4

PORT DEVELOPMENTS

This chapter covers container port throughput, developments in terminal operations and some of the current challenges facing ports. World container port throughput increased by an estimated 5.6 per cent to 651.1 million TEU in 2013. The share of port throughput for developing countries increased by an estimated 7.2 per cent in 2013, higher than the 5.2 per cent increase estimated for the previous year. Asian ports continue to dominate the league table for port throughput and for terminal efficiency.

Table 4.1. Container port throughput for 80 developing countries/economies and economies in transition for years 2011, 2012 and 2013 (TEUs)

Country/economy	2011	2012	Preliminary figures for 2013 [a]	Percentage change 2012/2011	Percentage change 2013/2012
China	144 641 878	160 058 524	174 080 330	10.66	8.76
Singapore	30 727 702	32 498 652	33 516 343	5.76	3.13
Republic of Korea	20 833 508	21 609 746	22 582 700	3.73	4.50
China, Hong Kong SAR	24 384 000	23 117 000	22 352 000	-5.20	-3.31
Malaysia	20 139 382	20 897 779	21 426 791	3.77	2.53
United Arab Emirates	17 548 086	18 120 915	19 336 427	3.26	6.71
China, Taiwan Province of	14 076 069	14 976 356	15 353 404	6.40	2.52
India	10 284 885	10 290 265	10 653 343	0.05	3.53
Indonesia	8 966 146	9 638 607	10 790 450	*7.50*	11.95
Brazil	8 714 406	9 322 769	10 176 613	6.98	9.16
Thailand	7 171 394	7 468 900	7 702 476	4.15	3.13
Panama	6 911 325	7 217 794	7 447 695	4.43	3.19
Turkey	5 990 103	6 736 347	7 284 207	12.46	*8.13*
Egypt	7 737 183	7 356 172	7 143 083	-4.92	-2.90
Viet Nam	6 929 645	2 937 119	8 121 019	-57.62	176.50
Saudi Arabia	5 694 538	6 563 844	6 742 397	15.27	2.72
Philippines	5 288 643	5 686 179	5 860 226	7.52	3.06
Mexico	4 228 873	4 799 368	4 900 268	13.49	2.10
South Africa	4 392 975	4 320 604	4 595 000	-1.65	6.35
Sri Lanka	4 262 887	4 180 000	4 306 000	-1.94	3.01
Russian Federation	3 954 849	3 930 515	3 968 186	-0.62	0.96
Oman	3 632 940	4 167 044	3 930 261	14.70	-5.68
Chile	3 450 401	3 606 093	3 784 386	4.51	4.94
Islamic Republic of Iran	2 740 296	2 945 818	3 178 538	*7.50*	*7.90*
Colombia	2 584 201	2 804 041	2 718 138	8.51	-3.06
Morocco	2 083 000	1 800 000	2 500 000	-13.59	*38.89*
Pakistan	2 193 403	2 375 158	2 562 796	8.29	*7.90*
Jamaica	1 999 601	2 149 571	2 319 387	*7.50*	*7.90*
Peru	1 814 743	2 031 134	2 191 594	11.92	*7.90*
Argentina	2 159 110	1 986 480	2 143 412	-8.00	*7.90*
Costa Rica	1 233 468	1 329 679	1 880 513	7.80	41.43
Dominican Republic	1 461 492	1 583 047	1 708 108	8.32	*7.90*
Bangladesh	1 431 851	1 435 599	1 571 461	0.26	9.46
Bahamas	1 189 125	1 278 309	1 379 296	*7.50*	*7.90*
Bolivarian Republic of Venezuela	1 162 326	1 249 500	1 348 211	*7.50*	*7.90*
Guatemala	1 163 100	1 158 400	1 211 600	-0.40	4.59
Ecuador	1 081 169	1 117 047	1 205 294	3.32	*7.90*
Kuwait	1 048 063	1 126 668	1 215 675	*7.50*	*7.90*
Lebanon	1 034 249	882 922	1 117 000	-14.63	26.51
Nigeria	839 907	877 679	1 010 836	4.50	15.17
Angola	676 493	750 000	913 000	10.87	21.73
Uruguay	861 164	753 000	861 000	-12.56	14.34
Kenya	735 672	790 847	853 324	*7.50*	*7.90*
Yemen	707 155	760 192	820 247	*7.50*	*7.90*
Ukraine	696 641	748 889	808 051	*7.50*	*7.90*
Syrian Arab Republic	685 998	737 448	795 707	*7.50*	*7.90*

Table 4.1. Container port throughput for 80 developing countries/economies and economies in transition for years 2011, 2012 and 2013 (TEUs) *(continued)*

