C. CONTAINER SHIPPING: PORT PERFORMANCE

1. Container terminal performance

On average, 75–85 per cent of the port call time of container ships is taken up by container operations, that is to say, the time between the first and last container lifts, while the remaining time may be due to pilotage, mooring, customs formalities and other operational or procedural requirements. The efficiency of the container operation segment is influenced by the combination of crane speed multiplied by the quantity of cranes deployed (crane intensity). Although constrained occasionally by stowage plans, a ship's overall length or available cranes, crane intensity is also largely influenced by the call size.

There are large variations in average port times, and this should be seen as an opportunity for improvement. The gaps are too large to be closed with a single giant step, so a succession of smaller but progressive steps is required in all countries located towards the bottom of table 3.6.

The lead metric for the 2019 port turnaround times is the average of total port hours per port call. For this, port hours are counted from the time a ship reaches the port limits (pilot station or anchorage) until it departs from the berth after operations are completed. It therefore incorporates waiting/idle time, steaming-in time and berth time. The time taken to steam out of the port limits is not included because first, it is very homogeneous, and second, it is not influenced by port effectiveness. Any delays in departure due to channel congestion; absence of pilots, tugs or other resources; and ship readiness are all incurred before a ship departs from the berth and the last line is released. Ships may also sit idle on departure for bunkering or repair or simply in safe waters if the next port cannot accommodate berthing on arrival.

The data used in this section are provided by IHS Markit from its extensive, proprietary Port Productivity Programme. It comprises close to 200,000 container ship port calls per year, approximately 42 per cent of the total. It combines data on the vessel calls and time in port with detailed information about the containers loaded and unloaded at each call, totalling more than 300 million TEUs, at more than 430 ports in 138 countries. The underlying data are provided by 10 of the world's largest shipping lines and are enhanced with matched port arrival times from the IHS Markit automatic identification system database.

The time ships spent in port in 2019 is reported in section A (table 3.3). It is measured in absolute numbers, without considering the number of containers loaded or unloaded during this period. For the selected ports and carriers analysed in this section, the Journal of Commerce–IHS Markit database makes it possible to adjust the port turnaround time for loading and unloading operations during this period.

For an objective overview of container ship in-port time, different factors need to be considered, including the call size and quantity of container moves per ship call. For objective benchmarking, the actual port call hours are weighted by the quantity of containers exchanged per call. The formula used to achieve this for each country is as follows:

Actual port hours/actual call size x actual call size of full benchmark group

For example, if a country takes 12 hours to handle a ship with 1,200 containers loaded and unloaded, and the average of the benchmark group is 1,500 moves per call, it is then assumed that it will take the subject port 15 hours to handle that same quantity (*12/1,200 x 1,500*). In sum, the resulting weighted port hours represent the time a ship spends in port per container loaded and unloaded, multiplied by the global average number of containers of the benchmark group.

2. Most of the countries with the best port performance are in Asia

A shorter time in port is a positive indicator of a port's efficiency and trade competitiveness. Based on the criteria explained above, container ships spent an average time of 23.2 hours (0.97 days) in port per call in 2019.

Table 3.6 lists the world's leading 25 economies in terms of total container ship port calls (as per table 3.3) and provides their average in-port time, weighted by call size. The average port-call time across these 25 economies in 2019 was 21.7 hours (0.91 days), slightly less than the global average.

Among the leading 25 countries in terms of container ship port calls, the United Arab Emirates hold the record for the shortest in-port time (14.1 hours of weighted port time), followed by China (15.5 hours), Singapore (17.4 hours) and the Republic of Korea (17.8 hours). Of the nine countries performing better than the average of the entire group, only two (Belgium and the Netherlands) are outside Asia. The lowest levels of performance are represented by France (41.8 hours), Italy (36.5 hours), Australia (34.6 hours) and Brazil (33.6 hours).

Table 3.7 lists the top and bottom 10 countries in terms of their weighted average port hours, as well as the average vessel size in terms of container-carrying capacity (TEUs). Four Middle Eastern countries were among the top 10 in 2019. Along with the Republic of Korea, Singapore and Sri Lanka, the ports of these countries handle predominantly trans-shipment containers. They generally have high crane densities on the quay walls, enabling high crane intensities. The ratio of yard to quay equipment is similar to that of most contemporary container terminals but a trans-shipment container has only one yard move per quay move, whereas that number is doubled in gateway ports.

