4

PORTS

Developing economies' share of world container port throughput increased marginally to approximately 71.9 per cent. This continues the trend of a gradual rise in developing countries' share of world container throughput. The increased share of world container throughput for developing countries reflects an increase in South–South trade.

The performance of ports and terminals is important because it affects a country's trade competitiveness. There are many determinants to port/terminal performance – labour relations, number and type of cargo handling equipment, quality of backhaul area, port access channel, land-side access and customs efficiency, as well as potential concessions to international terminal operators. The world's largest terminal operator handled 65.4 million 20-foot equivalent units (TEUs) in 2014, an increase of 5.5 per cent over the previous year. Of this figure, 33.6 million TEUs related to its operations at the port of Singapore and 31.9 million TEUs from its international portfolio. Hutchison Port Holdings trust is the second largest international terminal operator by market share. With operations in China and Hong Kong, China, it is not as geographically diverse as some other international terminal operators. APM Terminals has a geographical presence in 39 countries. DP World is the most geographically diverse of the global terminal operators, with a network of more than 65 terminals spanning six continents.

The economic, environmental and social challenges facing ports include growing and concentrated traffic volumes brought about by ever-increasing ship size; the cost of adaptation of port and port hinterland infrastructure measures; a changing marketplace as a result of increased alliances between shipping lines; national budget constraints limiting the possibilities of public funding for transport infrastructure; volatility in energy prices, the new energy landscape and the transition to alternative fuels; the entry into force of stricter sulphur limits (in, for example, International Maritime Organization (IMO) emission control area (ECA) countries); increasing societal and environmental pressure; and potential changes in shipping routes from new or enlarged international passage ways.

A. PORTS AND PORT-RELATED DEVELOPMENTS

Globally, there are a number of major developments under way that will have a direct impact on shipping and ports. For instance, construction of a second Suez Canal alongside the existing Suez Canal began in 2014 and continued into 2015. Traffic through the canal is expected to increase from an average of 49 ships per day to 97. Both transit times and waiting times will be reduced. For example, transit times will be shortened from 11 to 18 hours for the southbound convoy and the waiting time for vessels reduced from the present 8–11 hours to 3 hours. The New Suez Canal project is part of a major fiscal stimulus package meant to regain pre-2011 economic growth rates of around 7 per cent per year.

The development programme includes the creation of an industrial hub in adjacent areas, the development of five new seaports, a technology valley, and a centre for supplies and logistics. The project will cost an estimated $8.4 billion and is expected to more than double the canal's current annual revenue of $5 billion to $13 billion by 2023. Financing for the project was opened to Egyptian nationals, with a rate of return guaranteed at 12 per cent. The impact of the expansion of the Suez Canal on ports in the region is also likely to include an increase in the number of ships calling at the ports.

In contrast, the Panama Canal expansion project (see previous editions of the *Review of Maritime Transport*) is likely to be a game changer for regional ports as its expansion will allow for bigger vessels to transit. Bigger vessels mean more cargo, which means more revenue, but also increased adaption costs. Elsewhere, construction on the Nicaragua Canal has reportedly been delayed. An estimated $50 billion is needed to complete the construction (Gracie, 2015). A proposal to develop a canal through the isthmus of Thailand (Kra Canal) is also currently seeing another revival, having first been postulated 350 years ago. However, the proposal has not been officially confirmed (*Channel News Asia*, 2015). The cost of building the canal is estimated at $28 billion and, while it is technically feasible, the economic benefits have always remained uncertain as the time saving – an estimated three days (depending on speed) – is not as significant as 10 days for the Panama Canal and 20 days for the Suez Canal. In an era of economic uncertainty, vessel oversupply and the industry's response to slow-steam vessels, time saving is not the priority it once was. The cost to the environment and possible social tensions that may arise with any physical splitting of a country provide many reasons for careful analysis beyond mere economics.

1. Container ports

Container port throughput is measured by the number of TEUs that are handled. One FEU represents two TEU moves and the repositioning of containers to reach those stacked underneath/on top of others can also constitute a move. In chapter 1 it was observed that the number of full containers transported globally by sea in 2014 was estimated at 182 million, and yet the estimated port throughput is more than two and a half times that number, signifying that a lot of repositioning of empty containers occurs. The volumes reported in this chapter mainly relate to containerized cargo, which in turn represents more than half the value of all international seaborne trade and around one sixth of its volume. Container ports are multiple-user ports, that is, no one cargo owner has a monopoly of trade. Shipping lines may have dedicated terminals at which only they can call, but the cargo still has multiple owners. Other ports/terminals, for example for dry bulk and liquids, tend to be owned/operated by a single company that also owns the cargo. This is particularly so with commodity trade, where a large conglomerate may own an extraction mine, the railway, a processing plant and port facilities. The consequence of this is that operational data on bulk ports tend to be confidential and more difficult to ascertain. In addition, information on the volume and origin/destination of a particular commodity can affect its price in global markets as traders anticipate supply/demand levels, and thus industry practice tends to be selective in the information it releases to the public domain. Hence, this chapter mainly deals with container trade.

Chinese ports operate the largest number of berths (31,705) and handle more cargo both in terms of metric ton volume and number of TEUs than any other country. China's combined navigable rivers, at 126,300 kilometres, are also the longest of any single country. Understanding events in Chinese ports is thus a good indication of the global port industry. In 2014, Chinese river and sea ports handled 12.45 billion tons of cargo, an increase of 5.8 per cent over the previous year. Similarly, containerized cargo grew to 202 million TEUs, an increase of 6.4 per cent. China's major ports handled 2.7 billion tons of cargo, a modest increase of 2.2 per cent over the previous year. This slowdown in bulk imports is mostly driven by a weaker demand for major commodities, such as coal and iron ore (Yu, 2015).