Country/economy	2011	2012	Preliminary figures for 2013 [a]	Percentage change 2012/2011	Percentage change 2013/2012
Ghana	683 934	735 229	793 312	*7.50*	*7.90*
Jordan	654 283	703 354	758 919	*7.50*	*7.90*
Côte d'Ivoire	642 371	690 548	745 102	*7.50*	*7.90*
Djibouti	634 200	681 765	735 624	*7.50*	*7.90*
Honduras	662 432	665 354	670 726	0.44	0.81
Trinidad and Tobago	605 890	651 332	702 787	*7.50*	*7.90*
Mauritius	462 747	576 383	621 917	24.56	*7.90*
Tunisia	492 983	529 956	571 823	*7.50*	*7.90*
Sudan	464 129	498 938	538 354	*7.50*	*7.90*
United Republic of Tanzania	453 754	487 786	526 321	*7.50*	*7.90*
Libyan Arab Jamahiriya	195 106	369 739	434 608	89.51	17.54
Senegal	369 137	396 822	428 171	*7.50*	*7.90*
Qatar	365 722	393 151	424 210	*7.50*	*7.90*
Congo	358 234	385 102	415 525	*7.50*	*7.90*
Benin	334 798	359 908	388 341	*7.50*	*7.90*
Papua New Guinea	313 598	337 118	363 750	*7.50*	*7.90*
Bahrain	306 483	329 470	355 498	*7.50*	*7.90*
Cameroon	301 319	323 917	349 507	*7.50*	*7.90*
Algeria	295 733	317 913	343 028	*7.50*	*7.90*
Mozambique	269 219	289 411	312 274	*7.50*	*7.90*
Cuba	246 773	265 281	286 238	*7.50*	*7.90*
Georgia	239 004	256 929	277 226	*7.50*	*7.90*
Cambodia	236 986	254 760	274 886	*7.50*	*7.90*
Myanmar	200 879	215 945	233 005	*7.50*	*7.90*
Guam	193 657	208 181	224 628	*7.50*	*7.90*
El Salvador	161 200	161 000	180 600	-0.12	12.17
Gabon	162 415	174 597	188 390	*7.50*	*7.90*
Madagascar	149 135	160 320	172 986	*7.50*	*7.90*
Croatia	144 860	155 724	168 026	*7.50*	*7.90*
Aruba	137 410	147 716	159 385	*7.50*	*7.90*
Namibia	107 606	115 676	124 815	*7.50*	*7.90*
Brunei Darussalam	105 018	112 894	121 813	*7.50*	*7.90*
New Caledonia	95 277	102 423	110 514	*7.50*	*7.90*
Albania	91 827	98 714	106 512	*7.50*	*7.90*
Subtotal	**412 682 164**	**434 325 380**	**465 475 613**	**5.24**	**7.17**
Other reported [b]	**562 723**	**590 637**	**630 276**	**4.96**	**6.71**
Total reported	**413 244 887**	**434 916 017**	**466 105 889**	**5.24**	**7.17**
World Total	**587 484 148**	**616 675 181**	**651 099 413**	**4.97**	**5.58**

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

[a] In this list, Singapore includes the port of Jurong.

[b] The term “other reported” refers to countries for which fewer than 100,000 TEU per year were reported.

Note: Many figures for 2012 and 2013 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.

A. PORT THROUGHPUT

This chapter deals with containerized cargo, which accounts for more than half the value of all international seaborne trade and around one sixth of its volume. Container port throughput is the measurement of the number of containers that pass through the port and is recorded in TEUs.

1. Container ports

Table 4.1 lists the aggregate container throughput of 80 developing countries and economies in transition that have an annual national throughput of over 100,000 TEU (throughput figures for 126 countries/economies can be found at http://stats.unctad.org/TEU). In 2013, the container throughput for developing economies grew by an estimated 7.2 per cent to 466.1 million TEU. This growth is higher than the 5.2 per cent seen in the previous year. The growth rate for container throughput in all countries in 2013 is estimated at 651.1 million TEU, a rise of 5.6 per cent over the previous year.

Developing economies' share of world throughput increased by 1 per cent to approximately 71.6 per cent. Over recent years there has been a gradual rise in developing countries' share of world container throughput; this was influenced by their greater participation in global value chains and the ever-increasing use of containers for dry-bulk cargo. Out of the developing economies and countries with economies in transition listed in table 4.1, only four (Colombia, Egypt, Hong Kong (China) and Oman) experienced negative growth in port throughput in 2013, whereas in the previous year 12 countries experienced negative growth. Colombia's decline appears to be part of a wider regional decline in port throughput as ports in general in the Caribbean basin experience a decline in foreign trade (*The Gleaner*, 2014). With regards to Egypt, political uncertainty appears to be keeping away some cargoes (UKPRwire, 2014). Hong Kong (China) has struggled in recent years to maintain its leading position in the face of strong competition from Shanghai and Singapore. Oman's decline in container moves appears to be a result of strong competition from

Table 4.2. Top 20 container terminals and their throughput for 2011, 2012 and 2013 (TEUs and percentage change)