Trans-shipment ports have some fundamental advantages, such as limited gateway cargo, with fewer outside trucks causing congestion in the yards, and potentially planned days ahead, with cargo arriving and departing in large batches. Last, but not least, most ports are operated by global terminal operators, and many are set up as cost centres or joint ventures with the ship operators.

Hub ports face other challenges, such as tight connections, fragmented discharge and roll-overs with an impact on yard integrity; in addition, the last port

Table 3.6	Weighted average port call hours in top 25 economies, 2019
Country	**Number of weighted average port hours**
United Arab Emirates	14.1
China	15.5
Singapore	17.4
Republic of Korea	17.8
India	18.2
Thailand	20.0
Netherlands	20.3
Malaysia	20.5
Belgium	20.7
Hong Kong, China	22.5
Germany	23.0
Viet Nam	23.0
United States	24.7
Taiwan Province of China	25.8
United Kingdom	26.5
Spain	26.8
Indonesia	27.2
Japan	28.2
Philippines	31.7
Panama	32.3
Turkey	32.5
Brazil	33.6
Australia	34.6
Italy	36.5
France	41.8
Top 25 economies	**21.7**

Source: Journal of Commerce–IHS Markit Port Productivity Programme.

Note: The top 25 countries are derived from the total number of container ship port calls shown in table 3.3.

Table 3.7	Weighted average port call hours, top and bottom 10 countries or territories	
Economy	**Weighted average port hours**	**Average vessel size**
Oman	12.5	9 002
United Arab Emirates	13.8	7 619
China	15.1	8 483
Poland	16.6	6 357
Saudi Arabia	16.8	8 351
Singapore	17.0	6 183
Republic of Korea	17.4	7 425
Qatar	17.7	7 081
India	17.8	7 463
Sri Lanka	18.5	5 749
Top 10	**15.9**	**7 769**
Canary Islands	61.7	984
Mozambique	62.6	2 533
Norway	62.9	1 259
Cameroon	63.7	2 541
Bulgaria	64.1	1 162
El Salvador	64.2	2 203
Nigeria	65.0	4 379
Gabon	65.9	1 559
Namibia	71.8	3 561
Trinidad and Tobago	72.1	1 490
Bottom 10	**65.1**	**2 530**

Source: Journal of Commerce–IHS Markit Port Productivity Programme.

before a head-haul must often contend with scattered load stowage in high-profile stacks.

Five of the lowest-ranking countries in table 3.7 are in Africa, which is still catching up in terms of building sufficient infrastructure and implementing the necessary port and trade facilitation reforms to be able to handle ever-growing demand effectively. Much additional investment is required, and the performance indicators presented above suggest that this could well come from private sector operators.

