.org

TEL: +86 21 65853850*8038/65355897

Fax: +86 21 65373125

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

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

Shanghai International Shipping Institute		
Business Consultation（021-65853850）		
International Shipping Market Analysis Report	021-65853850*8025	Zhang Yongfeng
International Container liner Shipping Market Analysis Report		
International Dry Bulk Shipping Market Analysis Report		
Chinese Coastal Dry Bulk Shipping Market Analysis Report	021-65853850*8039	Zhou Dequan
Chinese Shipping Prosperity Report		
Global Port Development Report	021-65853850*8033	Zhao Nan
Global Modern Shipping Services Development Report	021-65853850*8015	Jin JiaChen
Chinese Cruise Market Analysis Report		Cheng Juehao
China Shipping Financial Market Report		Gan Aiping
Shipping Review Magazine	021-65853850*8032	Liu Zhengyu
Maritime intelligence		
CHINA SHIPPING AND PORTS（E-JOURN）		
China Maritime Information Website		
China Shipping Database	021-65853850*8006	Xu Kai
Shipping Information Development Report		

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.

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

SISI serves as a key government think tank. In August 2012, 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

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

- Function 3. Talent service

Set up 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.

Shanghai International Shipping Institute Secretariat

Secretary General: Professor Zhen Hong

Deputy Secretary General: Professor Yin Ming

Associate Professor Li Gang

Professor Zhang Jieshu

Assistant to the Secretary General: Dai Jin

Zhao Nan

Director of Port Research Department: Ph.D. Zhao Nan

Director of International Shipping Research Department: Ph.D. Zhang Yongfeng

Director of Shipping Center Construction Research Department: Ph.D. Jin Jiachen

Director of Domestic Shipping Research Department: Ph.D. Zhou Dequan

Director of Shipping Information Research Department and

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

Shanghai International Shipping Institute

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

TEL: +86 21 65853850*8038/65355897

Fax: +86 21 65373125

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