Port Name	2011	2012	Preliminary figures for 2013	Percentage change 2012-2011	Percentage change 2013 -2012
Shanghai	31 700 000	32 529 000	36 617 000	2.62	12.57
Singapore	29 937 700	31 649 400	32 600 000	5.72	3.00
Shenzhen	22 569 800	22 940 130	23 279 000	1.64	1.48
Hong Kong (China)	24 384 000	23 117 000	22 352 000	-5.20	-3.31
Busan	16 184 706	17 046 177	17 686 000	5.32	3.75
Ningbo	14 686 200	15 670 000	17 351 000	6.70	10.73
Qingdao	13 020 000	14 503 000	15 520 000	11.39	7.01
Guangzhou	14 400 000	14 743 600	15 309 000	2.39	3.83
Dubai	13 000 000	13 270 000	13 641 000	2.08	2.80
Tianjin	11 500 000	12 300 000	13 000 000	6.96	5.69
Rotterdam	11 876 921	11 865 916	11 621 000	-0.09	-2.06
Port Klang	9 603 926	10 001 495	10 350 000	4.14	3.48
Dalian	6 400 000	8 064 000	10 015 000	26.00	24.19
Kaohsiung	9 636 289	9 781 221	9 938 000	1.50	1.60
Hamburg	9 014 165	8 863 896	9 258 000	-1.67	4.45
Long Beach	6 061 099	6 045 662	8 730 000	-0.25	44.40
Antwerp	8 664 243	8 635 169	8 578 000	-0.34	-0.66
Xiamen	6 460 700	7 201 700	8 008 000	11.47	11.20
Los Angeles	7 940 511	8 077 714	7 869 000	1.73	-2.58
Tanjung Pelepas	7 500 000	7 700 000	7 628 000	2.67	-0.94
Total top 20	274 540 260	284 005 080	299 350 000	3.45	5.40

Source: UNCTAD secretariat and Dynamar B.V., June 2014.
Note: In this list Singapore does not include the port of Jurong.

neighbouring ports but is in contrast to general cargo volumes, which increased by 9.5 per cent (Business Monitor Online, 2014).

Of the top 10 developing countries and countries with economies in transition, all are located in Asia. Sixteen of the top 20 developing countries and countries with economies in transition are also in Asia, while three are in Central and South America (Brazil, Mexico and Panama) and one is in Africa (Egypt). The country with the largest share of container throughput continues to be China. Including Hong Kong (China) and Taiwan Province of China, half of the top 20 ports are Chinese. Chinese port throughput, excluding Hong Kong (China), experienced a positive growth of 8.7 per cent, at 173.9 million TEU. Chinese ports, with the exception of Hong Kong (China) and those of Taiwan Province of China accounted for around 26.8 per cent of world container throughput in 2013, up from 25.8 per cent in the previous year (a more detailed account of international trade demand and supply is given in chapter 1).

Table 4.2 shows the world's 20 leading container ports for the period 2011–2013. The top 20 container ports accounted for approximately 46 per cent of world container-port throughput in 2013. Combined, these ports showed a 5.4 per cent increase in throughput in 2013, up from an estimated 3.5 per cent increase in 2012. The list includes 15 ports from developing economies, all of which are in Asia; the remaining five ports are in developed countries, three of which are located in Europe and two in North America. All of the top 10 ports are located in Asia, signifying the importance of the region in the movement of finished and semi-finished goods. Shenzhen port moved up one place to overtake for the first time the port of Hong Kong (China) to become the world's third largest container port. In 2013, Hong Kong (China) experienced a negative growth of 3.3 per cent, the largest fall of any of the top 20 ports. Rotterdam experienced a decline of 2 per cent but managed to maintain its position as the world's eleventh largest container port. Antwerp, Los Angles and Tanjung Pelepas also experienced negative growth in 2013. Qingdao moved up two places while Dubai, Long Beach and Xiamen all moved ahead by one place. Dalian Port made significant progress by moving ahead five places with a growth of 24.2 per cent. Dalian has the largest free trade zone in China, the Dalian Free Trade Zone, with an area of 251 square kilometres, which helps to boost trade through the port. In 2013, Dalian's GDP grew at an annual rate of nine per cent to exceed RMB 765.08 billion ($123 billion), with primary industries growing by 4.8 per cent and secondary industries by 9.4 per cent. The service sector grew by 9.1 per cent so that by the end of 2013, 639 financial institutions were operating in the city, signifying its growing importance (Rainy Yao, 2014).

B. TERMINAL OPERATIONS

The container terminal industry is a very fragmented business. Despite this there are several international players that have expanded to achieve a global presence. Table 4.3 lists the top 10 global terminal operators by container throughput and market share. Together these top 10 global container terminals control around 224 million TEU, that is, around 37 per cent of the world's container port throughput that is depicted in table 4.1.

Despite weak growth in port throughput volumes compared to the pre-economic-crisis levels, the terminal operating sector is very active. Several global terminal operators have sold part of their stakes as they seek to streamline and focus their operations. Terminal operators closely linked to shipping links, such as APM Terminal and Mitsui O.S.K. Lines, have sold terminals, while traditional terminal operators such as DP World and Stevedoring Services of America have attempted to strengthen their position by focusing on investment. The smaller ICTSI terminal operator has also sold terminals; however, this is no doubt due to the growth of these terminals and the focus of the company to invest in small and medium-sized terminals.

Table 4.3. Top 10 global terminal operators, 2012 (TEUs and market share)

	Operator	Million TEU	% share
1	PSA	50.9	8.2
2	HPH	44.8	7.2
3	APMT	33.7	5.4
4	DPW	33.4	5.4
5	Cosco	17	2.7
6	Terminal Investment Ltd.	13.5	2.2
7	China Shipping Terminal Development	8.6	1.4
8	Hanjin	7.8	1.3
9	Evergreen	7.5	1.2
10	Eurogate	6.5	1

Source: Drewry Maritime Research.