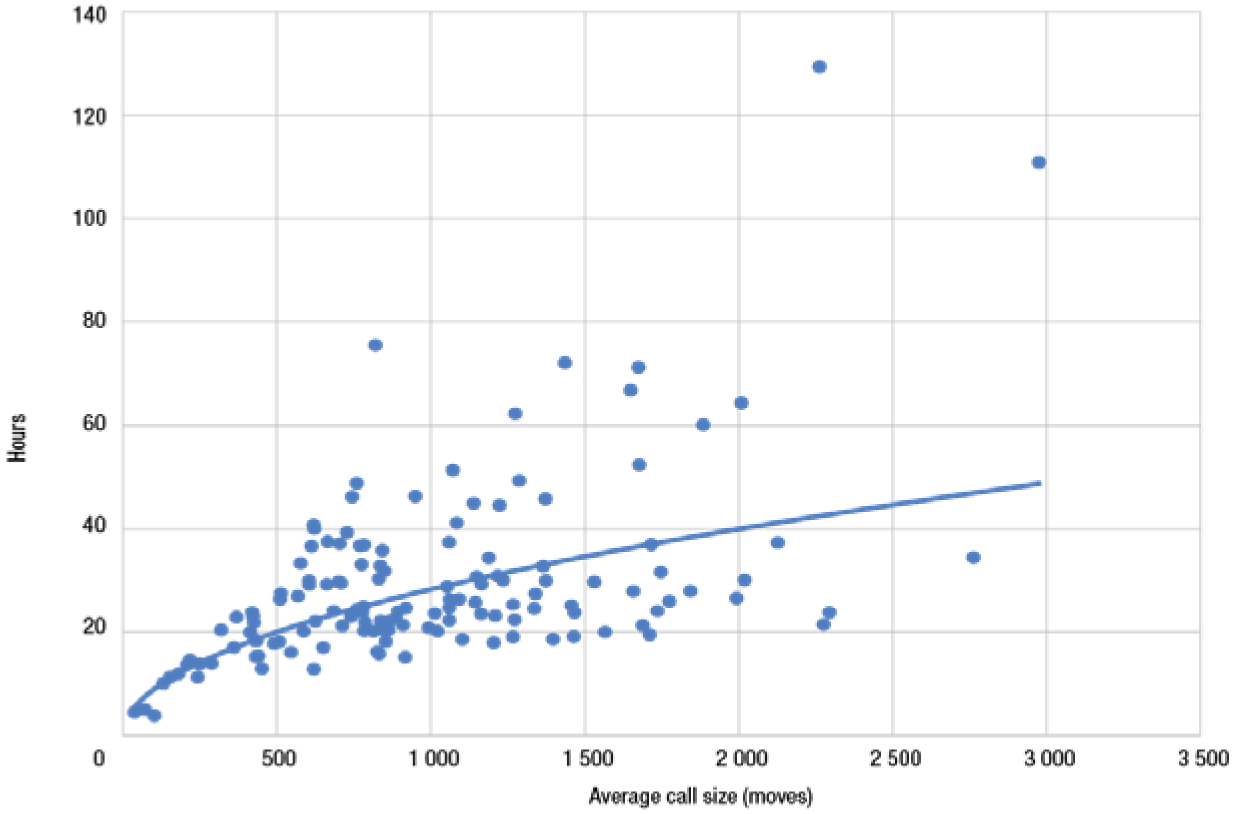
3. Economies of scale in port performance

The larger container ships appear to benefit from economies of scale. As a general rule of thumb, higher move counts (call size) on the larger ships allow terminals to deploy a higher quantity of cranes (crane intensity), and therefore handle more containers per ship hour than countries with smaller average vessel calls. Larger vessels also tend to be assigned a higher priority when scarce resources within a terminal or port are being shared among multiple ships. The larger vessels tend to be deployed to modern and efficient ports where the handling efficiency is significantly more refined than ports and terminals in secondary or tertiary ports of call.

As shown in figure 3.15, the more containers loaded and unloaded per port call (call size), the longer a ship needs to stay in port (average port hours). However, thanks to economies of scale, this relationship is not linear; as the call size goes up by 1 per cent, the time spent in port increases only by 0.5 per cent. The regressions illustrated in figures 3.15 and 3.16 statistically explain 47 per cent of the variance of the time a ship spends in port (R^2 = 0.47), while the remainder of the differences between countries need to be explained by factors such as trans-shipment incidence, port infrastructure, management and trade facilitation, as well as other parameters often associated with economic and institutional development.

