4

PORTS

In 2017, global port activity and cargo handling of containerized and bulk cargo expanded rapidly, following two years of weak performance. This expansion was in line with positive trends in the world economy and seaborne trade. Global container terminals boasted an increase in volume of about 6 per cent during the year, up from 2.1 per cent in 2016. World container port throughput stood at 752 million TEUs, reflecting an additional 42.3 million TEUs in 2017, an amount comparable to the port throughput of Shanghai, the world's busiest port.

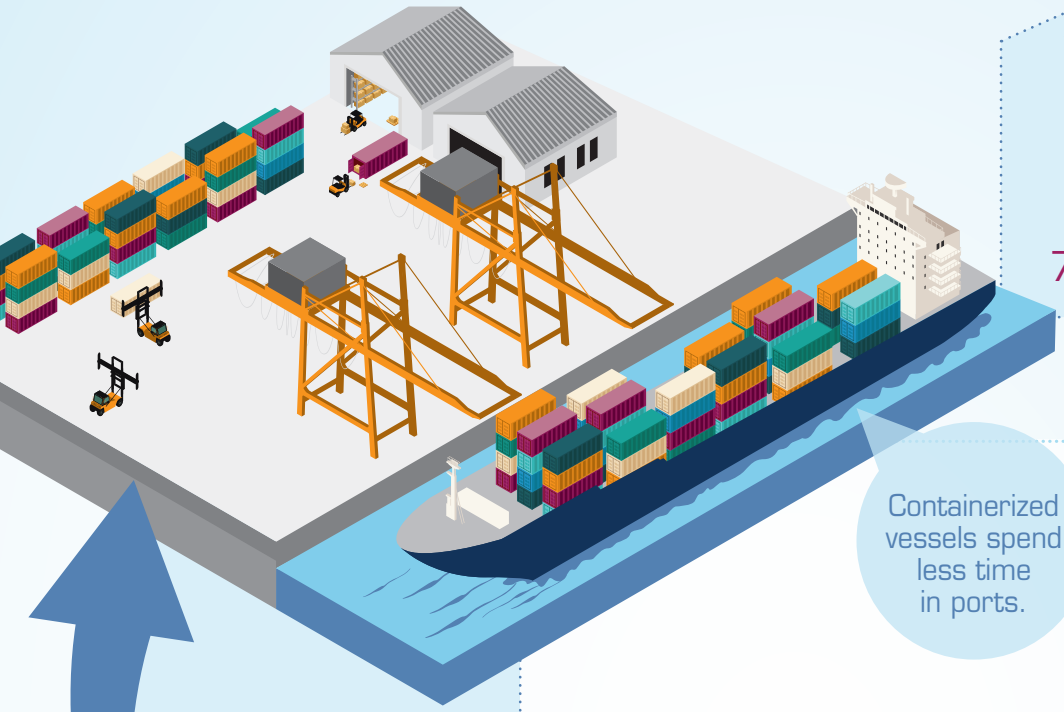
While overall prospects for global port activity remain bright, preliminary figures point to decelerated growth in port volumes for 2018, as the growth impetus of 2017, marked by cyclical recovery and supply chain restocking factors, peters out. In addition, downside risks weighing on global shipping, such as trade policy risks, geopolitical factors and structural shifts in economies such as China, also portend a decline in port activity.

Today's port-operating landscape is characterized by heightened port competition, especially in the container market segment, where decisions by shipping alliances regarding capacity deployed, ports of call and network structure can determine the fate of a container port terminal. The framework is also being influenced by wide-ranging economic, policy and technological drivers of which digitalization is key. More than ever, ports and terminals around the world need to re-evaluate their role in global maritime logistics and prepare to embrace digitalization-driven innovations and technologies, which hold significant transformational potential.

Strategic liner shipping alliances and vessel upsizing have made the relationship between container lines and ports more complex and triggered new dynamics, whereby shipping lines have stronger bargaining power and influence. The impact of liner market concentration and alliance deployment on the port–carrier relationship will need to be monitored and assessed. Areas of focus include the impact on the selection of ports of call, the configuration of liner shipping networks, the distribution of costs and benefits between container shipping and ports, and approaches to container terminal concessions, as shipping lines often have stakes in terminal operations.

Enhancing port and terminal performance in all market segments is increasingly recognized as critical for port planning, investment and strategic positioning, as well as for meeting globally established sustainability benchmarks and objectives such as the Sustainable Development Goals. Ports and their stakeholders, including operators, users and Governments, should collaborate to identify and enable key levers for improving port productivity, profitability and operational efficiencies.

PORTS IN 2017



World container port throughput:

+6%

Volumes:
752 million TEUs

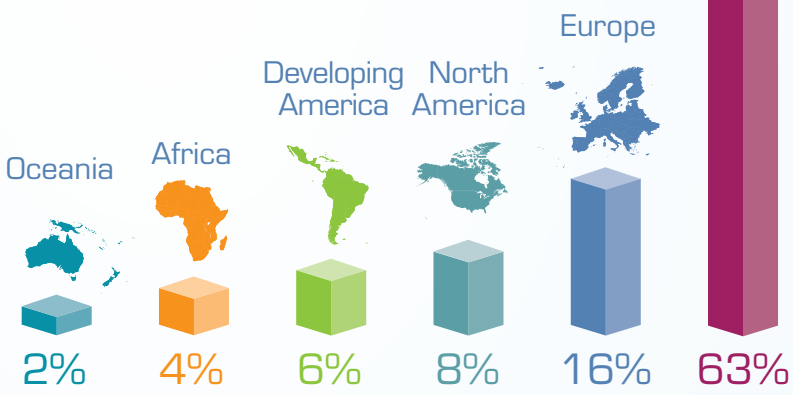
Containerized vessels spend less time in ports.

Average port times for all ships improved in 2017

31.2 hours

33.6 hours in 2016

WORLD CONTAINER PORT VOLUMES BY REGION



A. OVERALL TRENDS IN GLOBAL PORTS

As key players in international trade and logistics and critical nodes in global supply chains, seaports continue to underpin globalized production processes, market access and effective integration in the global economy. World seaports are principal infrastructural assets that service shipping and trade, and their performance is largely determined by developments in the world economy and trade. Cargo-handling activity and throughput in global ports, which reflected a recovery in the global economy and a rebound in trade volumes that boosted shipping demand and seaborne trade in 2017, showed overall improvement and promising trends.

Since over 80 per cent of world merchandise trade in volume terms is handled by ports worldwide and nearly two thirds of this trade is loaded and unloaded in the ports of developing countries, the strategic importance of well-functioning and efficient ports for growth and development cannot be overemphasized. Global ports cater to ships and cargo across various stages of port-handling operations, starting with the shoreside, to the berth, the yard and the landside. Therefore, enhancing port efficiency throughout the various cargo- and vessel-handling phases is crucial for overall efficiency and to ensure that gains achieved by one segment of the maritime logistics chain are not cancelled out by inefficiencies arising elsewhere in the process.

Ports are at the intersection of many developments. They benefited from a global recovery in 2017 that remains nevertheless fragile, owing to ongoing downside risks. They also face challenges arising from the changing dynamics in the liner shipping market, the need to embrace technological advances brought about by digitalization, the requirement to comply with a heightened global sustainability agenda and the imperative of remaining competitive and responding to the demands of the world economy and trade.

1. Improvements in global port cargo throughput

A widely used indicator providing insights into the functioning of ports and their ability to attract business is volumes handled by ports. As cargo flows are largely determined by changes in demand, port volumes help take the pulse of the world economy and inform about potential transport infrastructure needs and investment requirements. As such, port cargo throughput, including all cargo types, can serve as a leading economic indicator. While data for global port throughput in 2017 was not available at the time of writing, a look at data for 2016 indicates the scale of overall port-handling activity. Cargo throughput (all cargo types, including containerized and bulk commodities) at world major ports was estimated at over 15 billion tons in 2016, following an increase of 2.1 per cent over 2015 (Shanghai International Shipping Institute, 2016).

A study describing the performance of leading global ports between 2011 and 2016 found that bulk-handling terminals captured most of the expansion gains of all ports, including container- and bulk-handling ports (Fairplay, 2017a). Almost all leading ports recorded a volume increase, except Shanghai, where the amount of cargo handled declined over the review period. With 485 million tons handled in 2016, Port Hedland, Australia saw rapid growth during the same period, followed by the Chinese ports of Ningbo-Zhoushan, Caofeidian, Tangshan and Suzhou. The top 20 global ports included only three ports outside Asia: the ports of Hedland, Rotterdam and South Louisiana. Compared with other ports on the list, cargo handled at the port of Rotterdam expanded at a slower rate between 2011 and 2016, owing to a relative decline in bulk commodity volumes handled. Overall, and despite their predominance, port volumes in China are said to be increasingly affected by the country's gradual transition towards a more service- and consumption-oriented economy. In Singapore, port volumes between 2011 and 2016 increased, and the first liquefied natural gas bunkering terminal was opened in 2017.

Preliminary analysis suggests that port volumes increased in 2017 reflecting, to a large extent, global economic recovery and growth in seaborne trade (see chapter 1). Estimates indicate that volumes handled in the top 20 global ports increased by 5 per cent to 9.4 billion tons in 2017, compared with 8.9 billion tons in 2016 (Shanghai International Shipping Institute, 2017).

Table 4.1. provides a list of leading global ports, measured by total tons of all cargo handled. Among the top 10 ports, 8 were in Asia, mainly from China. Ningbo-Zhoushan ranked first, with total volumes handled surpassing the 1 billion ton mark for the first time. Aside from Tianjin, which saw an 8.4 per cent drop in volumes, all ports on the list recorded volume increases in 2017. Reduced volumes in Tianjin may reflect the delayed effect of the industrial accident that occurred in 2015 and involved two explosions in the port's storage and handling of hazardous materials facilities. It may also reflect government restrictions on the use of tracks for the carriage of coal. With regard to Shanghai, the continued rebalancing of the Chinese economy towards domestic consumption and services was a major factor in the port's ranking.