Table 4.4. Top global terminals, 2013 (Container moves per ship, per hour, on all vessel sizes, and throughput by port and country)

Terminal	*Port*	*Country*	*2013 berth productivity*	*Port rank (throughput)*	*Country rank (throughput)*
APM Terminals Yokohama	Yokohama	Japan	163	41	7
Tianjin Xingang Sinor Terminal	Tianjin	China	163	10	1
Ningbo Beilun Second Container Terminal	Ningbo	China	141	6	1
Tianjin Port Euroasia International Container Terminal	Tianjin	China	139	10	1
Qingdao Qianwan Container Terminal	Qingdao	China	132	7	1
Xiamen Songyu Container Terminal	Xiamen	China	132	18	1
Tianjin Five Continents International Container Terminal	Tianjin	China	130	10	1
Ningbo Gangji (Yining) Terminal	Ningbo	China	127	6	1
Tianjin Port Alliance International Container Terminal	Tianjin	China	126	10	1
DP World-Jebel Ali Terminal	Jebel Ali	United Arab Emirates	119	9	9
Khorfakkan Container Terminal	Khor al Fakkan	United Arab Emirates	119	34	9

Source: UNCTAD secretariat and *JOC* Port Productivity Database, June 2014.
Note: Although 11 terminals are listed, the DP World Jebel Ali Terminal and the Khorfakkan Container Terminal share joint tenth place.

Table 4.4 lists the top performing container terminals as ranked by *JOC*.[11] The results show that Japan, China and the United Arab Emirates are the only three countries to feature in the top 10, with China accounting for eight terminals. Interestingly, in terms of the UNCTAD country ranking by port throughput volume (see http://stats.unctad.org/TEU), Japan is ranked in seventh position while China ranks in first place, illustrating that a high volume of throughput is not needed to achieve berth efficiency. In terms of ports, Yokohama is ranked first in terms of berth efficiency but forty-first in terms of volume. Four different terminals within the port of Tianjin, China, are positioned in the top 10, signifying the high level of berth efficiency at that port.

Table 4.5 ranks Tianjin as the world's most efficient container port, having made productivity gains of over 50 per cent on the previous year. The port of Tianjin is home to numerous international terminal operators, such as APM Terminals, China Merchants Holdings International, COSCO Pacific, CSX World Terminals OCCL, PSA and DPW, and in-port terminal competition may thus be a driver for increased efficiency.

In Europe, the top-performing terminal was the Euromax Terminal Rotterdam, with a ranking of 100 container moves per ship, per hour for all vessel sizes, followed by MSC Gate Container Terminal in Bremerhaven, Germany (ranked 98). In the Middle

Table 4.5. World's leading ports by productivity, 2013 (Container moves per ship, per hour, on all vessel sizes and percentage increase)

Port	Country	2013 berth productivity	2012 berth productivity	Percentage increase 2013/2012
Tianjin	China	130	86	51%
Qingdao	China	126	96	31%
Ningbo	China	120	88	36%
Jebel Ali	United Arab Emirates	119	81	47%
Khor al Fakkan	United Arab Emirates	119	74	61%
Yokohama	Japan	108	85	27%
Yantian	China	106	78	36%
Xiamen	China	106	76	39%
Busan	Republic of Korea	105	80	31%
Nansha	China	104	73	42%

Source: UNCTAD secretariat and the *JOC* Port Productivity Database June 2014.

East the Salalah Container Terminal in Salalah, Oman, achieved 91 container moves per ship, per hour. No figures for terminal efficiency in African ports were given although, in 2012, the average figure that was provided for the continent was 19 container moves per ship, per hour for all vessel sizes. This is significantly below the current highest ranking terminal and while it shows that there is opportunity for improvement the absence of a corresponding figure for 2013 probably signifies a lack of change. Interestingly, the increased efficiency for the world's leading ports ranges from 27 per cent (Yokohama) to 61 per cent (Khor al Fakkan), and these are substantial improvements and not incremental as would be expected. For Yokohama, APM Terminal is the operator and no doubt the company's considerable experience gained from managing its global portfolio of terminals has helped. For Khor al Fakkan the explanation maybe the recent port improvements. Phase two of a major expansion was recently completed, providing six Super Post-panamax gantries, and four Mega-max Tandem-lift cranes on 800 metres of berth, with 16 metres of draft alongside (United Arab Emirates, Department of Seaports and Customs, 2014).