Table 4.1. Container port throughput for 80 developing countries/territories and economies in transition, 2012–2014 (TEUs)

Country/territory	2012	2013	Preliminary figures for 2014	Percentage change 2013–2012	Percentage change 2014–2013
China	161 318 524	170 858 775	181 635 245	5.91	6.31
Singapore	32 498 652	33 516 343	34 832 376	3.13	3.93
Republic of Korea	21 609 746	22 588 400	23 796 846	4.53	5.35
Malaysia	20 873 479	21 168 981	22 718 784	1.42	7.32
Hong Kong (China)	23 117 000	22 352 000	22 300 000	-3.31	-0.23
United Arab Emirates	18 120 915	19 336 427	20 900 567	6.71	8.09
Taiwan Province of China	14 976 356	15 353 404	16 430 542	2.52	7.02
Indonesia	9 638 607	11 273 450	11 900 763	16.96	5.56
India	10 279 265	10 883 343	11 655 635	*5.88*	7.10
Brazil	9 322 769	10 176 613	10 678 564	9.16	4.93
Viet Nam	7 509 119	9 036 095	9 424 699	20.33	4.30
Egypt	8 140 950	8 248 115	8 810 990	1.32	6.82
Thailand	7 468 900	7 702 476	8 283 756	3.13	*7.55*
Panama	7 217 794	7 447 695	7 942 291	3.19	6.64
Turkey	6 736 347	7 284 207	7 622 559	8.13	4.65
Saudi Arabia	6 563 844	6 742 697	6 326 861	2.72	-6.17
Philippines	5 686 179	5 860 226	5 869 427	3.06	0.16
Mexico	4 799 368	4 900 268	5 273 945	2.10	7.63
Islamic Republic of Iran	5 111 318	4 924 638	5 163 843	-3.65	4.86
Sri Lanka	4 321 000	4 306 200	4 907 900	-0.34	13.97
South Africa	4 360 100	4 694 500	4 831 462	7.67	2.92
Russian Federation	3 930 515	3 968 186	3 903 250	0.96	-1.64
Chile	3 596 917	3 722 980	3 742 520	3.50	0.52
Oman	4 167 044	3 930 261	3 620 364	*-5.68*	*-7.88*
Colombia	2 991 941	2 746 038	3 127 994	-8.22	13.91
Morocco	1 826 100	2 558 400	3 070 000	40.10	*20.00*
Pakistan	2 375 158	2 485 086	2 597 395	4.63	*4.52*
Peru	2 031 134	2 086 335	2 234 582	*2.72*	*7.11*
Costa Rica	1 329 679	1 880 513	1 960 267	41.43	*4.24*
Dominican Republic	1 583 047	1 708 108	1 795 221	7.90	*5.10*
Ecuador	1 594 711	1 675 446	1 786 981	5.06	6.66
Argentina	1 986 480	2 141 388	1 775 574	7.80	*-17.08*
Bangladesh	1 435 599	1 500 161	1 655 365	4.50	10.35
Jamaica	1 855 400	1 703 900	1 638 100	*-8.17*	*-3.86*
Bolivarian Republic of Venezuela	1 249 500	1 348 211	1 416 970	*7.90*	*5.10*
Bahamas	1 202 000	1 400 000	1 399 300	16.47	-0.05
Kuwait	1 126 668	1 215 675	1 277 674	7.90	*5.10*
Guatemala	1 158 400	1 211 600	1 273 392	*4.59*	*5.10*
Lebanon	882 922	1 117 300	1 210 400	26.55	8.33
Nigeria	877 679	1 010 836	1 062 389	15.17	5.10
Kenya	903 400	894 000	1 010 000	-1.04	12.98
Angola	750 000	913 000	1 000 000	21.73	9.53
Uruguay	753 000	861 000	904 911	*14.34*	*5.10*
Yemen	760 192	820 247	862 079	*7.90*	*5.10*
Ukraine	748 889	808 051	849 262	*7.90*	*5.10*
Syrian Arab Republic	737 448	795 707	836 288	*7.90*	*5.10*

Table 4.1. Container port throughput for 80 developing countries/territories and economies in transition, 2012–2014 (TEUs) *(continued)*