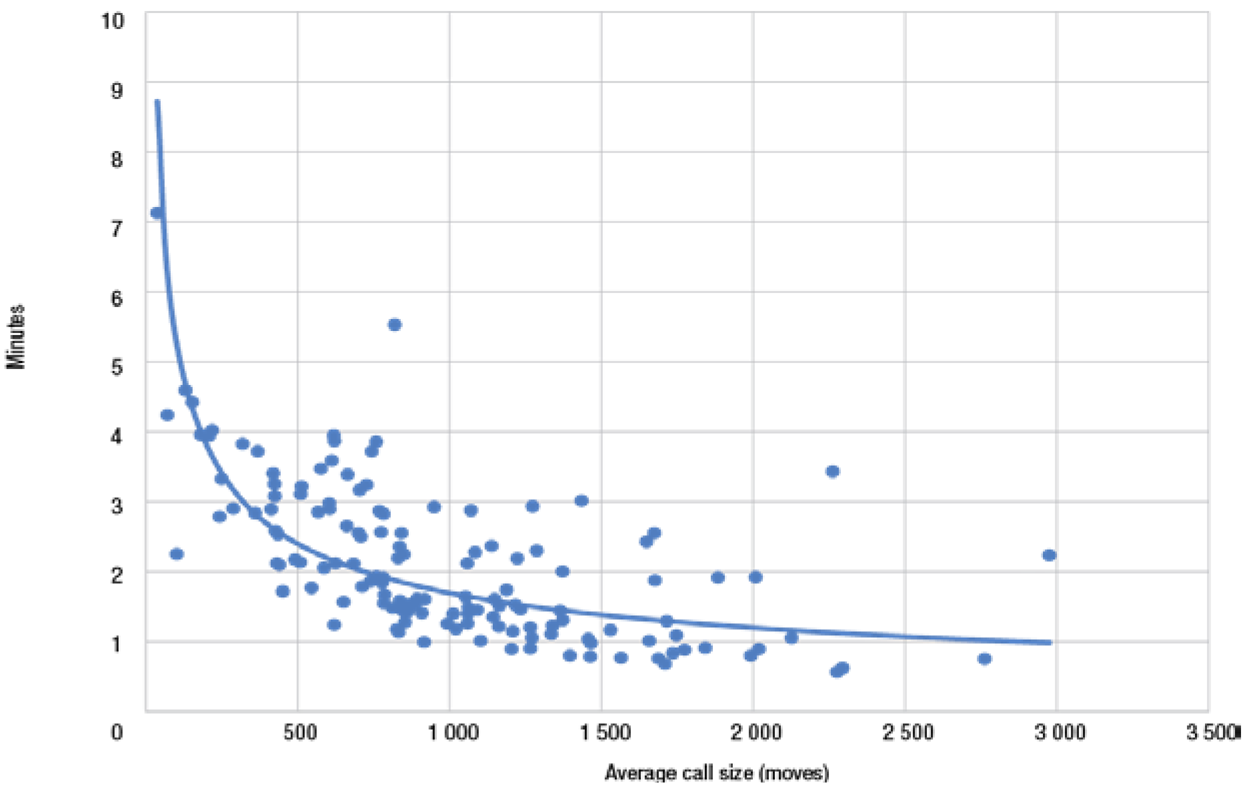
As shown in figure 3.15, the longest average port call durations are those of the Sudan and Yemen. Although both had few port calls in 2019, those port calls involved

Figure 3.15 Country averages of port time per ship and call size, 2019
(Hours in port and moves per port call)



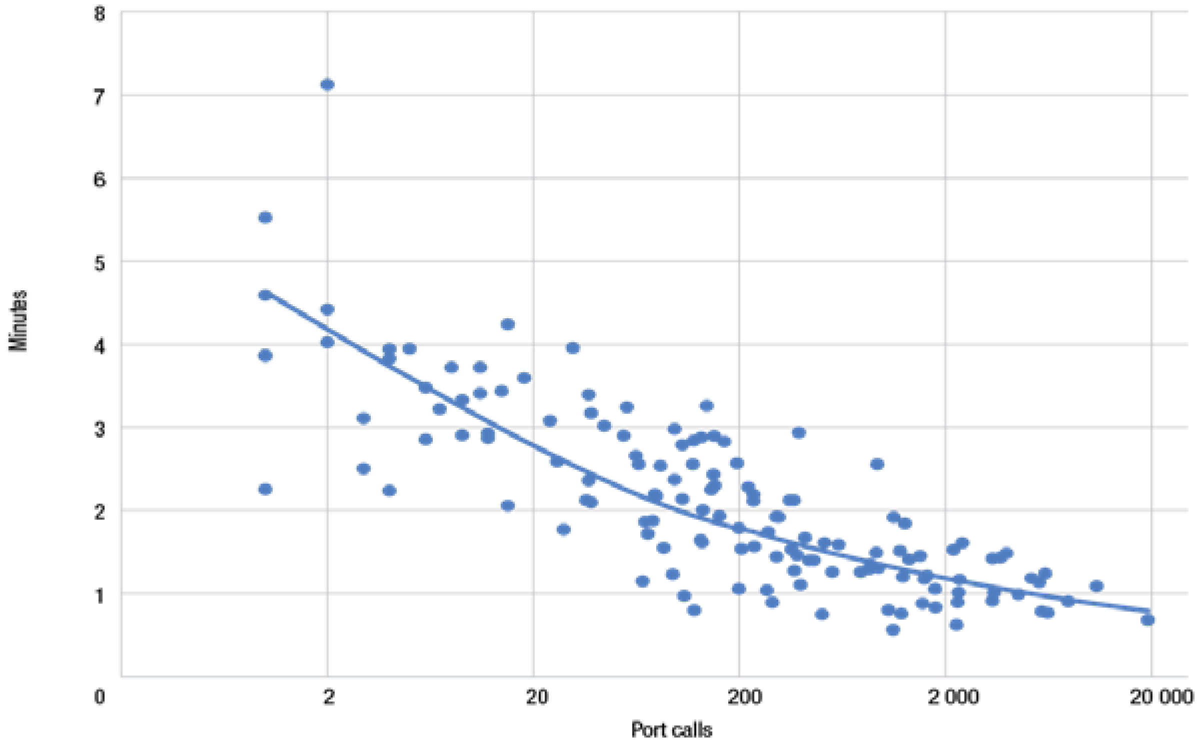
Source: UNCTAD calculations, based on data provided by the Journal of Commerce–IHS Markit Port Productivity Programme.
Note: $R^2 = 0.47$; $y = 0.90\ x^{0.50}$.