Global port activity, which mirrored global economic recovery in 2017, improved across all regions, albeit with some variations. Existing data highlight the positive performance of ports in Europe and the United States, with volumes handled increasing at an annual rate of 4.9 per cent and 7 per cent,

Table 4.1 Global top 20 ports by cargo throughput, 2016–2017
(Million tons and annual percentage change)

Rank	Port	Cargo throughput		Percentage change
2017		2016	2017	2017–2016
1	Ningbo-Zhoushan	918	1 007	9,7
2	Shanghai	700	706	0,8
3	Singapore	593	626	5,5
4	Suzhou	574	608	5,9
5	Guangzhou	522	566	8,5
6	Tangshan	516	565	9,6
7	Qingdao	501	508	1,4
8	Port Hedland	485	505	4,3
9	Tianjin	549	503	-8,4
10	Rotterdam	461	467	1,3
11	Dalian	429	451	5,2
12	Busan	362	401	10,5
13	Yingkou	347	363	4,4
14	Rizhao	351	360	2,7
15	South Louisiana	295	308	4,4
16	Gwangyang	283	292	3,1
17	Yantai	265	286	7,6
18	Hong Kong SAR	257	282	9,7
19	Zhanjiang	255	282	10,3
20	Huanghua	245	270	10,0
	Total	**8 907**	**9 354**	**5,0**

Source: Shanghai International Shipping Institute, 2017.
Note: Figures cover all cargo types.
Abbreviation: SAR, Special Administrative Region.

respectively. Reflecting Asia's position as the main source of world shipping demand and the influence of China, port volumes handled at Asian ports increased by 7.2 per cent in 2017. Main ports in China handled 12.6 billion tons, an increase of 6.9 per cent over 2016. Ports in the Republic of Korea handled 1.57 billion tons, a 4.1 per cent improvement over 2016. Port volumes in Africa rose by 3.5 per cent, compared with 2016, reflecting overall improved economic conditions, a recovery in commodity export earnings and higher import demand in the region. Volumes handled at major ports in Australia expanded at the slow pace of 2.3 per cent in 2017, as port activity was affected by *Hurricane Debbie*. In particular, the hurricane undermined the performance of the port of Hay Point, the largest coal port in Australia.

2. Tracking and measuring port performance

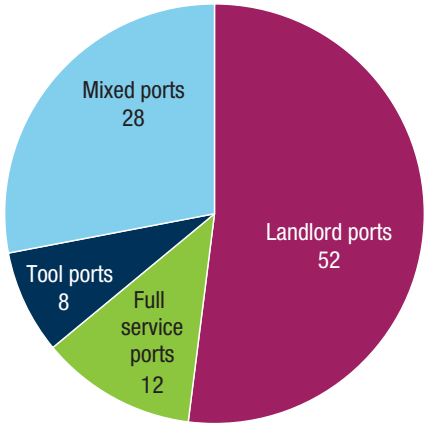
Global trade, supply chains, production processes and countries' economic integration are heavily dependent on efficient port systems and supporting logistics. It is therefore becoming increasingly important to monitor and measure the operational, financial, economic, social and environmental performance of ports.

In 2013, the Port Management Programme of the UNCTAD Train for Trade Programme developed a port performance measurement component (see box 4.1). This work culminated in the adoption of 26 indicators across six areas: finance, human resources, gender, vessel operations, cargo operations and environment (UNCTAD, 2016). The main objective was to provide members of the Programme's port network with a useful instrument that would benchmark performance and carry out port and regional comparisons. Ports in the network involved in port performance measurement were landlord ports, full service ports, tool ports and mixed ports (figure 4.1). The port performance measurement system adopted under the Programme draws largely on the balance scorecard concept (table 4.2).

Results achieved between 2010 and 2017 are summarized in figures 4.2 to 4.6. When comparing port performance, the standard caveat is that ports are difficult to compare, with many context variables to consider. The scorecard describes the data profile for the 48 reporting ports since 2010 in terms of data set metrics, port size, modal mix, governance, market and regulatory structures. The indicators are sourced from wide-ranging ports, 66 per cent of which have annual volumes below 10 million tons.

Results presented in figures 4.2 to 4.6 reflect data provided by the reporting countries and port entities that are members of the network only. They should not

Figure 4.1 **Port models of the Port Management Programme port network, 2016**
(Share in percentage)



Source: UNCTAD, 2016.

be generalized or interpreted as reflecting all ports in the four regions defined under this scheme. Benchmarking has been developed for Asia, Africa, Europe and developing America. The global average is provided for all port networks of the Programme – French-, English-, Spanish- and Portuguese-speaking – reporting over a period of eight years and representing a total of 48 port entities from 24 countries.

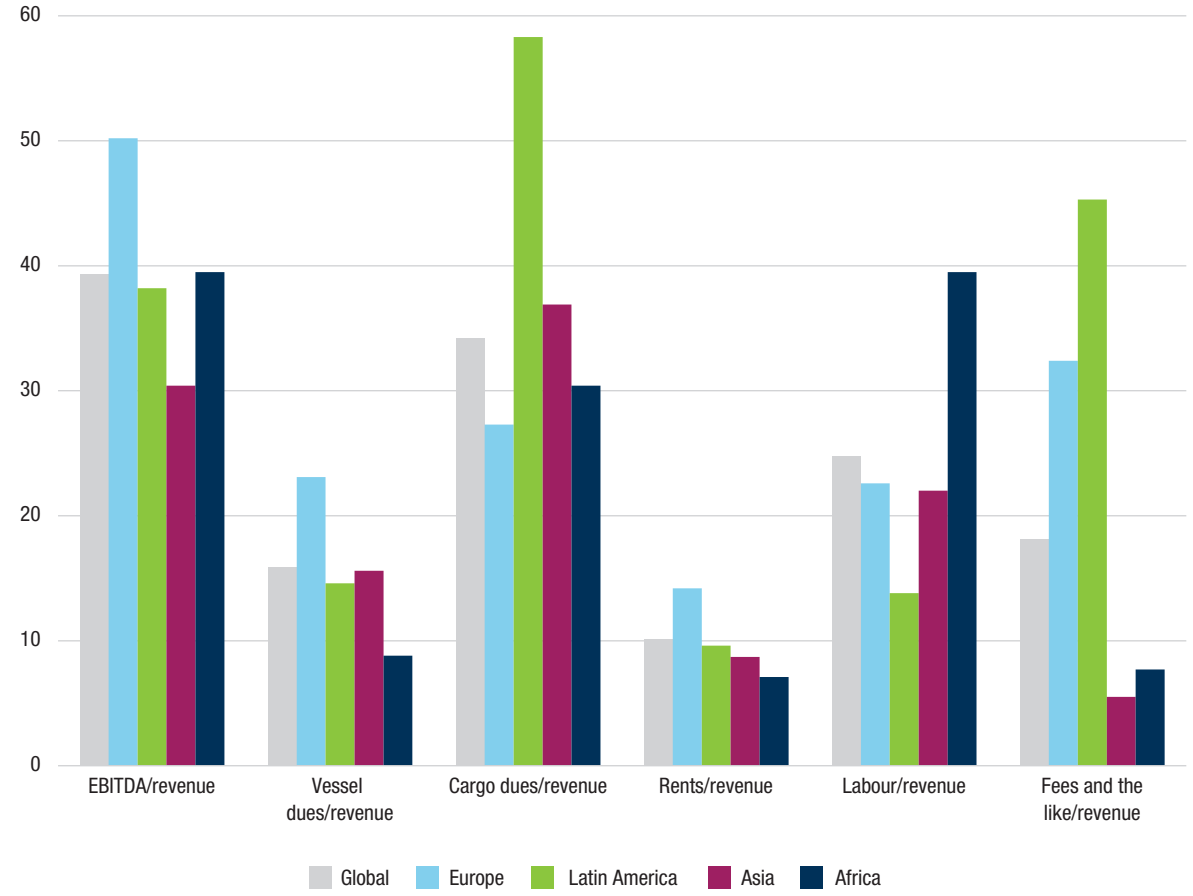
Profit levels can vary considerably between ports, depending on the accounting treatment, capital reward structure and profit definition used in the indicator. Operating profit margins are considered the best level to make cross-country and time comparisons, given their composition. Therefore, the indicator is focused on the trading and management performance of the port entity. There are some outliers in the data, including a loss-making entity for one period. However, over time, the mean value has remained robust, ranging between 35 per cent and 45 per cent.