Country/territory	2012	2013	Preliminary figures for 2014	Percentage change 2013–2012	Percentage change 2014–2013
Ghana	735 229	793 312	833 771	*7.90*	*5.10*
Jordan	703 354	758 919	797 624	*7.90*	*5.10*
Côte d'Ivoire	690 548	745 102	783 102	*7.90*	*5.10*
Djibouti	681 765	735 624	773 141	*7.90*	*5.10*
Trinidad and Tobago	651 332	702 787	738 630	7.90	5.10
Honduras	665 354	670 726	704 934	*0.81*	*5.10*
Mauritius	576 383	621 917	653 635	7.90	*5.10*
United Republic of Tanzania	487 786	526 321	638 023	*7.90*	*21.22*
Tunisia	529 956	571 823	600 986	*7.90*	*5.10*
Sudan	498 938	538 354	565 811	*7.90*	*5.10*
Libya	369 739	434 608	456 773	17.54	5.10
Senegal	396 822	428 171	450 008	*7.90*	*5.10*
Qatar	393 151	424 210	445 845	*7.90*	*5.10*
Congo	385 102	415 525	436 717	*7.90*	*5.10*
Benin	359 908	388 341	408 146	*7.90*	*5.10*
Papua New Guinea	337 118	363 750	382 301	*7.90*	*5.10*
Bahrain	329 470	355 498	373 628	*7.90*	*5.10*
Cameroon	323 917	349 507	367 332	*7.90*	*5.10*
Algeria	317 913	343 028	360 522	*7.90*	*5.10*
Mozambique	289 411	312 274	328 200	*7.90*	*5.10*
Cuba	265 281	286 238	300 836	*7.90*	*5.10*
Georgia	256 929	277 226	291 365	*7.90*	*5.10*
Cambodia	254 760	274 886	288 905	*7.90*	*5.10*
Myanmar	215 945	233 005	244 888	*7.90*	*5.10*
Guam	208 181	224 628	236 084	*7.90*	*5.10*
Gabon	174 597	188 390	197 998	7.90	5.10
El Salvador	161 000	180 600	189 811	*12.17*	*5.10*
Madagascar	160 320	172 986	181 808	*7.90*	*5.10*
Croatia	155 724	168 026	176 596	*7.90*	*5.10*
Aruba	147 716	159 385	167 514	*7.90*	*5.10*
Namibia	115 676	124 815	131 180	*7.90*	*5.10*
Brunei Darussalam	112 894	121 813	128 026	*7.90*	*5.10*
New Caledonia	102 423	110 514	116 150	*7.90*	*5.10*
Nicaragua	93 737	96 472	101 392	*2.92*	*5.10*
Subtotal	**443 672 437**	**466 256 062**	**491 169 015**	**5.09**	**5.34**
Other reported	**689 351**	**739 276**	**761 420**	**7.24**	**3.00**
Total reported	**444 361 788**	**466 995 338**	**491 930 435**	**5.09**	**5.34**
World Total	**624 480 174**	**651 200 742**	**684 429 339**	**4.28**	**5.10**

Source: UNCTAD secretariat, derived from various sources including Dynamar B.V. publications and information obtained by the UNCTAD secretariat directly from terminal and port authorities.

Notes: Singapore includes the port of Jurong. The term "other reported" refers to countries/economies with fewer than 100,000 TEUs per year. Many figures for 2013 and 2014 are UNCTAD estimates (these figures are indicated in italics). Country totals may conceal the fact that minor ports may not be included; therefore, in some cases, the actual figures may be different than those given.

In the first quarter of 2015, Chinese ports handled 49 million TEUs, an increase of 7.3 per cent over the same period in the previous year. This was largely due to a recovery in the United States economy. The figures would suggest that the major Chinese exporting ports experienced a significant growth while the growth of importing ports (for example, in bulk cargo) has slowed. This could mean that factories are reducing their stockpiles in anticipation of a slow growth in the world economy.

Table 4.1 lists the container throughput of 80 developing countries and economies in transition with a national throughput greater than 100,000 TEUs (port throughput figures for 126 countries/territories are available at http://stats.unctad.org/TEU). In 2014, the container throughput for developing economies grew by an estimated 5.34 per cent to 491 million TEUs. This growth is higher than the 5.1 per cent seen in the previous year. The container throughput growth rate for all countries in 2014 is estimated at 684.4 million TEUs, a rise of 5.1 per cent over the previous year.

Developing economies' share of world throughput increased by 0.2 per cent to approximately 71.9 per cent. This continues the trend of a gradual rise in developing countries' share of world container throughput. The two main drivers of this process are developing countries' greater participation in global value chains and the continued increase of containers for transporting dry bulk cargo.

Table 4.2 shows the world's 20 leading container ports for the period 2012–2014. The top 20 container ports accounted for approximately 45.7 per cent of world container port throughput in 2014. These ports showed a 4.5 per cent increase in throughput compared to 2013, the same as the estimated increase for 2013. The list includes 16 ports from developing economies, all of which are in Asia; the remaining four ports are from developed countries, three of which are located in Europe and one in North America. All of the top 10 ports continue to be located in Asia, signifying the importance of the region as a manufacturing hub. Ningbo remained in fifth position but achieved the highest growth at 12 per cent, a growth rate closely followed by Dubai and Tanjung Pelepas. The port of Tanjung Pelepas moved up two places to eighteenth position following completion of infrastructure investments. The port of Long Beach was displaced from the top 20 list due to low growth as a result of labour disputes at the port and the higher

Table 4.2. Top 20 container terminals and their throughput, 2012–2014 (TEUs and percentage change)

Port Name	2012	2013	2014	Percentage change 2013–2012	Percentage change 2014–2013
Shanghai	32 529 000	36 617 000	35 290 000	12.57	-3.62
Singapore	31 649 400	32 600 000	33 869 000	3.00	3.89
Shenzhen	22 940 130	23 279 000	24 040 000	1.48	3.27
Hong Kong	23 117 000	22 352 000	22 200 000	-3.31	-0.68
Ningbo	15 670 000	17 351 000	19 450 000	10.73	12.10
Busan	17 046 177	17 686 000	18 678 000	3.75	5.61
Guangzhou	14 743 600	15 309 000	16 610 000	3.83	8.50
Qingdao	14 503 000	15 520 000	16 580 000	7.01	6.83
Dubai	13 270 000	13 641 000	15 200 000	2.80	11.43
Tianjin	12 300 000	13 000 000	14 060 000	5.69	8.15
Rotterdam	11 865 916	11 621 000	12 298 000	-2.06	5.83
Port Klang	10 001 495	10 350 000	10 946 000	3.48	5.76
Kaohsiung	9 781 221	9 938 000	10 593 000	1.60	6.59
Dalian	8 064 000	10 015 000	10 130 000	24.19	1.15
Hamburg	8 863 896	9 258 000	9 729 000	4.45	5.09
Antwerp	8 635 169	8 578 000	8 978 000	-0.66	4.66
Xiamen	7 201 700	8 008 000	8 572 000	11.20	7.04
Tanjung Pelepas	7 700 000	7 628 000	8 500 000	-0.94	11.43
Los Angeles	8 077 714	7 869 000	8 340 000	-2.58	5.99
Jakarta	6 100 000	6 171 000	6 053 000	1.16	-1.91
Total top 20	**284 059 418**	**296 791 000**	**310 116 000**	**4.48**	**4.49**