C. PORT RELATED DEVELOPMENTS

Port development is an essential process for any country wishing to successfully engage in international trade. Ports are the gateway to access global trading partners and shipping is one of the most cost-effective means of transport over long distances. Historically, ports have been regarded as critical assets as, in addition to being the gateway to a country, they are also where taxes on imports and excise duties are collected. However, the port's role is continuing to evolve and there exists a difference between developing and developed countries. In many developing countries, tax collection at the port accounts for a major share of all government revenue. For example, the Tanzania Ports Authority is one of the top payers of tax in the United Republic of Tanzania. In 2011, the Authority and Tanzania International Container Terminal Services paid $43 million and $15 million, respectively, giving them a combined position of third place in the country for tax contributions and signalling the importance of the port to the GDP of the country. In 2009/2010, the United Republic of Tanzania collected TSh 4.5 trillion ($2.8 billion) in taxes, around 30 per cent of which came from value added tax and a further 30 per cent from income tax, while excise duties accounted for around 18 per cent and import duties for around 9 per cent (Tanzania Episcopal Conference, National Muslim Council of Tanzania and Christian Council of Tanzania, 2012). A recent report by the World Bank on the United Republic of Tanzania cited that "[i]mproved efficiency at the port would enable greater efficiency in tax collection, which in turn would substantially increase tax revenues" (World Bank Group Africa Region Poverty Reduction and Economic Management, 2013). Thus, port development and port reform are essential components of a country's financial well-being. However, in developed countries tax collection at the port has become less important. This is partly due to the advent of new methods to tax, for example, income tax and payroll taxes, as well as to efforts to streamline port processes and facilitate the flow of goods. For example, in the United States excise duties and customs duties amount to 3 per cent and 1 per cent respectively of total government revenue (National Priorities Project, 2014).

1. Transit routes

In the Americas the Panama Canal expansion, which began in 2007, is still the main reason for many port development projects. Despite a series of setbacks and cost overruns in 2013–2014, the canal is now slated for completion in December 2015. The expansion work includes the addition of a third set of locks to the Canal system as well as deepening and widening existing channels (to 54.86 metres) so that container ships of up to 13,500 TEU and other large vessels can be accommodated. The largest container ships afloat will not be able to transit the expanded Canal. The expansion project is presently costing $7 billion, an overrun of $1.6 billion. In 2013, the Canal generated tolls amounting to $1.8 billion, down 0.2 per cent on the previous year, and the Panama Canal Authority forecasts an extra $1 billion of additional revenue from increased traffic flows once the newly expanded Canal becomes operational.

The Panama Canal serves more than 144 maritime routes connecting 160 countries and reaching some 1,700 ports in the world. Total crossings in the Panama Canal reached 12,045 in 2013, minus 6.5 per cent over the previous year. Of this total, around 25 per cent of the number of vessels transiting (3,103) were container ships, down 6.4 per cent on the previous year. Yet container ships carry an estimated 52 per cent of global seaborne trade in terms of value and are therefore significantly important to world trade. During 2013, more than 319 million tons, down 3.9 per cent on the previous year, of cargo was transited through the canal, representing about 3.4 per cent of world seaborne trade. The immediate beneficiaries of the Panama Canal expansion are likely to be East Coast United States ports, such as New York and Virginia.

A rival to the Panama Canal is also attracting interest in Nicaragua. A Nicaragua Canal proposal was passed through congress in June 2013. The canal is likely to be three times longer, at 278 kilometres, than the Panama Canal. If built, the Nicaragua canal will be wider than the Panama Canal and be able to cater for the world's largest cargo ships existing at present. The cost of the canal is estimated to be $40 billion and it will be built and operated by a Chinese company – the Hong Kong Nicaragua Canal Development Investment Co. Ltd. The company has been granted a 50-year concession to build and operate the waterway with the option to extend the concession for another 50 years. The Nicaraguan Canal project will directly employ about 50,000 people and indirectly benefit another 200,000. Construction is expected to begin in December 2014 and take five years to complete. (NBC News, 2014).

While clearly the development of transit canals entails numerous implications, these remain difficult to assess with any great degree of certainty. Any expansion project involves multiple players and is subject to many unknowns given, in particular, global economic uncertainties and rapid advances in technology, including ship size and design.

2. Other port-related developments

During 2013, container weights became a critical issue for container terminals around the world. Mandatory container weight checks are to be introduced following an agreement at the IMO. Verification of container weights as a condition for loading packed export containers aboard ships will become part of a revision to the Safety of Life at Sea Convention that is due to enter into force in July 2016. These weight restrictions are to be adhered to by packers and shippers, but will most probably be verified in the port. Weigh bridges and twist-lock load sensors on cranes will probably be the two favoured means to verify weight. These regulations come following recent high-profile incidents such as the MSC Napoli grounding in 2007.

The United Kingdom Government's concerns over the reliance by shipping lines on technology to navigate the world's busiest waterway, the English Channel, prompted it to begin the installation of seven eLoran stations along the United Kingdom coastline.[12] The stations will act as a backup to global positioning systems, which will still be the primary means ships' masters will use to determine the position and course in case of incidences such as deliberate or accidental "jamming" by persons, or extreme weather (for example, hurricanes or blizzards) or extraterrestrial events (for example, solar storms). By 2019, an additional 20 stations each the size of a filing cabinet will be installed around the United Kingdom and Ireland. Consultations between the United Kingdom and the Republic of Korea are ongoing to see how a similar system might be implemented on the Korean peninsula.