Table 4.2 **Port performance scorecard indicators**

Categories		Port entity indicators	Number values	Mean in percentage (2010–2017)
Finance	1	EBITDA/revenue (operating margin)	126	39,30
	2	Vessel dues/revenue	135	15,90
	3	Cargo dues/revenue	120	34,20
	4	Rents/revenue	117	10,10
	5	Labour/revenue	106	24,80
	6	Fees and the like/revenue	114	18,10
Human resources	7	Tons per employee	134	54 854
	8	Revenue per employee	128	$235 471
	9	EBITDA per employee	107	$119 711
	10	Labour costs per employee	89	$42 515
	11	Training costs/wages	101	1,30
Gender	12	Female participation rate, global	54	15,70
	12,1	Female participation rate, management	53	30,90
	12,2	Female participation rate, operations	39	12,30
	12,3	Female participation rate, cargo handling	29	5,30
	12,4	Female participation rate, other employees	8	32,00
	12,5	Female participation rate, management plus operations	119	19,60
Vessel operations	13	Average waiting time	129	15 hours
	14	Average gross tonnage per vessel	165	17 114
	15,1	Oil tanker arrivals, average	28	10,80
	15,2	Bulk carrier arrivals, average	28	11,20
	15,3	Container ship arrivals, average	28	40,30
	15,4	Cruise ship arrivals, average	29	1,80
	15,5	General cargo ship arrivals, average	28	16,50
	15,6	Other ship arrivals, average	27	19,10
Cargo operations	16	Average tonnage per arrival (all)	156	6 993
	17	Tons per working hour, dry or solid bulk	91	402
	18	Boxes per hour, containers	120	29
	19	TEU dwell time, in days	73	6
	20	Tons per hour, liquid bulk	46	299
	21	Tons per hectare (all)	130	131 553
	22	Tons per berth metre (all)	143	4 257
	23	Total passengers on ferries	18	811 744
	24	Total passengers on cruise ships	20	89 929
Environment	25	Investment in environmental projects/total CAPEX	10	0,90
	26	Environmental expenditures/revenue	17	0,30

Source: UNCTAD, 2016.
Note: Number of values is a product of ports providing data for the variable by the number of years reporting.
Abbreviations: CAPEX, capital expenditure; EBITDA, earnings before interest, taxes, depreciation and amortization.

Figure 4.2 Financial indicators, 2010–2017
(Share in percentage)



Source: UNCTAD, 2016.
Abbreviation: EBITDA, earnings before interest, taxes, depreciation and amortization.

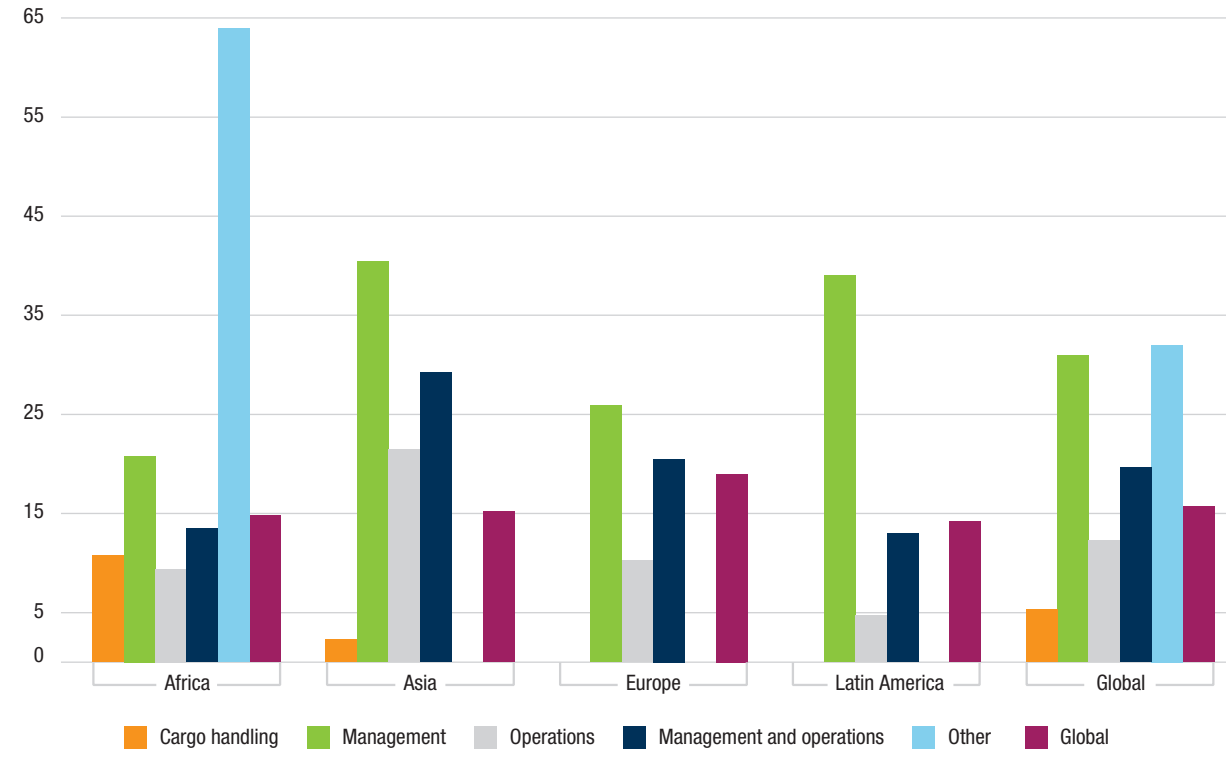
It is useful to consider port dues for cargo and vessels together. The regional differences are less for the gross port dues (cargo plus vessels) proportion of revenue. Total revenue when averaged across volumes suggests that just over $4 is earned by a port entity on each ton of cargo.

Rent is a traditional source of independent income for ports. The clustering of the data in figure 4.2 is consistent with previous reporting. When contrasted with a concession or fee variable, it varies significantly across the network. There is a shift towards concessions to the private sector but thus far it has not necessarily implied a move away from leasing. It remains unclear whether this is due to concessions being added to a lease rather than replacing a lease.

Data in figure 4.3 are a significant addition to the scorecard and chart the changing gender balance across port authorities in the data set. There is a clear distinction between categories of employees across traditional lines that has yet to reflect the technological shift in working methods and skill sets on the quays. The data suggest that Africa is an outlier characterized by a high average payroll cost as a proportion of revenue. It remains unclear whether this could be attributed to lower revenue levels or higher staffing levels. The average wage is estimated at $47,000, with a large range of values. It is a number that requires considerable nuance and comparison with local economic indicators that will be examined in future port performance conferences.

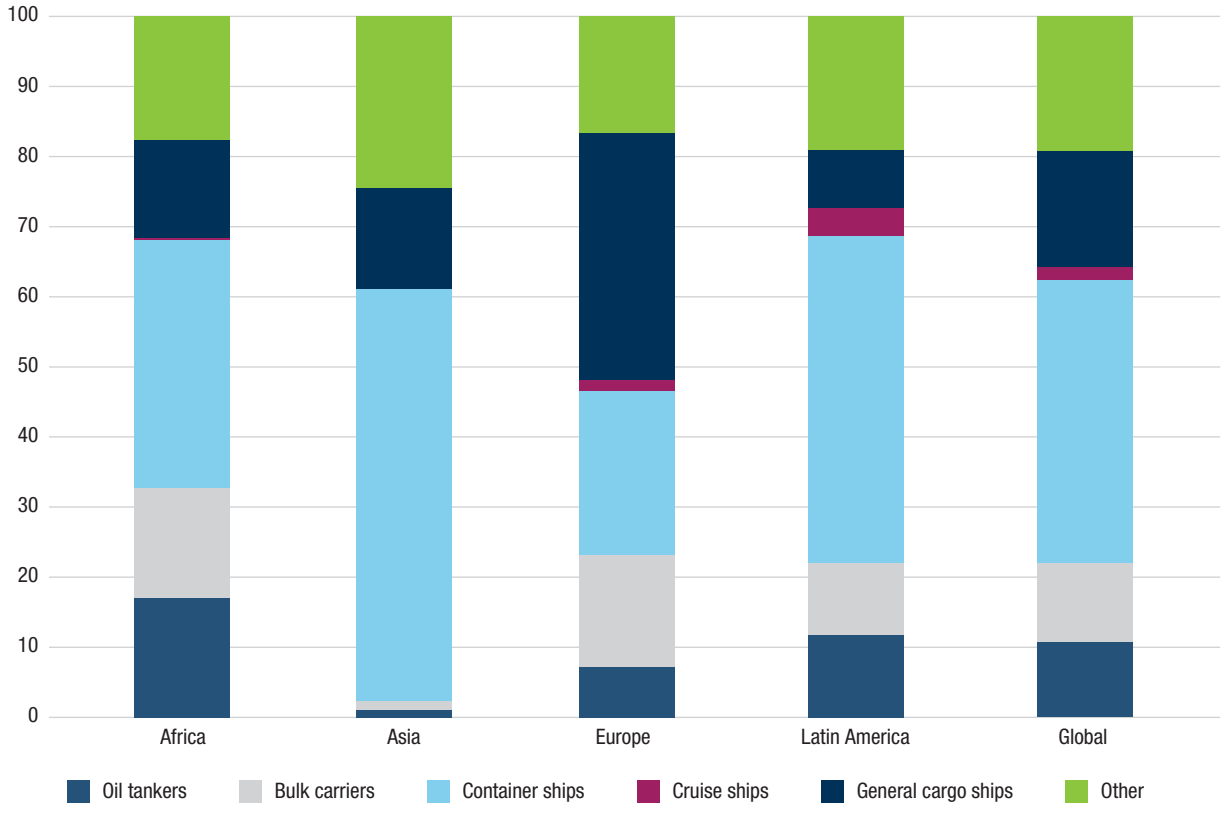
Reflecting the growing importance of containerized trade and the role of containers in multimodal transport, container ship arrivals represented 36 per cent of all arrivals during the review period. Given that 48 port entities located in 24 countries provided data entries in the system for almost all 26 indicators, data points are above 100. This enhances the robustness of the statistical results, which can, nevertheless, be further improved through additional port reporting. Work aimed at interpreting the results has been initiated, including the use of a five-year moving average for analysis. There remains the question, however, of how insights generated from this work can be further leveraged to support informed strategic planning and decisions relating to ports.