Figure 3.16 Minutes in port per container move and average call size, 2019



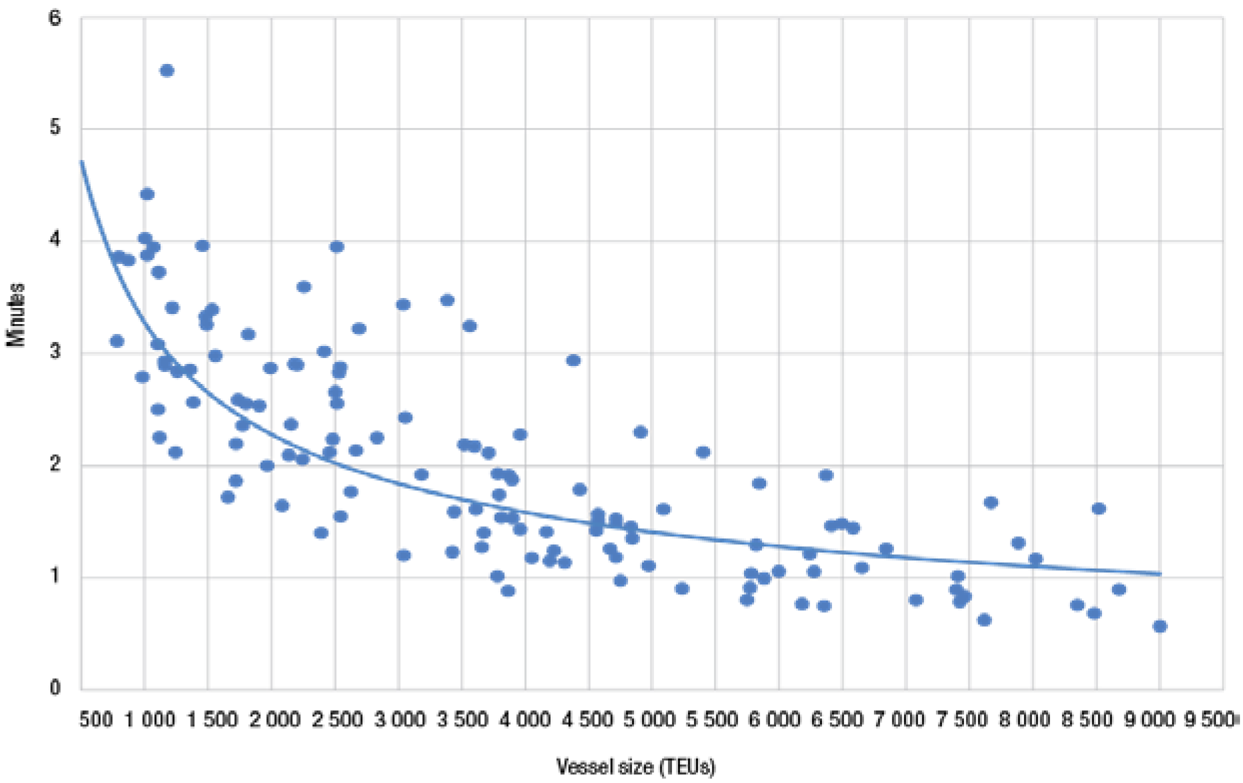
Source: UNCTAD calculations, based on data provided by the Journal of Commerce–IHS Markit Port Productivity Programme.
Note: $R^2 = 0.47$; $y = 53.83\ x^{-0.50}$.