Source: UNCTAD secretariat, based on Dynamar B.V., June 2015, and various other sources.
Note: Singapore does not include the port of Jurong.

rates of growth of other ports. Jakarta port was a new entrant to the list as a result of a continued steady increase in demand that has seen throughput at the port grow by more than 50 per cent since 2009 due to the buoyant economy (*Drewry*, 2015).

B. INTERNATIONAL TERMINAL OPERATORS

1. Operational performance

The performance of ports and terminals can significantly affect a country's trade competitiveness. One chief economist even cited port congestion as the new barrier to international trade (van Marle, 2015). There are many determinants to port/terminal performance – for example, labour relations, number and type of cargo handling equipment, quality of backhaul area, port access channel, land-side access, customs efficiency, and the like. These specific operational indicators are generally more useful to port operators and do not include non-tangible assessments (for example, users' perceptions, service quality, innovation levels, and the like) that port customers may find more beneficial (Cetin, 2015).

Terminal operators rarely publish their performance ratings, but are sometimes obliged to do so due to publicity, for example Malaysia's Westports "set a new world record for container terminal productivity, notching an impressive 793 moves in one hour over the CSCL [China Shipping Container Lines] Le Havre (9,572 TEU vessel) with the deployment of nine twin-lift cranes" (Westports, 2015). Ports and terminals rarely publish data on their performance that allow shippers to make informed choices or policymakers to identify best practices. While there may be many reasons for this, such as no statutory requirement or limited readership, the strongest reason is likely to be the unnecessary scrutiny it would generate without any immediate return. In an age where many companies' chief executive officers have limited time in their positions and short reporting periods the situation is unlikely to change. However, international pressure, for instance in the area of sustainability reporting, may help to change this situation. Until then it tends to be the customers who report on the performances of their service providers. For instance, Drewry Shipping Consultants has launched its Drewry Benchmarking Club. The club is limited to importers and exporters (that is, buyers of shipping services) and excludes providers of shipping services (carriers) and intermediaries/brokers (forwarders/non-vessel operating common carriers). While it aims to benchmark ports and routes, its primary focus seems to be on freight costs. The *JOC* recently produced its port productivity rankings, which examine loading/unloading data from 17 carriers at over 500 ports worldwide. From these two initiatives it is clear that it is the ports' customers (that is, shippers and carriers) who are sharing information for their mutual benefit about the ports' performance. Ports may be forced to publish their own data should they not agree with how their customers are assessing them. Table 4.3 shows the ranking of port terminals in 2014, with Yokohama ranking as the world's most efficient container port, having increased productivity by 10 per cent over the previous year. Unlike other terminals, APM Terminals Yokohama has been successful in improving its efficiency year after year due to the synchronized process developed between the vessel and the container yard that eliminates virtually all wasted time between the quay crane and yard equipment operations.

Table 4.3. Top global terminals' berth productivity, 2014 (container moves per ship, per hour on all vessel sizes)

Terminal	Port	Country	Berth productivity
APM Terminals Yokohama	Yokohama	Japan	180
Tianjin Port Pacific International	Tianjin	China	144
DP World-Jebel Ali Terminal	Jebel Ali	United Arab Emirates	138
Qingdao Qianwan	Qingdao	China	136
Tianjin Port Alliance International	Tianjin	China	132
Ningbo Beilun (second)	Ningbo	China	127
Guangzhou South China Oceangate	Nansha	China	122
Busan Newport Co. Ltd.	Busan	Republic of Korea	119
Yantian International	Yantian	China	117
Nansha Phase I	Nansha	China	117

Source: *JOC* Port Productivity Database 2015.

Table 4.4 shows the productivity ranking of ports in 2014 and the change over the preceding two years. Some ports are home to several terminal operators, thus providing intra-port competition. For example, the port of Tianjin, which is ranked in second place, is home to numerous international terminal operators,

such as APM Terminals, China Merchants Holdings International, COSCO Pacific, CSX World Terminals OCCL, PSA and DPW. Interestingly, while all the ports in this table experienced productivity gains of between 30 and 60 per cent in 2013 over the previous year, in 2014 only three ports managed to continue the upward improvement. This suggests that port performance and continued improvement are still difficult to achieve.