Figure 4.3 **Female participation rate, by area of activity, 2010–2017**
(Percentage)



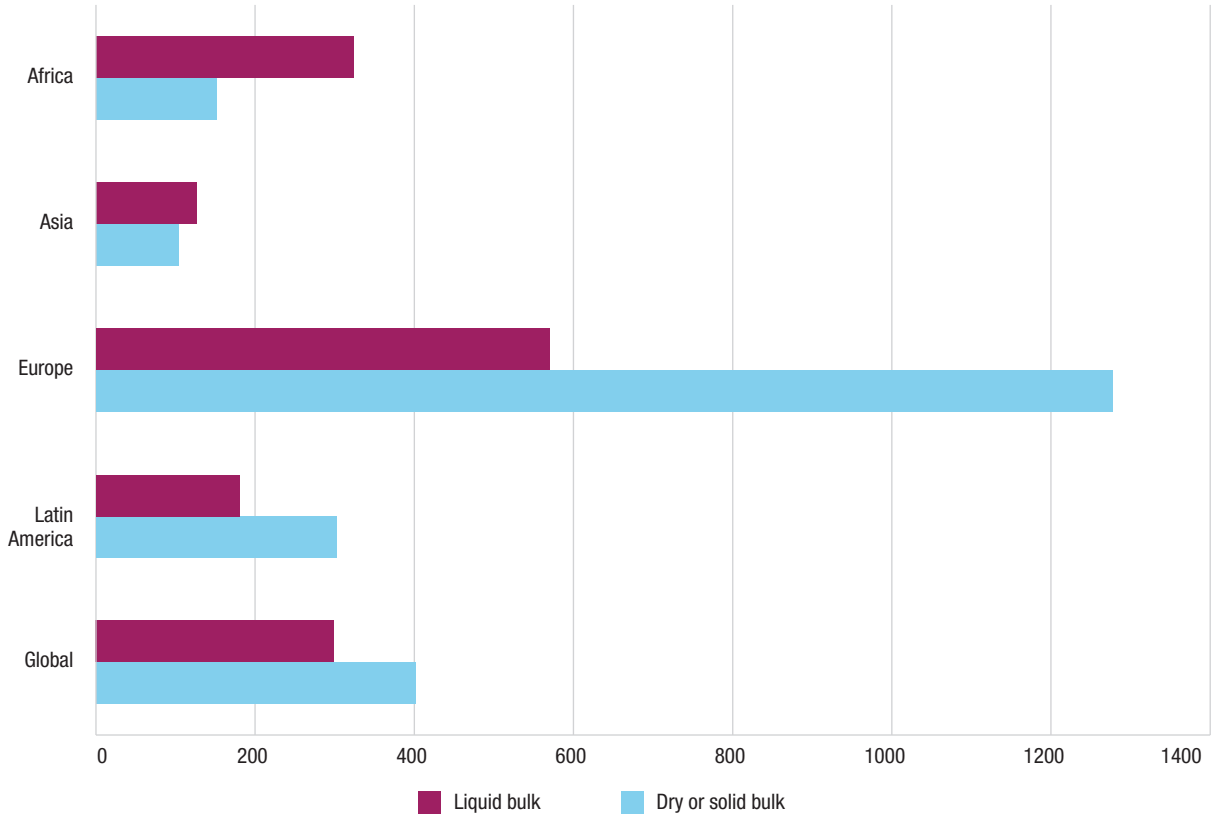
Source: UNCTAD, 2016.
Note: The female participation rate includes a five-year moving average.

Figure 4.4 **Average arrivals by type of vessel, 2010–2017**
(Share in percentage)



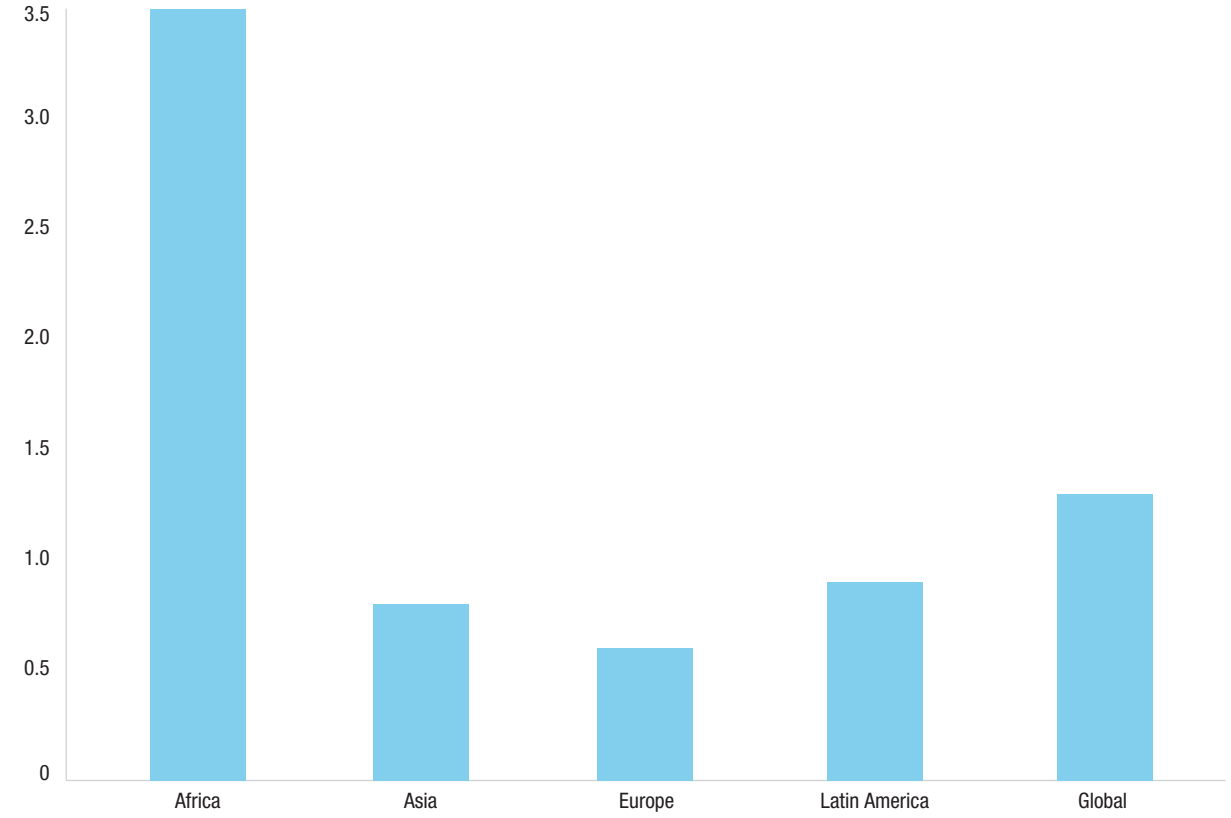
Source: UNCTAD, 2016.

Figure 4.5 Dry and liquid bulk cargo operations, 2010–2017
(Tons per working hour)



Source: UNCTAD, 2016.

Figure 4.6 Training costs as a percentage of wages, 2010–2017



Source: UNCTAD, 2016.

Box 4.1 UNCTAD port performance scorecard indicators

Train for Trade is a component of the UNCTAD Port Management Programme, which supports port communities in developing countries seeking to ensure efficient and competitive port management, and in turn, support trade and economic development. The Programme creates port networks bringing together public, private and international entities. The aim is for port operators from public and private entities worldwide to share knowledge and expertise and to capitalize on research conducted in port management and port performance indicators (UNCTAD, 2016). For over 20 years, the Programme has provided training and capacity-building activities for four language networks (English, French, Portuguese and Spanish); 3,500 port managers from 49 countries in Africa, developing America, Asia, the Caribbean and Europe; and 110 replication cycles of one to two years at the national level. The Programme is recognized by beneficiaries, donors, partners and evaluators as a successful model of technical assistance. Under the activities of the Programme, UNCTAD has initiated work on port performance measurement. Starting in 2014, a series of international conferences brought together over 200 representatives from 30 member countries of the four language networks. The aim was to identify the port performance indicators that should be collected, the corresponding definitions, the underlying methodology and the technology to be adopted. The latter aims to ensure a common denominator across the various ports of the network of the Programme to promote meaningful comparisons.

One of the challenges faced by the Programme was the ability to discriminate results at the port level instead of country level. This is often the case with indicators such as the logistics performance index (World Bank), the global competitiveness index (World Economic Forum) and the liner shipping connectivity index (UNCTAD). These indicators are aggregated at the country level and do not provide a port-level perspective.

Additional information about the UNCTAD Port Management Programme and port performance scorecard is available at https://learn.unctad.org/course/index.php?categoryid=2.

Source: UNCTAD, 2017a.

B. GLOBAL CONTAINER PORTS

Container port throughput is driven to a large extent by developments in the world economy and global demand, including investment, production and consumption requirements. Trans-shipment is a major area of container port activity that results in particular from hub-and-spoke container networks and could be enhanced by the further deployment of ultralarge container vessels. Trends in 2016 and 2017 point to the strategic importance of containerized port activity. Some 873 ports worldwide received regularly scheduled calls from fully cellular container ships across 141 countries, leading to over 560,000 individual port calls (Clarksons Research, 2017).

1. Increase in global container port throughput

UNCTAD estimates that global container port throughput rose by 6 per cent in 2017, three times the rate of 2016 (table 4.3). Increased port activity reflected the recovery of the world economy and the associated increase in trade flows. According to UNCTAD calculations, 752.2 million TEUs were handled by container ports in 2017. This total reflects the addition of some 42.3 million TEUs, an amount comparable to total container volumes handled by Shanghai, the top-ranked global port in volume terms.

Key factors contributing to higher volumes included strong growth on the intra-Asian trade route; improved consumer demand in the United States and Europe; and an increase in North–South trade volumes, which was supported by higher commodity export earnings in Africa and developing America, thus stimulating imports. However, the relatively rapid growth achieved by container ports after the weak performance of 2015 and 2106, suggests that apart from the cyclical recovery, some supply chain restocking may have further supported growth in 2017. Trans-shipment declined slightly from 26 per cent in 2016 to 25.8 per cent in 2017. While the configuration of capacity along shipping networks has reached a level of stability, the expansion of the Panama Canal could imply more direct calls to the East Coast of the United States and probably slower growth in trans-shipment activity in the Panama Canal and Caribbean region.