Figure 3.17 Minutes in port per container move and number of port calls per country, 2019



Source: UNCTAD calculations, based on data provided by Journal of Commerce–IHS Markit Port Productivity Programme.
Note: $R^2 = 0.65$; $y = 4.63\ x^{-0.18}$.

Figure 3.18 Minutes in port per container move and average vessel size, 2019



Source: UNCTAD calculations, based on data provided by Journal of Commerce–IHS Markit Port Productivity Programme.
Note: $R^2 = 0.64$; $y = 123.04\ x^{-0.52}$.
Abbreviation: TEU, 20-foot equivalent unit.

a large number of loaded and unloaded import and export containers, for which the ships spent an average of more than 100 hours in port. The three countries with the highest average call size below the trend line (that is to say, they are more efficient) are Oman, Poland and the United Arab Emirates, which have a large share of trans-shipment cargo and whose main terminals are operated by international private terminal operators.

To shed further light on port performance and economies of scale, it is worth considering the time spent in port per container loaded and unloaded.

Economies of scale and efficiencies are mutually beneficial. The faster a ship can load and unload containers (the fewer minutes it needs per container in port), the more ships ports can accommodate with a given number of piers and infrastructure (figure 3.17). Increasing the number of calls by 1 per cent is associated with a decrease of the time in port per container by 0.18 per cent.

A similar picture emerges when the time in port is correlated with average ship sizes (figure 3.18). Larger ships will bring more containers and be assigned more resources (cranes, piers on arrival, yard equipment), and they will thus also spend less time in port for each container loaded and unloaded. At the same time, carriers will assign their largest and most expensive ships, preferably to those ports that can handle them in the shortest time. On average, increasing the average vessel size by one per cent is associated with an improvement in the time spent per container by 0.52 per cent. Among the five countries with the largest average vessel sizes, four are below the trend line, meaning they are more efficient. These are China, the Netherlands, Oman and Saudi Arabia. One is above the trend line: Croatia.

The economies of scale illustrated above are in line with the analysis of other data sets discussed in this chapter, in particular those relating to port traffic and fleet deployment (figure 3.12) and to the time spent in port (table 3.3). The importance of economies of scale does not bode well for small island economies (figure 3.6), which have fewer possibilities to attract more cargo, services or larger ships.

The following section will further explore the issue of port performance from the perspective of ports.

D. PORT PERFORMANCE: LESSONS LEARNED FROM THE TRAINFORTRADE PORT MANAGEMENT PROGRAMME OF UNCTAD

1. TrainForTrade port performance scorecard

Within the framework of the port network of the TrainForTrade Port Management Programme, over 3,600 port managers have been trained in the last two decades in 60 countries in Africa, Asia, Europe, Latin America and the Caribbean.[17]

This section reports on the latest developments regarding the port performance component of the TrainForTrade Port Management Programme. The initiative started in 2012 with a series of international conferences held in cities belonging to the TrainForTrade network (Belfast, Northern Ireland; Ciawi, Indonesia; Geneva, Switzerland; Manila, the Philippines; and Valencia, Spain). Thereafter, the port performance scorecard has gone through enhancements and upgrades to respond to four main technical requests from port members. The new pps.unctad.org website now features a more user-friendly interface, incorporated data-consistency checks, an automated past-entry function and advanced analysis tools by regions and categories with automated graphics and filters. The process captures data through annual surveys (starting with the year 2010) sent to focal points in each port entity around April, to report for the previous calendar year.

In 2020, 24 port entities (out of the 50 ports which reported data since the inception of the port performance scorecard) completed the 2019 survey, reporting a total of 2,509 data points with an average of 72 data points for the five-year rolling back average of the global results. The data were collected through a series of questions (82) from which the port performance scorecard derives 26 agreed indicators under the following six categories: finance, human resources, gender, vessel operations, cargo operations, and environment (table 3.8). This approach has been used since the inception of the port performance scorecard to ensure consistency and comparability of measures over time.