In a study involving 203 ports in 70 developing countries, with 1,750 data points, it was observed that operational changes rather than scale efficiency (the process of adding more equipment) resulted in increases in port efficiency. It should be noted that pure efficiency is the result of input divided by output. With regard to ports, inputs may be numerous and difficult to calculate (for example, utilized space, multiple currencies' operational hours and the like). Most port-related studies avoid this shortcoming by measuring productivity (output) over a certain period. Both efficiency and productivity tend to be referred to interchangeably to a large extent. From 2000 to 2010 there was an upward trend in increasing port efficiency within developing regions, from 47 per cent to 57 per cent. The main determinants were private sector participation, the reduction of corruption in the public sector and improvements in liner connectivity, as well as the increased provision of multimodal links that led to an increase in the level of port efficiency in developing regions (Suárez-Alemán et al., 2015). Port performance matters the most on a regional basis where there is a real possibility that cargo can move to a competing, more efficient port. A study of ports in West Africa showed that they exhibited high levels of efficiency and that four out of six ports had an average efficiency score of 76 per cent or higher for the period under study (van Dyck, 2015). Yet in another study by the *JOC* for all Africa, African ports were on average ranked as the least productive of all regional groups (*Data in Motion*, 2015). The poor performance of port management and operations, together with other procedural inefficiencies along the logistics chain, and imbalanced freight rates that shipping lines charge because of empty backhaul cargo, are all contributing factors to high transport costs (Bofinger et al., 2015). Every minute that a vessel stays at a terminal means money lost for the shipping company, and this in turn places pressure upon the terminal operator to ensure it does not lose business to more efficient competitors (ACS–AEC, 2015). Port privatization is often seen as the best means to bring in private sector expertise and turn around the performance of a port. Many countries privatized their ports in the 1990s, but there are still many State-owned and operated ports around the world. In Viet Nam, the Government plans to privatize an estimated 432 State-owned enterprises during the period 2014–2015, including 19 seaports (*Vietnam Briefing*, 2015).

When Governments review proposals for new port infrastructure projects it is difficult for them to judge whether the traffic volumes and marginal cost savings will match predictions. In a recent survey of around 500 terminals worldwide it was observed that the average TEU per metre of quay per year was 1,072, while the TEU per hectare was 24,791 and TEU per gantry crane 123,489 (Drewry, 2014b). Some of the worst performing ports per TEU, hectare and crane utilization were in North America. Varying levels of

Table 4.4. World's leading ports by productivity, 2014 (container moves per ship, per hour on all vessel sizes and percentage increase)

Port	*Country*	*2012 berth productivity*	*2013 berth productivity*	*2014 berth productivity*	*Percentage increase 2013/2012*	*Percentage increase 2014/2013*
Jebel Ali	United Arab Emirates	81	119	138	47%	16%
Tianjin	China	86	130	125	51%	-4%
Qingdao	China	96	126	125	31%	-1%
Nansha	China	73	104	119	42%	14%
Yantian	China	78	106	117	36%	10%
Khor al Fakkan	United Arab Emirates	74	119	108	61%	-9%
Ningbo	China	88	120	107	36%	-11%
Yokohama	Japan	85	108	105	27%	-3%
Busan	Republic of Korea	80	105	102	31%	-3%
Xiamen	China	76	106	90	39%	-15%

Source: UNCTAD secretariat and *JOC* Port Productivity Database 2015.

cargo volumes, trans-shipment share and automation of processes all contributed to the outcome. While the provision of more space or bigger cranes is not a guarantee for additional cargo, it is useful for policymakers to know when examining project proposals what they can expect from proposed new facilities. Interestingly, the study also shows that, on average, gantry crane productivity tends to be about 50 per cent of the maximum capacity advertised by the manufacturer. This could have a financial impact upon ports when planning future improvements.

According to one study, the largest liner shipping company, Maersk Line, makes around 31,000 port calls, with 1,500–1,800 moves per call, and spends some 19 per cent of its total costs on ship fuel. A 7 per cent reduction in port stay during a 13–18-hour call would allow the company to steam slower once a vessel leaves port and reduce fuel consumption by around $120 million per year (van Marle, 2015). The reduction in a ship's time in port primarily depends on the performance of the port in fulfilling its functions.

2. Financial performance

The traditional role of ports as gateways between foreign and domestic markets has meant that growth in throughput and revenue for a port is reliant upon external factors beyond the control of the port, such as the ability of the port's hinterland to either import or export more goods. For terminal operators, replicating home-grown efficiencies in foreign markets can be an ideal way for the businesses to expand when faced with domestic limitations beyond their control. Many terminal operators have expanded horizontally (for example, doing the same thing in a different place) or vertically (for example, by controlling different aspects of a supply chain). Presently there are numerous owners of terminal operators that control ports on a worldwide basis. Together, the leading global container terminals accounted for around 300 million TEUs in 2013, or around 47 per cent of the world's container port throughput (Drewry, 2014b).

The world's largest terminal operator, PSA International (formally the Port of Singapore Authority) handled 65.4 million TEUs in 2014, an increase of 5.5 per cent over the previous year. Of this figure, 33.6 million TEUs are accounted for by its operations in the port of Singapore (+4.2 per cent) and 31.9 million TEUs by its international portfolio (+7.2 per cent). Its international portfolio stretches across 16 countries and three continents. However, it does not operate terminals in Africa, Australia or North America. Revenue for the company grew slightly in 2014 to $3.8 billion, whereas profit slightly decreased to $1.4 billion (PSA, 2014). Among the major terminal operators, PSA International is the market leader in terms of not only market share of global port throughput, but also the ratio of revenue to profits.

Hutchison Port Holdings Trust is the second largest international terminal operator by market share. With operations in China, including Hong Kong (China), it is not as geographically diverse as some other international terminal operators. Its 2014 throughput of approximately 24.2 million TEUs was up 6.3 per cent over the previous year. Revenue increased 1.9 per cent to HK$12.6 billion ($1.63 billion) for 2014, while operating profit increased 5.5 per cent to HK$4.2 billion ($540 million).