Table 4.3 World container port throughput by region, 2016–2017
(20-foot equivalent units and annual percentage change)

	2016	2017	Annual percentage change
Asia	454 513 516	484 176 997	6,5
Africa	30 406 398	32 078 811	5,5
Europe	111 973 904	119 384 254	6,6
North America	54 796 654	56 524 056	3,2
Oceania	11 596 923	11 659 835	0,5
Developing America	46 405 001	48 355 369	4,2
World total	**709 692 396**	**752 179 321**	**6,0**

Source: UNCTAD secretariat calculations, based on data collected by various sources, including Lloyd's List Intelligence, Jean-Paul Rodrigue, Hofstra University, Dynamar BV, Drewry Maritime Research and information posted on websites of port authorities and container port terminals.

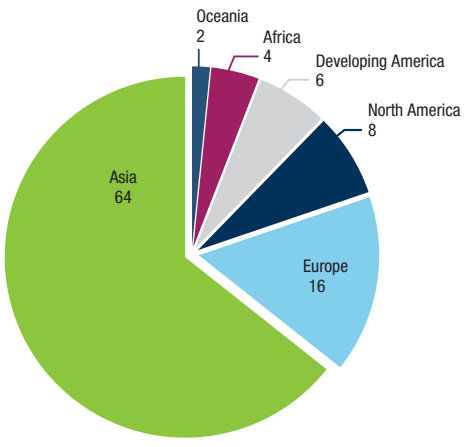
Note: Data are reported in the format available. In some cases, country volumes were derived from secondary sources and reported growth rates. Country totals may conceal the fact that minor ports may not be included. Therefore, data in the table may differ from actual figures in some cases.

Asia plays a central role in global trade and shipping, as shown by activity in the container shipping sector. The Asia–Pacific region accounts for over 42 per cent of the number of ports and 60 per cent of the calls, with China representing 19 per cent of all calls alone (Clarksons Research, 2017). These trends have been largely supported by globalization. The second most important player is Europe, which accounts for 28 per cent of world container ports and 21 per cent of port calls.

In line with trends in port calls, Asia dominates the container-handling business. The region continued to account for nearly two thirds of the global container port throughput (figure 4.7). Volumes handled in the region increased by 6.5 per cent. Some 240 million TEUs were recorded in China, including Hong Kong, China and Taiwan Province of China. This represents almost half of all port volumes handled in the region. Restrictions imposed by the Government of China limiting imports of some waste material on the backhaul journeys from North America and Europe are likely to increase the incidence of empties in the overall traffic handled by ports, which could exacerbate the trade and freight rate imbalances on the trans-Pacific route.

Elsewhere in Asia, container port throughput in 2017 was influenced by developments in the Islamic Republic of Iran and sanctions imposed on Qatar. While volumes in Bandar Abbas port increased by over 20 per cent, the imposition of sanctions on the Islamic Republic of Iran had already started to weigh on port performance in late 2017 (Drewry Maritime Research, 2018a). Jebel Ali faced some competition from Bandar Abbas port, despite increasing volumes by 4 per cent over 2016. Port Sohar in Oman gained the most from sanctions imposed on Qatar. Growth in South Asia surpassed 10.7 per cent, reflecting among other factors, the growing shift of manufacturing towards Bangladesh, India and Pakistan. In India, Jawaharlal Nehru Port terminals attracted 4.8 per cent more business in 2017. A new container terminal in Jawaharlal Nehru Port, which has been running close to design capacity for several years, was opened in early 2018.

Figure 4.7 **World container port throughput by region, 2017**
(Percentage share in total 20-foot equivalent units)



Source: UNCTAD secretariat calculations, derived from table 4.3.

Reflecting to a large extent the recovery in the European Union in 2017, volumes handled in European ports increased by 6.6 per cent. With volumes reaching nearly 120 million TEUs, Europe accounted for 16 per cent of global container port throughput.

A development affecting European ports during the year was the growing presence of the China Ocean Shipping Company as a principal port investor. After acquiring port facilities in Greece, Italy and Spain, the company established a presence in Northern Europe by signing a concession agreement with Zeebrugge Port Authority to open a container terminal – this was made possible in part by the Belt and Road Initiative. The company is expected to emerge as a world leader among terminal operators by 2020 (Wei, 2018).

North America maintained an 8 per cent share of total container port volumes, supported by strong activity in the United States. Africa's share of world container port throughput was estimated at 4 per cent, surpassing Oceania's 2 per cent share. However, this was still below the 6 per cent accounted for by developing American ports. Volumes in Africa increased due to stronger import demand. Many sub-Saharan African countries experienced a higher demand for their exports and recorded better export earnings than in the past. This in turn boosted imports, with the southbound Asia–West Africa trade growing at its fastest rate since 2014 (Drewry Maritime Research, 2017a). This is reflected in increased throughputs in South Africa and Western Africa, in contrast with losses incurred in 2016. In particular, the recovery in Angola and Nigeria from a low-price environment and the robust economies of Côte d'Ivoire and Ghana contributed favourably to a 9.5 per cent increase in West African ports' container throughput.

In Australia and New Zealand, growth in container port volumes was sustained by external demand and strong consumer spending, while in developing America, volumes were driven by the higher commodity prices environment and the end of recession in key economies such as in Brazil. Container traffic from Asia to the East Coast of South America bounced back in 2017, expanding by 15.5 per cent. The recovery was driven by Brazilian imports, which rose sharply, by 22 per cent.

As shown in table 4.4, container port activity tends to be concentrated in major ports. These are generally mega ports, which serve as hubs or gateways for important hinterlands (Clarksons Research, 2017). The combined throughput at the world's leading 20 container terminals increased by 5.9 per cent. Together, they handled an estimated 336.6 million TEUs, accounting for 45 per cent of the world's total. Except for the ports of Klang and Kaohsiung, all ports in the ranking recorded volume gains. The contribution of Asian container ports

Table 4.4 **Leading 20 global container ports, 2017**
(Thousand 20-foot equivalent units, percentage annual change and rank)

Port	Economy	Throughput 2017	Throughput 2016	Percentage change 2016–2017	Rank 2017
Shanghai	China	40 230	37 133	8,3	1
Singapore	Singapore	33 670	30 904	9,0	2
Shenzhen	China	25 210	23 979	5,1	3
Ningbo-Zhoushan	China	24 610	21 560	14,1	4
Busan	Republic of Korea	21 400	19 850	7,8	5
Hong Kong	Hong Kong SAR	20 760	19 813	4,8	6
Guangzhou (Nansha)	China	20 370	18 858	8,0	7
Qingdao	China	18 260	18 010	1,4	8
Dubai	United Arab Emirates	15 440	14 772	4,5	9
Tianjin	China	15 210	14 490	5,0	10
Rotterdam	Netherlands	13 600	12 385	9,8	11
Port Klang	Malaysia	12 060	13 170	-8,4	12
Antwerp	Belgium	10 450	10 037	4,1	13
Xiamen	China	10 380	9 614	8,0	14
Kaohsiung	Taiwan Province of China	10 240	10 465	-2,2	15
Dalian	China	9 710	9 614	1,0	16
Los Angeles	United States	9 340	8 857	5,5	17
Hamburg	Germany	9 600	8 910	7,7	18
Tanjung Pelepas	Malaysia	8 330	8 281	0,6	19
Laem Chabang	Thailand	7 760	7 227	7,4	20
Total		**336 630**	**317 929**	**5,9**	

Source: UNCTAD secretariat calculations, based on various industry sources.
Abbreviation: SAR, Special Administrative Region.

surpasses all other regions, as 80 per cent of the ports featuring in the top 20 are Asian. Nearly two thirds of these are in China.

Apart from the contraction in volumes experienced by the ports of Klang and Kaohsiung, growth of individual ports varied between a low of 0.6 per cent in Tanjung Pelepas and 14.1 per cent in Ningbo-Zhoushan. Shanghai remained the busiest container port worldwide; volumes handled expanded by 8.3 per cent, bringing the total volume to 40.2 million TEUs. Singapore ranked second, handling 33.7 million TEUs, a 9 per cent increase over 2016. In third position, the amount of volumes handled by Shenzhen increased by 5.1 per cent, to 25.2 million TEUs. Ranked fourth, Ningbo-Zhoushan saw the largest increase in volumes, which rose by 14.1 per cent to 24.6 million TEUs. As the biggest receiver of plastic waste, Guangzhou, and to some extent, Shenzhen, which imports wastepaper, are likely to be affected by a new regulation introduced in China in late 2017, limiting the imports of some types of wastes (Drewry Maritime Research, 2017a). Outside Asia, four ports, Rotterdam, Antwerp, Los Angeles and Hamburg, are among the top 20 ports. All four handled larger volumes in 2017, although Rotterdam saw the largest increase, as cargo throughput expanded by nearly 10 per cent, above levels in 2016.

2. Operational performance of world container ports

Strategic liner shipping alliances and the associated trend of vessel upsizing have added complexity to the container shipping and port relationship and triggered new dynamics where shipping lines have greater bargaining power and influence.

Vessel size increases and the rise of mega alliances have heightened the requirements for ports to adapt and respond to more stringent requirements. Bigger call sizes exert additional pressure on ports and terminals and require an effective response measure to ensure that space, equipment, labour, technology and port services are optimized. This raises the question of whether costs and benefits associated with the upsizing of vessels and alliances are fairly distributed between shipping lines and ports.

Liner shipping consolidation, alliance formation and the deployment of larger vessels have combined, leading to greater competition among container ports to win port calls (Notteboom et al., 2017). For example, the port of Klang handled less cargo during the year, as alliance members limited their port calls. Meanwhile, the ports of Singapore and Tanjung Pelepas recorded an increase of 8.2 per cent and 3.4 per cent, respectively, following the decision by shipping alliance members to use them as pivotal ports of call (Shanghai International Shipping Institute, 2017).