With the newest development of the port performance scorecard platform and the digital strengthening of the backbone information technology architecture, UNCTAD expects to increase the participation of port entities beyond the scope of the TrainForTrade network to provide more and more accurate and relevant data and analysis over time. Simultaneously, UNCTAD pursues efforts to include more port entities and countries from the TrainForTrade network that are not yet reporting

[17] See also TrainForTrade Port Management Series (volumes 1 to 7) featuring best case studies and actionable recommendations in line with the Sustainable Development Goals (https://tft.unctad.org/tft_documents/publications/port-management-series). The impact of the programme is measured regularly using two indicators from the TrainForTrade methodology: the performance rate (75 per cent global average) and the satisfaction rate (88 per cent global average) collected over time and for each activity conducted in the TrainForTrade network. Given the long-standing success of the Port Management Programme, which capitalizes on training and capacity-building for port managers and strengthening port institutions equally through the implementation of good governance mechanisms and best practices, it is now time for a deeper analysis of its long-term impact. Based on this assumption and with the support of member ports in the TrainForTrade network, Irish Aid and port partners (France, Ireland, Portugal, Spain and the United Kingdom), steps were taken at the operational level in 2012 to identify the necessary metrics for such an analysis.

Table 3.8	Port performance scorecard indicators, 2015–2019			
Category	**Indicator number**	**Description**	**Mean**	**Number of values**
Finance	1	EBITDA/revenue (operating margin)	38.8%	85
	2	Labour/revenue	22.3%	89
	3	Vessel dues/revenue	15.7%	90
	4	Cargo dues/revenue	34.9%	90
	5	Concession fees/revenue	14.7%	83
	6	Rents/revenue	6.4%	84
Human resources	7	Tons per employee	62 649	94
	8	Revenue per employee	$202 476	88
	9	EBITDA per employee	$104 812	80
	10	Labour cost per employee	$35 760	82
	11	Training cost/wages	1.6%	82
Gender	12	Female participation rate (global)	17.6%	96
	12.1	Female participation rate (management)	38.0%	95
	12.2	Female participation rate (operations)	13.2%	84
	12.3	Female participation rate (cargo handling)	5.5%	60
	12.4	Female participation rate (other employees)	29.4%	27
Vessel operations	13	Average waiting time (hours)	13	83
	14	Average gross tonnage per vessel	18 185	94
	15.1	Average oil tanker arrivals	10.4%	80
	15.2	Average bulk carrier arrivals	10.9%	81
	15.3	Average container ship arrivals	31.8%	79
	15.4	Average cruise ship arrivals	1.4%	78
	15.5	Average general cargo ship arrivals	23.6%	82
	15.6	Average other ship arrivals	24.2%	80
Cargo operations	16	Average tonnage per arrival (all)	7 865	103
	17	Tons per working hour, dry or solid bulk	416	60
	18	Tons per hour, liquid bulk	428	40
	19	Boxes per ship hour at berth	27	44
	20	20-foot equivalent unit dwell time (days)	7	54
	21	Tons per hectare (all)	140 408	91
	22	Tons per berth metre (all)	10 091	102
	23	Total passengers on ferries	1 458 596	57
	24	Total passengers on cruise ships	126 976	61
Environment	25	Investment in environmental projects/total CAPEX	7.2%	35
	26	Environmental expenditures/revenue	2.3%	50

Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.
Abbreviations: CAPEX, capital expenditure; EBITDA, earnings before interest, taxes, depreciation and amortization.

in the port performance scorecard component. Major advances in the port performance scorecard tools, enhanced in terms of how the data are validated, as well as comparisons with external data, essentially on gross tonnage and total time in port, add considerable value.

The number of participating ports across the regions has varied over the 10 years of reporting now held in the data set.[18] There are 23–26 ports that report comprehensively every year. This provides a basis for comparative financial and operational benchmarks. These reports can be applied by member ports in a range of planning and performance-based analyses. Table 3.9 provides a summary for the five-year period from 2015 to 2019 of the average port by region and size in each category using the traditional throughput performance measure.

The key elements of the data set are as follows:

- In 2019, port sizes ranged from 1.5 million tons to 80.7 million tons.
- The average port has handled 19.2 million tons per annum since 2015.
- The median value for the same period is 8 million tons.
- Twenty-five per cent of ports averaged less than 3.3 million tons over the 2015–2019 period.

[18] A partnership with MarineTraffic has been established to share data concerning the port entities participating in the port performance scorecard to ensure consistency of data provided by ports.