Terminal operating systems, an enterprise resource planning tool, are common place within port terminals. There exist various bespoke systems, their design usually stemming from large ports such as Singapore; the PSA Computer Integrated Terminal Operations System is a bespoke system that was designed to meet the port's needs. However, the market leader is Navis, a division of Cargotec Corporation and a dedicated software producer. Its latest generation terminal operating system, SPARCS N4, allows customers to run multiple operations spanning numerous geographic locations from one central location and is thus popular for global terminal operators with large international portfolios. SPARCS N4 is present in 107 sites in 47 countries, 63 of which are currently live (Navis, 2014).

D. SOME CURRENT CHALLENGES FACING PORTS

1. Larger vessels and cargo concentration

One of the major challenges for container ports today is the upgrading of facilities to cater for the increase in vessel size and the corresponding pressures this places upon the spatial and time aspects of cargo handling. Larger ships mean investment is needed in bigger cranes that can reach out to collect the furthest container from the berth. Traditionally, container cranes were designed to serve vessels 13 containers wide, and since shipowners began to order Post-panamax vessels in 1988, cranes with greater reach – up to 18 containers – were needed on major routes. The latest generation of vessels requires even greater reach (22–23 containers), and ports are hard-pressed by shipping lines to invest in this shore-side equipment or be excluded from major East–West trade lanes. With the arrival of larger vessels, the previously largest vessels are being redeployed from the voluminous East–West routes with advanced ports to smaller less voluminous ports on the North–South routes. The North–South routes tend to serve developing countries' ports that are hard pressed to invest in cranes of even greater outreach but risk relegation to feeder port status if they do not follow.

Investors in infrastructure often need to "future proof" their constructions to cater for the needs of future developments not yet conceived. Thus, the challenge for port planners is to understand how the market from their customers' perspective may change. Economies of scale and the use of the logistics chain as part of the production cycle are increasing trends. Technology, through better inventory management and reliability of ships, may enable the ship to be used as a floating warehouse. The next generation of container vessels will be bigger and plans have even been conceptualized for vessels of 22,800 TEU and 24,000 TEU. These vessels will have a width of around 64 metres and a length of 487 metres. Ship length, according to industry experts, is likely to be limited to around 400–450 metres, primarily due to the increased costs associated with making ships longer. Shorter and wider ships are more stable and have shallower draft, enabling them to better serve ports in developing countries that cannot afford dredging costs. In addition, wider ships require less ballast water than narrower ships and thus contribute less to the harmful invasion of foreign microbes in non-indigenous waters, which can cause major environmental pollution in some fragile regions (*Lloyd's List Containerisation International*, 2013). Thus, ports need not necessarily build longer berths, unless they want to cater for multiple ships simultaneously, but must construct deeper access channels, wider turning basins, more pilotage facilities, strengthened quays, larger storage areas and more sophisticated terminal operating systems within the port. Thus, the real limitation is not just financial but spatial too. Outside the port, the highways, inland waterways and rail networks need to be able to cater for increased cargo volumes. In addition, the number of freight vehicles, railway wagons, barges or trucks needs to be increased. Given land transporters' preferences for road haulage (due to the greater predictability and reliability brought about by ownership) this invariably means higher carbon emissions and increases in other associated externalities. Choosing a new greenfield site for the container terminal may solve some of the problems, but it creates additional ones too.

Larger cranes are also invariably taller, and they increase exposure of both the crane and the driver to greater instability brought about by higher wind forces. These may lead to slower overall performance and greater increases in human errors. Ports such as Felixstowe and Dubai already have Super Post-panamax ship-to-shore container gantry cranes with an outreach of 69.5 metres. In addition to being practical, there is also a marketing advantage to being able to claim that any size of container ship can be handled, and hence there is a premium to be gained from future-proofing. Where the most uncertainty occurs is in ports that are the main gateways for their country and the region, and that face a choice of catering for vessels of around 5,000 TEU (present Panamax vessels) to 13,500 TEU (the 2015 Panamax vessels). Here, the choice of buying cranes to cater for future demand is more of a gamble. The purchase of larger gantry cranes is not in itself a panacea and not the only cost a port must meet to service larger vessels. In Jebel Ali terminal, Dubai, the purchase of 19 ship-to-shore quay cranes accompanied an order of 50 automated rail-mounted gantry cranes, four of which were recently delivered. At almost 50 metres wide and 32 metres high, these gantry cranes can twin-lift containers in stacks of up to 10 containers wide and 6 high (*Seatrade*, 2014).

2. Environmental concerns

Like most industrial sectors, ports are under increased pressure to reduce the impact they have upon the environment. In 2015, the United Nations is expected to adopt sustainable development goals to build upon the Millennium Development Goals. Currently under discussion through a series of dialogues at the Open Working Group, these goals are expected to be finalized for adoption at the United Nations General Assembly in New York in September 2015. The new goals will build upon the Rio+20 outcome document "The Future We Want" by addressing a multitude of issues on sustainable development, not least how to achieve development with the least impact upon the environment.[13]

Ports affect the environment in a number of ways. For example, their initial construction at green-field sites may displace indigenous wildlife. The wake of vessels may also disturb natural wildlife and make certain areas no longer habitable. The construction of ports close to cities may affect the health of humans living and working close by. The use of construction materials like cement has a well-documented impact upon the environment at all stages of its use from quarry to utilization. The need to dredge channels and berths has an impact upon the area being dredged and where the extracted material is then placed. Sometimes this material can be laden with toxins from vehicles or cargo contaminants that enter the sea as rainwater run-off from the quays.