As ports compete for fewer services by larger vessels, ports and terminals are interacting with carriers that have strong negotiating and decision-making power. The stakes are high for terminal operators, as a call made by alliance members using larger vessels can generate significant port volumes and business. For example, a weekly call concerning one of the services between Northern Europe and the Far East is estimated to result in annual container volumes of about 300,000 TEUs

per port of call. A liner service using ships with only a capacity of 20,000 TEUs could increase this estimate to an average of about 450,000 TEUs per year per port of call (Notteboom et al., 2017).

The dynamics between shipping lines and container port terminals is further shaped by the ability of lines to take part in port operations though shareholdings and joint ventures with terminal operators, sister companies or subsidiaries involved in terminal operations. This can affect approaches to terminal concessions. Although a terminal operator owned by a shipping line may have a more stable cargo base, regulators may prefer that concessions be granted to independent operators to allow access to all port-handling service providers.

Some of these concerns, including the operational challenges arising from the growing use of mega ships and formation of mega alliances, are reflected in port productivity and performance patterns. While liner shipping networks seem to have benefited from efficiencies arising from consolidation and alliance restructuring, gains at the port level have not evolved at the same pace. Container berth productivity is constrained by the growing volume of boxes exchanged in vessel calls during peak hours (Fairplay, 2018). The deployment of larger vessels and alliance network design have direct implications for the number of boxes exchanged per call, which in turn, exerts additional pressure on ports' handling capacities.

Existing data for 2017 indicate an annual global increase of 9 per cent in the number of containers handled per call. Northern European ports experienced the largest growth – 20 per cent – in average call sizes, compared with 2016. In comparison, call sizes at ports in South-East Asia and developing America increased by 11 per cent in each region. Elsewhere, results were less positive, showing no growth (Africa) or modest declines (Oceania). With regard to results in individual container ports and terminals, the largest increases in call sizes were seen in Antwerp (29 per cent), Yangshan (27 per cent) and Manila (22 per cent) (Fairplay, 2018).

The need to handle more containers at the same time exerts pressure on berth and yard operations. While the increased demand for cargo-handling operations can be mitigated to some extent through the container distribution in ship-planning processes, larger call sizes, combined with a limited number of cranes, reduces optimal crane intensity. The gap between growth in call size and productivity widens when the number of boxes exchanged exceeds 4,000 (Fairplay, 2017b). Some observers contend that ports perform best when ship sizes are within the range of 4,000–14,000 TEUs. These sizes are optimal for quayside performance, although they allow for fewer rows of containers than larger ships. Performance of ships with a capacity of more than 14,000 TEUs is negatively affected by the pressure on equipment and space, for example spreaders, trolley distances, berth and yard areas.

Global port productivity fell in 2017, indicating that container terminals were challenged by the deployment of larger vessels and the growth in port call sizes. In this context, port productivity refers to the number of container moves per hour of time spent by vessels in port, weighted by the call size, which is significantly impacted by the number of cranes deployed to service a ship. Bearing these considerations in mind, some estimates for 2017 indicate a 3 per cent average drop in weighted port productivity globally, compared with 2016 (JOC.com, 2018).

The decline in port productivity affected all regions. One of the steepest declines was experienced in Africa, where port productivity dipped by 12 per cent. Productivity fell by more than 7 per cent in developing America, Western Asia and Indian ports. The impact on European and North American ports was less pronounced, with reductions of 3 per cent in the number of container moves per hour spent by vessels in time at berth. South-East Asia was the only region where some port productivity gains were achieved, despite an increase in call sizes. In terms of individual ports, the greatest declines in port productivity were seen in Manila (21 per cent), and in Dalian and Laem Chabang, where productivity declined by 16 per cent. On the other hand, some ports such as Long Beach, California and Chiwan, China recorded an increase in productivity.

Interestingly, both the number of moves per total hours spent by vessels in port and the waiting time between arrival and the allocation of berth decreased, the latter by 6 per cent worldwide (JOC.com, 2018). The world's largest ports recorded a reduction in the port-to-berth time; the largest improvements were witnessed in the ports of Antwerp and Hamburg. Less positive performances were recorded elsewhere. For example, berth-waiting times more than doubled in Manila and increased almost by half in the port of Shekou. Increases in port-to-berth waiting times were also recorded in India and some African countries.

The performance of major trans-shipment hubs was reported to be relatively even among the various ports. The average port-to-berth waiting time in Jebel Ali was estimated at 2.7 hours, while in Hong Kong (China), Busan and Singapore, waiting times averaged about 2.4 hours. The competitiveness of ports such as Tanjung Pelepas and Klang could be observed with waiting times of 2.2 hours and 2.4 hours, respectively. The average waiting time at Tanjung Priok, which attracted mainline calls in 2017, was also 2.4 hours.

Table 4.5 shows the average time in port by vessel type at the global level. In 2017, the average time in port for all ships was estimated at 31.2 hours, an improvement over the previous year when ships stayed an average of 33.6 hours in ports. Containerized vessels tend to spend less time in ports, followed by dry cargo ships, gas carriers and tankers. Bulk carriers experience the longest time in port, about 65 hours on average, more than double the global average for all ships.

Table 4.5 Average time in port, world, 2016 and 2017

	Days in port		Total arrivals	Total deadweight tonnage (thousands of tons)
Vessel type	2016	2017	2017	2017
Container ships	0,87	0,92	447 626	18 894 342
Tankers	1,36	1,30	301 713	9 648 282
Gas carriers	1,05	1,10	64 603	890 880
Bulk carriers	2,72	2,68	236 407	13 152 509
Dry cargo and passenger ships	1,10	1,02	3 995 242	7 280 933
Total	**1,37**	**1,31**	**5 045 591**	**49 866 946**

Source: Data provided by Marine Traffic, 2018.
Notes: Averages refer to medians. Time in port is defined as the difference between the time that the ship enters the port limits (excluding anchorages) and the time that the ship exits those limits. Irrespective of whether the ship's visit is related to cargo operations or other types of operations such as bunkering, repair, maintenance, storage and idling, time in port includes the time prior to berthing, the time spent at berth (dwell and working times) and the time spent undocking and transiting out of port limits.

Aside from typical operational and service level indicators, such as crane moves per hour and berth allocation waiting time, port performance can also be assessed according to the intensity of port asset utilization. Quay lines, cranes and land are important and expensive assets, for which the level of utilization is a key performance indicator, especially for investors. As gantry crane expenditure hovers around $10 million per crane and quay construction can cost as much as $100,000 per metre – the greater the utilization levels, the higher the performance of these assets (Drewry Maritime Research, 2017b).

Table 4.6 features relevant industry benchmarks and design parameters generally used to measure intensity usage of assets and performance. Table 4.7 reviews the asset use intensity between 2013 and 2016. It shows that asset use intensity remained unchanged overall, although land use intensity decreased. On a global basis, the intensity of quay line usage typically achieved by terminals worldwide is estimated at 1,100 TEUs per metre per year. As shown in table 4.6, the actual performance in 2016 was about 1,150 TEUs per metre, an intensity usage below the theoretical design parameter of 1,500 TEUs per metre. That said, performance varied at some terminals, especially in Asia, where it was relatively better than typical industry performance. Quay line performance above 2,000 TEUs per metre per year were observed in the ports of Busan; Singapore; Shanghai; Ningbo-Zhoushan; Hong Kong, China; Klang; Laerm Chabang; and Jawaharlal Nehru Port Terminal. Many of these also reached more than 250,000 TEUs per crane per year, and more than 50,000 TEUs per hectare per year (Drewry Maritime Research, 2017b).

Overall, the deployment of larger container ships in recent years seems to have had little impact on the annual use of quay line assets and on TEUs handled per gantry crane, whose levels generally stood at some 127,000 TEUs per crane a year. Land use intensity declined slightly, averaging close to 27,000 TEUs per hectare per year in 2016. This may reflect the impact of the growing size of ships calling at ports and the associated pressure on yard operations during periods of peak volumes.

An increase in yard space to alleviate pressure can have the effect of reducing intensity usage. However, other factors may also affect land usage, as shown in North America, where a shift from chassis operations towards fully rounded yard systems improved port performance (Drewry Maritime Research, 2017b). Similarly, ports in developing America improved land usage by increasingly moving away from small multi-purpose terminals in many locations towards larger, specialized container terminals. A terminal's size can also influence usage performance, as illustrated by the relatively higher performance observed in Asia. A terminal's function also has a role to play, with trans-shipment ports generally performing at higher levels than gateway ports. Operational factors such as cargo-handling equipment and working hours tend to have a strong impact on asset usage indicators such as TEUs handled per hectare, per metre of quay line and per crane.

Table 4.6 Usage intensity of world container terminal assets, 2016

Measure per annum	Typical industry design parameters	Performance	Remarks
TEUs per metre of quay	1 500	1 154	Design parameters typically range from 800–1700 TEUs per metre per year
TEUs per ship to shore gantry crane	200 000	127 167	Design parameters are influenced by ratio of number of boxes to TEUs
TEUs per hectare	40 000	26 366	Design parameters are highly dependent on yard equipment type and dwell times

Source: Drewry Maritime Research, 2017b.
Note: Figures on actual performance are based on a sample of 321 terminals handling over 200,000 TEUs per annum.