APM Terminals has a geographical presence in 39 countries. This includes 65 port and terminal facilities and 200 inland services. In 2014, its revenue was the highest of all international terminal operators at $4.5 billion, an increase of 2.7 per cent, while internal efficiencies pushed operating profit to $900 million, an increase of 14.4 per cent from the previous year despite substantial losses in its Russian business. Of the leading global terminal operators, APM Terminals has seen the biggest impact of international sanctions placed on the Russian Federation. To illustrate this, volumes from Asia to Russian Black Sea ports dropped almost 50 per cent in the first four months of 2015, compared with the same period in 2014 (*Lloyd's List – Daily Briefing*, 2015). APM Terminals has a 30.75 per cent stake in Global Ports, the Russian Federation's leading operator, with seven maritime container terminals representing about half of the country's annual throughput. Financial shares in Global Ports dropped almost 80 per cent from $16 per share to just $3 in the year following the start of the crisis (Pasetti, 2015).

DP World is the most geographically diverse of the global terminal operators with a network of more than 65 terminals spanning six continents. Recent new projects include DP World London Gateway and Embraport (Brazil), which both became operational in 2013. Expansion to existing facilities occurred with the opening of terminal 3 at its home port of Jebel Ali in the United Arab Emirates and a new container terminal at Southampton in the United Kingdom. In 2014, it handled 60 million TEUs, an increase of 8.9 per cent over the previous year. In 2014, revenue increased by 10 per cent to $3.4 billion and profit by a similar growth rate to $675 million.

From the above brief overview of the leading container terminal operators it can be seen that the enterprise is profitable. The top four global terminal operators combined generated $3.5 billion in profit in 2014 on total revenues of $13.3 billion, an average return of 26 per cent. For policymakers this poses a challenge – profits earned by international terminal operators increase transport costs, which can affect national competitiveness. Yet by having an efficient port and being better connected to international markets, transport costs could be lower than otherwise possible. Ideally, having inter-port competition between multiple ports is best, or where this is not possible, intra-port competition with the presence of multiple terminal operations in one port, could help keep transport costs low. Some countries such as India and South Africa have set limits on the tariffs terminal operators are allowed to charge, although these have met with mixed results. Another issue to consider is that global terminal operators must be financially empowered to address the increasing costs associated with meeting sustainable development criteria.

C. SUSTAINABILITY CHALLENGES FACING PORTS

The economic, environmental and social challenges facing ports include: growing and concentrated traffic volumes brought about by ever-increasing ship size; the cost of adaptation of port and port hinterland infrastructure measures; a changing marketplace as a result of increased alliances between shipping lines; national budget constraints limiting the possibilities of public funding for transport infrastructure; volatility in energy prices, the new energy landscape and the transition to alternative fuels; entry into force of the stricter sulphur limits in, for example, IMO ECA countries; increasing societal and environmental pressure; potential changes in shipping routes from enlarged or new international passages (for example, the existing Suez and Panama Canals, and new proposals such as the Nicaragua and Kra Canals mentioned earlier); an uncertain geopolitical situation and its effect on shifting supply chains; further globalization of business and society; and barriers to internal markets (for example, customs inspection) for maritime transport.

1. Environmental challenges

The transportation industry's share of all the global energy consumed increased from 45 per cent in 1973 to 62 per cent in 2010 (Hui-huang, 2015). In terms of emissions, it is second only to the energy consumed to regulate indoor temperature. In 1992, UNFCCC considered how countries could limit industrial emissions and the anticipated planetary climate change. However, it was realized that emission reduction provisions in the Convention were inadequate and, as a result, new measures strengthening the global response to climate change were adopted under the 1997 Kyoto Protocol. The Kyoto Protocol, which entered into force on 16 February 2005, legally binds developed countries to emission reduction targets. There are now 195 Parties to the Convention and 192 Parties to the Protocol. Parties to the Protocol have continued the negotiations and have amended it to achieve more ambitious results. The Kyoto Protocol in effect "operationalizes" UNFCCC by committing industrialized countries to stabilize GHG emissions. It operates on the principle of "common but differentiated responsibility", where certain countries are obliged to make emission reductions in recognition of their contribution to the existing GHGs. Emissions from national maritime transport (for example, inland waterways, lakes and coastal shipping) and port emissions are included in the Kyoto Protocol. Emissions of CO_2 by shipping were estimated at 3.3 per cent of global emissions for 2007 (IMO, 2015). Greenhouse gas emissions produced from international maritime transport – for example, while sailing in international waters – are, however, not included in the Kyoto Protocol. International maritime transport emissions are estimated at 83 per cent of all shipping emissions (Villalba and Gemechu, 2011). The Kyoto Protocol recognizes that, concerning maritime issues, countries must work through IMO. However, IMO works on the principle of "no less favourable treatment of ships", which means ships must not be placed at a disadvantage because their country has or has not ratified a convention. Thus, in the field of environmental protection, ports face a complicated regulatory requirement as well as societal expectations (Lam and Notteboom, 2014). Such pressure can have an impact on the further space for the ports to grow, not only in terms of hectares, but also in terms of the "environmental space" concept.[1] This means that tackling maritime-related emissions is complicated and that valuable time may be spent interpreting text (Fitzgerald et al., 2011).

The ports with the greatest absolute emissions attributable to shipping are Singapore, Hong Kong (China), Tianjin (China) and Port Klang (Malaysia). The distribution of shipping emissions in ports is skewed:

the 10 ports with the greatest emissions represent 19 per cent of total CO_2 emissions in ports and 22 per cent of SOx emissions. The port with the lowest relative CO_2 emissions (emissions per ship call) is Kitakyushu (Japan); the port of Kyllini (Greece) has the lowest SOx emissions. Other ports with relatively low emissions are situated in Greece, Japan, Sweden, the United Kingdom and the United States (Merk, 2014).