In the construction of ports it is usual for an environmental impact assessment to be undertaken followed by consultation with affected parties or interest groups. The displacement of natural habitat and wildlife are thus considered in balance with the gains to be made to the local economy to produce a cost-benefit analysis report. Such public consultation can take years and cost millions for the end result to maintain the status quo. One example is that of the proposed £600-million greenfield container port project at Dibden Bay, Southampton in the United Kingdom. On the one hand the economic argument was (a) a national need for more container handling capacity, (b) job creation both during construction and for general operation, (c) increased efficiency leading to lower costs to consumers, and (d) local economic stimulus. The environmental argument against the project was that there was (a) a threat to designated environmental areas, (b) risk of oil spills, (c) habitat loss, and (d) visual impact on the landscape. In the end, the debate about whether to build a deep-water container terminal lasted 4–5 years, cost Associated British Ports £50 million, and failed (*Southern Daily Echo*, 2009). Several years later a new container port, DP World's London Gateway was built when a brownfield site approximately 100 miles to the northeast on the River Thames became available for reuse.

During the operation of a port there may be GHG emissions from inefficient diesel engines belonging to cranes, reach stackers and other port vehicles. These are not usually submitted to the often rigorous inspections applied to the vehicles of, for example, visitors or in some cases the three shifts of port workers who provide the 24-hour services needed in a modern port. The on-dock buildings for workers will also be using energy for heating and cooling to keep operations at temperatures appropriate for the workers. The cargo itself may also pollute through excessive noise or dust during its handling or storage.[14] Some cargoes are particularly problematic; for example cement, china clay, coal and iron ore are prone to dust pollution. Other dry-bulk cargoes such as fertilizers and animal feed have high concentrations of organic material and/or nutrients and any resulting spillage into the sea may cause localized nutrient enrichment and oxygen depletion, which can destroy marine life.

Depending on the type of port, there may also be ferry traffic that can lead to a long tailback of waiting cars and trucks. Likewise, there can be excessive light from all-night quayside operations. In addition, local service providers generate additional pollution in the course of their activities; there is considerable interest in switching local transport activities to less polluting sources of locomotion, such as compressed natural gas. Ship vibration from the use of ships engines for manoeuvring in port can also be a source of environmental disturbance. Ships have historically been the main polluters in ports because the fuel that they burn is high in GHGs. For instance, most diesel cars emit on average 0.3 to 0.5 per cent sulphur, whereas marine fuels were until recently capped at 4.5 per cent and will only be reduced to 0.5 per cent in 2020 through IMO regulation under the International Convention for the Prevention of Pollution from Ships (MARPOL) annex VI. However, ships are mainly manoeuvred into position by tugs within the port and therefore ports have some control over the level at which these contribute to the port's carbon footprint. In areas where there is high concern about air pollution, ports have been investing in shore power to reduce the use of vessel fuel while at berth. For example, the ports of Los Angles and Long Beach have been early pioneers of cold ironing technology. Recently in the port of Seattle, for the installation of cold ironing facilities for a cruise ship terminal, costs were estimated at $1.5 million per berth and $400,000 per vessel (*Port Technology International*, 2014).

The risk of pollution through accidental spillage is a real possibility for ports. Because the cargo and carrying vehicles (for example, truck, reach stacker or straddle carrier) are all manoeuvred in a restricted space, accidents are bound to happen at some point. Therefore, a risk assessment with plans drawn up for rapid response and mitigation measures is a necessary element in port strategic planning.

In addition, it's not just the port itself that may be polluting but also the ancillary services it attracts to settle nearby, for example, ship/container repair yards or supply factories. Perhaps because of poor hinterland connections, other industries also often decide to locate near a port so that the site becomes a magnet for other industries and part of a chain of pollution. In the case of some cargo, such as iron ore, it is more lucrative to export as a refined ingot; however, refining is very energy intensive and often takes place close to the port. The refineries are often supplied by coal-fired power stations and the issue thus becomes of concern to the municipality as well as the port.

The main pollutants produced in and around ports are GHGs, CO2, methane (CH4), nitrous oxide (N2O), NOx, particulate matter and SOx (World Ports Climate Initiative, 2010). The environmental hazards of harmful substances include damage to living resources (toxicity), bioaccumulation, hazard to human health (oral intake, inhalation and skin contact) and reduction of amenities (United Kingdom Marine Special Areas of Conservation Project, 2014).

The impact of ports upon the environment may be broadly classified into three areas: emissions, cargo operations and accidental pollution (table 4.6).

Solutions to tackle port pollution typically centre around the enforcement of standards and regulations through a mixture of financial incentives and penalties.

Some practical measures to reduce the carbon footprint and pollution of ports are as follows:

(a) Cold ironing: Instructing ships not to use fuel oil in port and instead insist upon shore-side electricity. For example, Melilla, the Spanish North African enclave, installed onshore power for its scheduled ro-ro services; this involved retrofitting the vessels to accept an external energy source as well as modifications on the port side to supply the energy. The reduction in ship's emissions from using onshore power is estimated at over 90 per cent (*Ports & Harbors*, 2014). In California, ships without a shore electricity connection will be banned from its ports in 2014, and by 2020 80 per cent of the power used by a ship must come from the shore connection. In Europe, ships berthing for more than two hours are required to switch to a 0.1 per cent sulphur fuel or use alternative technologies (*Ports & Harbors*, 2013).