Table 4.7 Usage intensity of world container terminal assets by region, 2003 and 2016			
Region	**2003**	**2016**	**Percentage change**
Developing America			
TEUs per metre of quay per annum	665	849	27,7
TEUs per ship to shore gantry crane per annum	105 517	110 307	4,53
TEUs per hectare per annum	16 696	27 752	66,2
Europe			
TEUs per metre of quay per annum	653	761	16,53
TEUs per ship to shore gantry crane per annum	100 110	94 819	-5,28
TEUs per hectare per annum	16 651	18 794	12,87
North America			
TEUs per metre of quay per annum	665	777	16,8
TEUs per ship to shore gantry crane per annum	90 661	91 885	1,4
TEUs per hectare per annum	9 604	14 407	50,0

Source: Drewry Maritime Research, 2017b.
Note: Figures on actual performance are based on a sample of 321 terminals handling over 200,000 TEUs per annum.

C. GLOBAL DRY BULK TERMINALS

1. Global dry bulk terminals benefit from growing demand for raw materials and energy

Positive trends in population growth, urbanization, infrastructure development, construction activity, and industrial and steel output, especially in rapidly emerging developing countries in Asia, have generally had a marked impact on bulk terminals worldwide. Dry bulk commodities have been the mainstay of international seaborne trade volumes in recent years, accounting for almost half of world seaborne trade flows in 2017.

Trends in coal trade volumes in 2017 were shaped by growing environmental sustainability imperatives. Many countries continued their energy transition towards less carbon-intensive, cleaner sources of energy, thereby lessening the demand for coal. While this may be true in terms of coal imports received in Europe, coal remained a major source of energy in many developing countries and a key export commodity for countries such as Australia, Colombia and Indonesia. For countries in South-East Asia, notably Indonesia, the Republic of Korea and Viet Nam, coal remained a key cargo import.

China remained the leading source of global import demand for iron ore, (see chapter 1). With regard to exports, Australia and Brazil remained the main players. Table 4.8 features some major dry bulk terminals and highlights the central role of countries such as Australia, China, Indonesia, the Russian Federation and the United States, as well as Northern European countries as main loading and unloading areas for major dry bulk commodities.

Dry bulk throughput at major world ports showed divergent growth. Throughput at Qinhuangdao, reflecting China's importance as the main market for iron ore, grew by 46 per cent between 2016 and 2017. Dry bulk throughput at major ports in Australia, notably at Port Hedland – the country's largest export facility and the world's largest iron ore loading terminal (Business Insider Australia, 2017) – continued to increase with an annual growth rate of 5.5 per cent. Three major global mining companies (Broken Hill Proprietary Billiton, Hancock Prospecting and Fortescue Metals Group) are using the port. Rio Tinto, however, is using another port (Port Dampier) (Market Realist, 2018). In Singapore, growth in volumes remained stable. While overall cargo volumes handled have grown steadily over the past few years, the port is said to be increasingly focused on trade in liquefied natural gas (Fairplay, 2017a). Rotterdam, the biggest and busiest port in Europe, recorded a slight decrease in throughput, reflecting reduced demand for European coal imports.

2. Performance of selected global dry bulk terminals

Being able to monitor and assess the performance of bulk terminals, including dry bulk terminals, is important for planning, investment, safety, productivity and service quality. To this end, the Baltic and International Maritime Council (BIMCO) launched a vetting system of dry bulk terminals around the world in 2015 (BIMCO, 2017). Relying upon reports by shipowners about their ships' visits to dry bulk terminals at the global level, the vetting scheme is considered useful in gathering information about terminal performance and highlighting areas that require further monitoring and improvement. Data collected between 2015 and 2017 focused on parameters such as mooring and berth arrangements, terminal services, equipment, information exchanges

Table 4.8 Main dry bulk terminals: Estimated country market share in world exports by commodity, 2017
(Percentage)

Iron ore	Percentage	Coal	Percentage	Grain	Percentage
Australia	**56,2**	**Australia**	**30,3**	**United States**	**27,7**
Cape Lambert		Abbott Point		Corpus Christi	
Dampier		Dalrymple Bay		Galveston	
Port Hedland		Gladstone		Hampton Roads	
Port Latta		Hay Point		Houston	
Port Walcott		Newcastle		New Orleans	
Yampi Sound		Port Kembla		Norfolk	
				Portland	
Brazil	**25,8**	**Indonesia**	**30,4**		
Ponta da Madeira		Balikpapan		**European Union**	**9,8**
Ponta do Ubu		Banjamarsin		Immingham	
Sepetiba		Kota Baru		Le Havre	
Tubarao		Pulau Laut		Muuga	
		Tanjung Bara		Rouen	
South Africa	**4,4**	Tarahan		Klaipeda	
Saldanha Bay				Riga	
Canada	**2,8**	**Russian Federation**	**11,4**	**Argentina**	**10,9**
Port Cartier		Vostochny		Bahia Blanca	
Seven Islands		Murmansk		Buenos Aires	
				La Plata	
Ukraine	**0,7**	**Colombia**	**7,1**	Necochea	
Yuzhny		Cartagena		Parana	
Illichevsk		Puerto Bolivar		Rosario	
		Puerto Prodeco			
Sweden	**1,5**	Santa Marta		**Australia**	**9,1**
Lulea				Brisbane	
Oxelsund		**South Africa**	**6,8**	Geraldton	
		Durban		Melbourne	
Chile	**1,0**	Richards Bay		Port Giles	
Caldera				Port Lincoln	
Calderilla		**United States**[a]	**6,9**	Sydney	
Chanaral		Baltimore		Wallaroo	
		Corpus Christi			
Iran (Islamic Republic of)	**1,3**	Long Beach		**Canada**	**7,0**
Bandar Abbas		Los Angeles		Halifax	
		Mississippi River System terminals		Baie Comeau	
Mauritania	**0,8**	Mobile		Prince Rupert	
Nouadhibou		Newport News		Vancouver	
		Norfolk			
Peru	**1,0**	Seward		**Russian Federation**	**10,2**
San Nicolas		Stockton		Novorossiysk	
				Rostov	
		Canada[b]	**2,3**		
		Canso Anchorage			
India	**2,0**	Neptune Terminal		**Ukraine**	**12,6**
Mormogao		Prince Rupert		Odessa	
Calcutta		Roberts Bank		Nikolaev	
Paradip				Ilychevsk	
New Mangalore		**China**	**0,3**		
Chenai		Dalian			
Kakinada		Qingdao			
		Qinhuangdao			
		Rizhao			
		Mozambique	**0,4**		
		Maputo			
		Beira			

Source: UNCTAD secretariat calculations, based on data from Clarksons Research, 2018.

[a] *Excluding* exports to Canada.

[b] *Excluding* exports to the United States.

between ships and terminals, and loading and unloading cargo handling. By 1 December 2017, 27 ports had more than five entries or reports. None of the ports had ratings below average. Scores were based on a weighting system where loading and unloading had the highest value, followed by mooring and berth arrangements, and information exchanges.

The three leading dry bulk terminals according to the BIMCO vetting scheme were Santander and Bilbao, Spain and Quebec, Canada. Santander ranked first in terms of terminal handling of loading and unloading operations, terminal mooring and berthing arrangements, and information exchanges between ships and terminals, and terminal equipment. According to the 2017 vetting report, over 93 per cent of ports in the analysis received an average score or better in terms of communications between ships and terminals, loading and unloading activity, and standards and maintenance of equipment. Areas requiring further improvement relate to challenges arising from the need for language skills, permanent pressure on ship crews and masters, unexpected claims, and unnecessary bureaucratic and aggressive port authorities (BIMCO, 2017). In addition, ports rated poorly when the cost of terminal services was either too high or the service was non-existent. While the vetting report is useful, there are limitations to the system. Additional data and reports would be required to improve the statistical validity and reliability of results obtained.

D. DIGITALIZATION IN PORTS

A factor that is evolving at an accelerated pace with potentially profound implications for port operations and management is digitalization. There is no widely accepted definition of the digital economy. The latest developments in digitalization are emerging from a combination of technologies that are becoming more pervasive across mechanical systems, communications and infrastructure (UNCTAD, 2017b). Key technologies supporting digitalization in maritime transport include innovations such as the Internet of things, robotics, automation, artificial intelligence, unmanned vehicles and equipment, and blockchain (see chapters 1, 2 and 5).

The application of such innovations in ports permeates all aspects of a port business, including operations, planning, design infrastructure development and maintenance. They bring new opportunities for ports by unlocking more value that extends beyond traditional cargo-handling activities. Relevant technologies can help optimize traffic; increase operational efficiency, process transparency and speed; automate processes; and reduce inefficiencies and errors. Concrete examples of ways in which the impact of innovative technologies will likely be felt in ports include changes to loading and unloading operations (machine-to-machine communication, platform solutions, robotics, intelligent asset development and mobile workforces), storage (big data analytics, smart metering and single views of stock) and industrial processing (smart grids, smart energy management, three-dimensional printing, safety analytics and predictive maintenance).

The maritime transport industry is increasingly playing catch-up when it comes to enhancing the use of innovative technologies to improve systems and processes. One industry survey reveals that according to 15 per cent of respondents, autonomous terminal equipment was already being used (Vonck, 2017). According to 9 per cent of the respondents, autonomous drones for port services are being used, while 43 per cent consider this a short-term trend. Respondents generally agreed that irrespective of the speed at which digitalization unfolds, there is a growing need to upgrade skills and enhance expertise, efficiency and knowledge.

A review of ports around the world indicates that the sector has embraced technology to a certain extent, with operations of many ports having changed dramatically over the past few decades. For example, scanning technologies are increasingly being used for security and trade facilitation, while automation is being introduced in various container terminals. A focus on container port terminals around the world provides a good overview of the actual state of play. Container terminal automation – the use of robotized and remotely controlled handling systems along with the transition from manual to automated processes – is still at relatively early stages of utilization, as 97 per cent of world container port terminals are not automated. The share of container terminals that are fully automated is estimated at 1 per cent, while semi-automated terminals account for 2 per cent thereof (Drewry Maritime Research, 2018b). Table 4.9 provides an overview of the main terminals where full or partial automation is being implemented or planned. Fully automated terminals are those where the yard stacking and the horizontal transfer between the quay and the yard is automated, while semi-automated terminals are those where only the yard stacking is automated.