Shipping emissions in ports are substantial, accounting for 18 million tons of CO_2, 0.4 million tons of NOx, 0.2 million of SOx and 0.03 million tons of "PM10" (particulate matter with diameter inferior to 10 micrometres) in 2011. Around 85 per cent of ships' emissions are attributable to two ship types, container ships and tankers. It is estimated that most shipping emissions in ports (CH_4, CO, CO_2 and NOx) will grow fourfold until 2050. Asia and Africa are expected to see the sharpest increases in emissions, due to strong port traffic growth and limited mitigation measures (Merk, 2014).

On 1 January 2015, IMO regulation 14 of annex VI of MARPOL on ship emissions came into force. The regulation is intended to improve air quality by limiting the sulphur content of fuels used by ships operating in ECAs, including ports, to 0.10 per cent. This will require existing vessels to switch to lower sulphur content fuel while in an ECA or retrofit vessels with scrubbers to clean the exhaust fumes before they enter the atmosphere. Scrubbing uses a fluid containing alkaline material that absorbs SOx and neutralizes them. The remaining exhaust gases are then released and the residue waste sludge is stored on board until it can be transferred ashore and safely disposed of. New vessels are, however, being built to ensure that they are fully compliant with MARPOL regulations. While the impact of the new regulation is not yet clear, some transport service providers believe that its immediate effect will be to increase transport costs and move short-haul cargo from sea to road. Outside the ECAs, the sulphur content of fuels is capped at 3.5 per cent but set to be reduced to 0.50 per cent from 1 January 2020 (or 2025, depending on the enforcement date and the result of an IMO review on the availability of low sulphur fuels). European ports have much lower emissions of SOx (5 per cent) and PM10 (7 per cent) than their share of port calls (22 per cent), which may be explained by the European Union regulation to use low sulphur fuels at berth (Merk, 2014).

During their stay in ports, ships emit pollutants such as CO_2, SO_2, NO_X (the sum of NO and NO_2 emissions) and, in smaller amounts, CO, PM, non-CH_4 volatile organic compounds, CH_4 and N_2O (Fitzgerald et al., 2011). Other pollutants include dust from bulk cargo handling, emissions related to electricity consumption, and gases from cargo handling equipment and trucks (Economic and Social Commission for Asia and the Pacific, 1992; and Villalba and Gemechu, 2011). Vibration, light pollution and wake damage also give rise to a variety of issues. Ports tend to be seen as sources of pollution because they are easily identifiable, immovable and close to the community most affected by the effects of the pollution. Health effects include bronchitic symptoms that have been linked to NO_2 and CO emissions, while exposure to SO_2 is associated with respiratory issues and premature births (Merk, 2014). Ports need employees from the local community and employees need their jobs, thus their relationship is much closer than it is to ship operators. This means that cooperation between ports and their local communities is mutually beneficial and easier to facilitate. The challenge for ports is that communities have, through the advent of the Internet, become more empowered with access to scientific information, more vocal and better organized. A port authority thus needs to ensure not only that it provides a safe working environment that protects workers' health and promotes their personal development but also provides social responsibility, ethical governance and accountability. The port authority must show it manages environmental risks well and furthers the economic and social development of the surrounding region, as well as promotes equality and respect for cultural diversity through the involvement of stakeholders in port development and operations (Doerr, 2011). For ports, the usual three pillars of sustainability (economic, environmental and social) must be entwined with an institutional dimension to cater for multiple stakeholders.

The 2012 United Nations Conference on Sustainable Development, known as Rio+20, acknowledged in its outcome document (known as "The Future We Want") the importance of corporate sustainability reporting and encouraged companies, especially large or publicly listed companies, to consider integrating sustainability information into their reporting cycles. To this end, UNCTAD was designated as one of the official implementing bodies for action on sustainability reporting, primarily through its role as the host of the Intergovernmental Working Group of Experts on International Standards of Accounting and Reporting. In 2014, UNCTAD published a report,

entitled *Best Practice Guidance for Policymakers and Stock Exchanges on Sustainability Reporting Initiatives*, recognizing the role stock exchanges have in influencing companies. This report cited as an example the fact that disclosure of "policy and performance in connection with environmental and social responsibility" was only mandatory in 56 per cent of 25 emerging markets, yet it was voluntarily reported by 91 per cent of 188 of the largest companies in those markets. Thus, mandatory rules are not necessarily the only course of action for policymakers – simply nudging businesses in a particular direction can be more effective.

Sustainability reporting for ports and terminals is still in its early stages. Key issues to address include the reduction of kilograms of CO_2 emitted per modified TEU ($kgCO_2e$/modTEU), the reduction in megajoules of energy used per total terminal moves, and the reduction in fresh water consumption for cleaning equipment. One terminal operator, DP World, reduced its fresh water consumption by 75 per cent (64 million litres) by installing water recycling plants. DP World's sustainability reporting also announced that the intensity of the company's CO_2 emissions had been reduced by 3 per cent over its 2013 figures to 15.8 $kgCO_2e$/modTEU. This represents a significant decrease from the 20.2 $kgCO_2e$/modTEU it reported for 2008. DP World's sustainability reporting has four main pillars: community, environment, marketplace, and people and safety. It has a dedicated sustainability advisory committee that sets development plans and policy and a sustainability champion team to identify best practices.