(b) Subject port equipment to the same rigorous tests as road-going vehicles to make manufactures change their products, or introduce emission-control systems or diesel-oxidation catalysts and particulate filters;

(c) Install water catchment facilities which filter the debris contained in quayside storm water run-off and prevent it from entering into the sea/river;

(d) Introduce regulations to limit noisy activities to daylight working hours (for example, cargo unloading operations, shunting of trains, and the like);

(e) Reduce drop height and fall velocity of bulk cargoes;

(f) Install cargo netting or dust extraction technology to reduce the spread of particulate matter;

(g) Insulate office buildings to better regulate temperatures;

(h) Utilize renewable energy sources where possible;

(i) Developing robust emergency-response plans to deal with spillages.

Some ports offer financial incentives to more efficient ships; for example, Busan Port Authority offers a 15 per cent discount on port dues for ships meeting a certain efficiency scoring, thus rewarding vessel owners that invest in technology and measures to improve their fleet's efficiency. The scorings are based upon the Environmental Shipping Index, an assessment of the amount of NOx and SOx produced by a ship that then enables particulate matter and GHG emissions to be assessed. The scheme has a growing database of over 2,500 existing vessels and a membership of over 30 ports.[15] For new vessels, there is the Energy Efficiency Design Index (EEDI), regulated by the IMO under MARPOL annex VI. There is also the

Table 4.6. Types of pollution occurring in ports

Emissions	*Cargo operations*	*Accidents*
Cars	Light	Oil spill
Trucks	Dust	Cargo spill
Railway	Noise	Sewage and sludge spills
Ships	Vibration	Ballast water contaminants
Cranes		Wash-off
Port equipment		
Office (cooling/heating)		

Source: UNCTAD secretariat.

"A to G" GHG emissions rating system developed by the Carbon War Room and Right Ship that contains information on over 70,000 existing vessels.[46] The tool enables ports to provide incentives without the need for additional paperwork.

E. CONCLUSIONS

Container-port throughput continues to grow at an annual rate of 5–6 per cent. This offers an excellent opportunity for exporters to seize the opportunities of utilizing empty containers in order to find new markets for existing products. Notwithstanding the operational issues of how to publicize and organize the availability of empty containers, there nevertheless exists potential for many developing countries to integrate further into global value chains through organizational planning. For ports, the challenge of how to cater for the growing demand and deal with the issues of increased cargo concentration, and reduce their carbon footprints and other pollution, is not insurmountable, but requires careful monitoring and planning. The improved performance of individual port terminals bodes well for the future organization and planning of all ports. Just as the container became a universal standard, the same is being seen in the development of terminal operating systems. Information technology systems that can integrate into other global systems will also be a key feature of the future. As larger ships cascade down to developing-country markets, these countries' ports will need to embrace the new technology. This will also make it easier for other parties, such as larger ports or customers, to provide assistance to make efficiency gains. Port collaboration will be a sign of the future and gradually the differences in port performance will narrow around the world.

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ENDNOTES

11 In 2013, the *Review of Maritime Transport reported on the development of the newly launched index by the JOC that ranked terminal productivity. Productivity is defined as the average of the gross moves per hour for each recorded call. Gross moves per hour for a single vessel is defined as the total container moves (loading, offloading and repositioning) divided by the number of hours for which the vessel is at berth. The index uses data recorded by 17 liner shipping companies, which in 2013 detailed their events pertaining to over 150,000 port calls.*

12 “eLoran” stands for enhanced long-range navigation and is an internationally-standardized positioning, navigation, and timing service for use by many modes of transport and in other applications.

13 In 1992, the United Nations Conference on Environment and Development held what is commonly called the Rio Summit, resulting in the signing of the Rio Declaration on Environment and Development. In 2012, a subsequent meeting, commonly called the Rio+20, reviewed the progress made and made further recommendations. The Rio+20 Summit resulted in an outcome document entitled The Future We Want. *This document describes the importance of transportation as a central issue to sustainable development. Sustainable transport has three main pillars: economic, social and environmental, covering both freight and passenger travel. The document acknowledges that transport itself is an enabler in the provision of access to other services, for example, education, health and employment. The document is available at* https://rio20.un.org/sites/rio20.un.org/files/a-conf.216l-1_english.pdf.pdf (accessed 15 October 2014).

14 At one terminal in Prince Rupert, Canada, 200 complaints about noise and dust were received from local residents in a six-month period (“Trouble with the terminal: Frustrations abound surrounding Westview Terminal”, *The Northern View*, 18 June; see http://www.thenorthernview.com/news/263559031.html, accessed 15 October 2014).

15 See http://www.environmentalshipindex.org/ (accessed 1 October 2014).

16 See http://www.imo.org/MediaCentre/HotTopics/GHG/ (accessed 1 October 2014).