Container terminals are increasingly using higher levels of automation to improve productivity and efficiency and secure a competitive advantage. An industry survey reveals that nearly 75 per cent of terminal operators consider automation critical in order to remain competitive in the next three to five years, while 65 per cent view automation as an operational safety lever (Hellenic Shipping News, 2018). Over 60 per cent of respondent terminal operators expect automation to help improve operational control and consistency, while 58 per cent expect it to cut overall terminal operational costs. Respondents were positive about the potential return on investment overall. About one third of respondents see in automation a way to increase productivity by up to 50 per cent, while about one fifth believe that automation could reduce operational costs by more than 50 per cent.

Table 4.9 Overview of automation trends in ports, 2017

Port	Terminal	Operational level of automation [a]
Brisbane, Australia	Container terminals, Fisherman Island Container Terminal	Semi
	Fisherman Island berths 8–10	Fully
Melbourne, Australia	Victoria International Container Terminal	Fully
Sydney, Australia	Sydney International Container Terminals	Semi
	Brotherson Dock North	Fully
Antwerp, Belgium	Gateway	Semi
Qingdao, China	New Qianwan	Fully
Shanghai, China	Yangshan, phase 4	Fully (trial vessels handled end-2017)
Tianjin, China	Dong Jiang	Not confirmed; in development
Xiamen, China	Ocean Gate Container Terminal [b]	Fully (phase 1 operational; phases 2 and 3 in development)
Hamburg, Germany	Altenwerder Container Terminal	Fully
	Burchardkai	Semi
Vizhinjam, India	Adani	Not confirmed; in development
Surabaya, Indonesia	Lamong Bay and Petikemas	Semi
Dublin, Ireland	Ferryport Terminals	Semi; planned
Vado Ligure, Italy	APM Terminals	Semi; due to be operational 2018
Nagoya, Japan	Tobishima Pier South Side Container Terminal	Fully
Tokyo, Japan	Oi Terminal 5	Semi
Lázaro Cárdenas, Mexico	Terminal 2	Semi
Tuxpan, Mexico	Port Terminal	Semi
Tanger Med, Morocco	Tanger Med 2	Not confirmed; due to open 2019
Rotterdam, Netherlands	"Delta Dedicated East and West Terminals, Euromax, World Gateway and APM Terminals"	Fully
Auckland, New Zealand	Fergusson Container Terminal	Semi; due to be completed 2019
Colón, Panama	Manzanillo International Terminal	Semi
Singapore	Pasir Panjang Terminals 1, 2, 3 and 4	Semi
	Tuas	Not confirmed; planned
Busan, Republic of Korea	"Pusan Newport International and container terminal, Newport Company, Hanjin Newport Company and Hyundai Pusan Newport"	Semi
Incheon, Republic of Korea	Hanjin Incheon Container Terminal	Semi
Algeciras, Spain	Total Terminal Internacional	Semi
Barcelona, Spain	Europe South	Semi
Dubai, United Arab Emirates	Jebel Ali Terminals 3 and 4	Semi (terminal 3 operational; terminal 4 due to be operational 2018)
Abu Dhabi, United Arab Emirates	Khalifa Container Terminal	Semi
Liverpool, United Kingdom	Liverpool 2 Container Terminal	Semi
London, United Kingdom	Dubai Ports London Gateway Container Terminal and Thamesport	Semi
Long Beach, United States	Container Terminal	Fully (Middle Harbour Redevelopment Project in development)
Los Angeles, United States	TraPac	Fully
New York, United States	Global Container Terminals	Semi
Norfolk, United States	Virginia International Gateway	Semi
	International Terminals	Semi; in development
Kaohsiung, Taiwan Province of China	Terminals 4 and 5 and Kao Ming Container Terminal	Semi
Taipei, Taiwan Province of China	Container Terminal	Semi

Source: Drewry Maritime Research, 2018b.

[a] *Those* not yet fully operational are indicated.

[b] Also known as Yuanhai Automated Container Terminal. Double trolley quay cranes will have significant automation.

However, the advantages of automation in ports should be considered within context. In some cases, there can be a delay in reaching expected productivity levels due to many different innovations coming together without sufficient integration, and a lack of overall controllability. While technology is a key enabler, it is not the only parameter influencing terminal productivity (Linked in, 2018).

Reported challenges to wider implementation of port automation solutions include costs, shortage of skills or resources to implement and manage automation, concerns of labour unions and time required for implementation. With respect to labour, one study focusing on the maritime cluster in the Netherlands finds that the number of jobs in the maritime cluster will decrease by at least 25 per cent with the advent of automation. Jobs in the port sector are projected to drop by 8.2 per cent. By comparison, the number of jobs in shipping is expected to fall by 1.8 per cent. The analysis concludes that the largest subsectors at risk are ports, maritime suppliers and inland navigation (Vonck, 2017).

In sum, a broad range of technologies with applications in ports and terminals offers an opportunity for port stakeholders to innovate and generate additional value in the form of greater efficiency, enhanced productivity, greater safety and heightened environmental protection. For ports to effectively reap the benefits of digitalization, various concerns will need to be monitored and addressed. These include the potential regionalization of production and trade patterns associated with robotics and three-dimensional printing, potential labour market disruptions, regulatory changes and the need for common standards, in particular when applying blockchain technology and data analytics. To do so, it is essential to improve understanding of issues at stake, and strengthen partnerships and collaboration mechanisms among all stakeholders – ports, terminal operators, shipping and cargo interests, makers of technology, Governments and investors.

E. OUTLOOK AND POLICY CONSIDERATIONS

In line with projected growth in the world economy, international merchandise trade and seaborne shipments (see chapter 1), prospects for global port-handling activity remain positive overall. The outlook on the supply side is also favourable, as the global port infrastructure market is expected to record the highest gains from 2017 to 2025, primarily owing to increased trade volumes and infrastructural development in emerging developing Asian countries (Coherent Market Insights, 2018).

Energy and container port construction are expected to attract large demand through the forecast period. Western Asia is projected to remain a key investment area, with construction projects such as the Fujairah Oil Terminal, the port and industrial zone of Khalifa (Abu Dhabi), Boubyan Island (Kuwait) and Sohar Industrial Port (Oman), being lined up by the Gulf Cooperation Council. Large-scale projects for fuel handling are also planned in Saldanha Bay (South Africa) and Mombasa (Kenya), as demand for fuels is set to rise with the projected growth of quickly emerging Asian developing countries (Coherent Market Insights, 2018). Port development and refurbishment projects under the Belt and Road Initiative, for example in Pakistan (Gwadar), Djibouti, Myanmar (Kyaukpyu), Greece (Piraeus), and Sri Lanka (Hambantota and Colombo) are contributing to the upgrading and upscaling of port infrastructure in Africa, Asia and Europe. Chinese investment in container ports is expected to grow as port operators in China continue to expand internationally, ultimately surpassing the growth of traditional global operators (Drewry Maritime Research, 2017b).

While overall prospects for global port activity remain positive, preliminary figures are pointing to decelerated growth in port volumes in 2018. This is a reflection of the waning impetus for growth from, in particular, cyclical recovery and supply chain restocking in 2017. Furthermore, downside risks weighing on global shipping, including trade policy risks, geopolitical factors and structural shifts in economies such as China, tend to detract from a favourable outlook. An immediate concern are the trade tensions between China and the United States, the world's two largest economies, and the emergence of inward-looking policies and protectionism (see chapter 1).

Today's overall port-operating landscape is characterized by heightened port competition, especially in containerized trade, where decisions by shipping alliances on capacity deployed and the structure of ports and networks can determine the fate of a container port terminal. Additional investment is required to accommodate larger vessels and larger volumes handled at peak port calls and will likely weigh on port operators' margins (Fairplay, 2017b). However, the cost of new investments could be partially mitigated by exploring tailored pricing to align port and terminal interests with carriers and incentivize shipping lines to work more productively (Port Technology, 2017). Productive and workable cooperative arrangements between port authorities, terminal operators, shipping lines and the trade community will be essential.

When studying the impact of continued market concentration in liner shipping and potential competition concerns, competition authorities and maritime transport regulators should also analyze the impact of market concentration and alliance deployment on the relationship between ports and carriers. Areas of focus include the impact on selection of ports of call, the configuration of liner shipping networks, the distribution of costs and benefits between container shipping and ports, and approaches to container terminal concessions in view of the fact that shipping lines often have stakes in terminal operations.

More than ever, ports and terminals around the world need to re-evaluate their role in global supply and logistics chains and prepare to deal with the changes brought about by the accelerated growth of technological advances with potentially profound impacts (Brümmerstedt et al., 2017). It is important for ports and terminals to seek effective ways to embrace the new technologies to remain competitive and avoid the risk of marginalization in today's highly competitive port industry (Port Equipment Manufacturers Association, 2018).

Enhancing port and terminal performance in all market segments is increasingly recognized as critical for port planning, investment and strategic positioning, as well as for meeting globally established sustainability benchmarks and objectives such as the Sustainable Development Goals. In this context, the port industry and other port stakeholders should work together to identify and enable key levers for improving port productivity, profitability and operational efficiencies. Governments should ensure that policy and regulatory frameworks are supportive and flexible.

Systems that monitor and measure relevant operational, financial and environmental metrics in ports are strategic-planning and decision-making tools that require further support and development. Greater data availability and range enabled by technological advances can be tapped to track, measure and report performance, as well as derive useful insights for port managers, operators, regulators, investors and users. Work carried out under the UNCTAD Port Management Programme on the port performance scorecard could be further developed and its geographical scope expanded.

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