Other voluntary measures exist whereby a port may report upon its environmental impact. For instance, in Europe, the Port Environmental Review System, implemented by the European Sea Ports Organization, provides a series of commitments for a port authority to undertake, for example, the publication of a periodical report on the state of the environment, the monitoring of a series of environmental indicators, and the like. Another regional measure, which can be applied to ports, is the Hawkama Environment, Social and Governance Index for the Middle East and North Africa region. The Hawkama Index was developed in cooperation with Standard and Poor's reporting agency, with the support of the International Finance Corporation. The index provides an incentive to listed companies in these emerging markets to pursue sustainable business practices through improved environmental and socially responsible operations, as well as enhanced corporate governance systems.

Monitoring emissions and reporting on them with a view to reducing them over time requires the implementation of practical measures. The repositioning of empty container trucks within a port is a wasteful practice that can contribute to its overall emissions without transporting any goods. A proper computer-based monitoring, planning and coordination system to reduce unnecessary repositioning could have a significant impact on emissions without the need to spend money on purchasing new equipment or retrofitting exiting equipment with newer technology. Such a system will be most effective and likely to lead to the greatest emission savings if it operates on a concept of shared ownership of vehicles. Just as for private cars, individual ownership of transport modes tends to mean low occupancy and poor utilization rates. Any concept that includes sharing space on transport to and from a local dry port to a sea port could reduce the amount of emissions in and around the port.

Cold ironing, also known as "alternative maritime power" or "onshore power", is the process of providing electrical power to a ship while at berth. This means the ship's engines can be turned off, thereby reducing fuel emissions, vibrations and noise. Cold ironing displaces power generation from the vessel to a centralized power source, usually a power grid, which is generally more energy-efficient (GreenSync, 2015). Cold ironing does not eliminate emissions but transfers them to another location and may or may not be more polluting. The spread of ultra-low sulphur fuel and exhaust gas scrubbers have made significant air quality improvements around ports and coastal zones in recent years and has led some commenators to suggest that cold ironing may become obsolete (*The Maritime Executive*, 2015). However, cold ironing has the advantage that it can reduce noise and vibration emissions that cannot be eliminated by burning alternative fuels or by adopting exhaust capture solutions. In the European Union, directive 2014/94/EU obliges member States to implement alternative infrastructure networks such as shoreside power technology by December 2025. For shipowners, switching to cold ironing may prolong the life of a ship's equipment but will incur upfront funding in the form of electricity bills that may be higher than the cost of fuel oils. Marine diesel is usually purchased free of tax, but whether onshore electricity will carry the same advantage depends upon the national

Government. There is no international uniform voltage and frequency requirement when it comes to plugging in ships to national grids. Some ships use 220 volts at 50 Hz or 60 Hz, while others use 110 volts.

2. Social challenges

The main social challenges facing ports today include safety, security and reliability: safety, in terms of ensuring that employees or the general public are not injured; security, in respect of preventing dangerous or illegal goods from being smuggled into or out of ports; and reliability, in ensuring that the port is resilient enough to be able to continue at optimum performance levels regardless of any unwanted human or natural disturbance. Labour issues are, however, perhaps the most difficult of all issues to overcome. Dock work has traditionally been labour intensive, but increasingly labour-saving technologies are being introduced. The reform process usually starts with a port privatization process, of which retrenchment of labour is often a key feature. Any reduction in a workforce can cause considerable discontent both for the remaining workers and the larger community that is reliant on the dock workers' salaries. Yet in many places dock workers are employed under a protective status that limits access to the labour market to approved persons only. In Europe, there has long been an attempt to harmonize dock workers throughout the European Union, but as yet no clear-cut solution exists (Verhoeven, 2011). In 2014, dock workers in the Port of Piraeus protested about working conditions that included 16-hour working shifts (Vassilopoulos, 2014). In 2014 and 2015 in the United States, discussions between the International Longshore and Warehouse Union and the Pacific Maritime Association lasted months and led to severe traffic disruption to vessels entering and leaving the country's 29 west coast ports (Vekshin, 2015). In the port of Callao, Peru, a new system designed to automate the roster of shift workers met with protests resulting in the closure of the port's main container terminal (*Lloyd's List – Daily Briefing*, 2015). The challenge for Governments and port operators is in determining how to meet the demands of increased automation and yet still provide valued employment. Deregulation, which often precedes port privatization, can, however, lead to higher wages for those that remain in the industry. Research has found that the real (adjusted for inflation) hourly and weekly wages of United States union dockworkers increased by 14.3 per cent and 15.3 per cent, respectively, in the post-deregulation period (Talley, 2009).

3. Conclusions

With increased volumes, greater efficiencies and profits are materializing for terminal operators but not necessarily for port authorities. The immediate challenge for ports is not only adapting to these increased volumes but attending to global issues such as climate change mitigation and adaption. Increased automation is both helping and hindering this process. While human labour per se produces no harmful emissions, it is increasingly being replaced by automated machines that, while on the one hand increase terminal and port efficiency and may help lower transport costs, yet on the other hand tend to increase harmful emissions within the port area. The challenge for policymakers is to achieve the right policy mix that benefits both industry and society.

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ENDNOTES

[1] The concept of "environmental space" describes the total amount of non-renewable resources, agricultural land and forests that can be used globally without impinging on access by future generations to the same resources. For one explanation of the environmental space concept, see the European Environment Agency: http://www.eea.europa.eu/publications/92-9167-078-2/page003.html (accessed 22 September 2015).