Table 3.9 Average annual throughput volume, 2015–2019
(Million tons)

Region	Category				
	Small <5m	Medium <10m	Large <20m	Very large <20m	Average
Africa	4.4	8.7	14.2	22.7	11.9
Asia	3.3	7.2		61.5	11.1
Europe	1.5			47.1	41.4
Latin America and the Caribbean	2.2	8.7	14.4	31.9	14.3
Average	**3.0**	**8.5**	**14.3**	**43.4**	**19.2**

Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

2. Financial sustainability

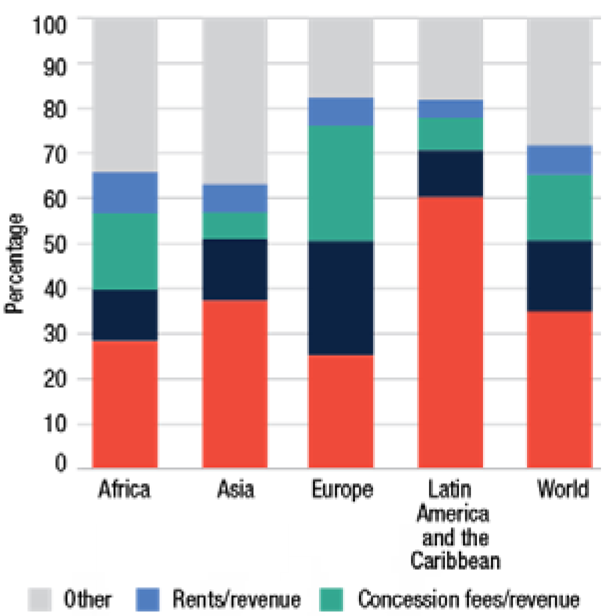
The financial analysis presented on the port performance scorecard platform shows the range of values for ports between 2015 and 2019. Over that period, the average of the annual total revenues of all participating ports was $1.97 billion or 417 million tons. The average revenue per ton varies widely, depending on a port's financial profile, including port dues, port estate, concessions and other services or investment income. Figure 3.19 shows the income categories of interest used in the data (indicators 3–6). The analysis of port revenue by region shows the expected dominance of cargo-related income for port entities, especially when compared with vessel-related income. Thus, ports generate a higher return on working quays for cargo and relatively less on marine assets such as dredged berths and channels.

The ports that show higher values in the concessions category tend to be larger ports with container terminals. Europe has the largest proportion of revenue for this income category.

Figure 3.20 represents the mean values for earnings before interest, taxes, depreciation and amortization as a proportion of revenue (indicator 1), while figure 3.21 shows labour costs as a proportion of revenue (indicator 2). Profit levels, represented here by indicator 1, were reported each year in a consistent range of 36–40 per cent as a global average; it appears reasonable to suggest that this average is a baseline required for a sustainable modern port.

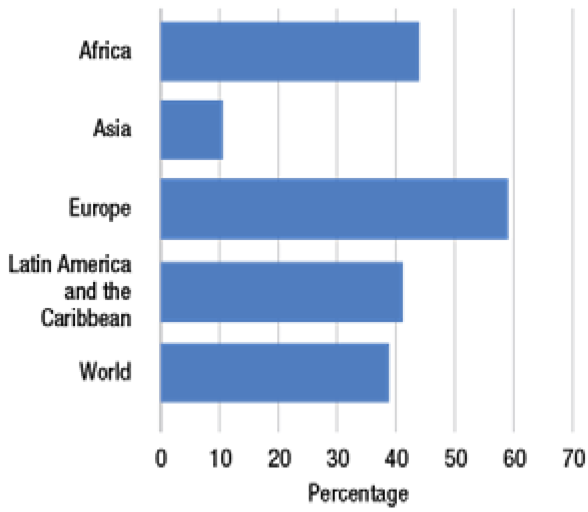
Between 2015 and 2019, the average revenue per port was $88.9 million; 50 per cent of ports brought in less than $49 million in revenue. The ports in quartile 1 (25 per cent of sample) averaged $13.3 million, whereas the large ports in quartile 3 (25 per cent of sample) averaged above $80 million per annum. It is not possible to share the results per individual port, but UNCTAD analysis finds evidence of average rates being closely aligned when similar ports in the same regional group are compared. For example, publicly available data for Irish ports shows this when gross revenue per ton is compared across Ireland. The financial indicators are useful benchmarks by region and by size when forecasting revenue for development projects.

Figure 3.19 Revenue mix of ports by region, 2015–2019



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

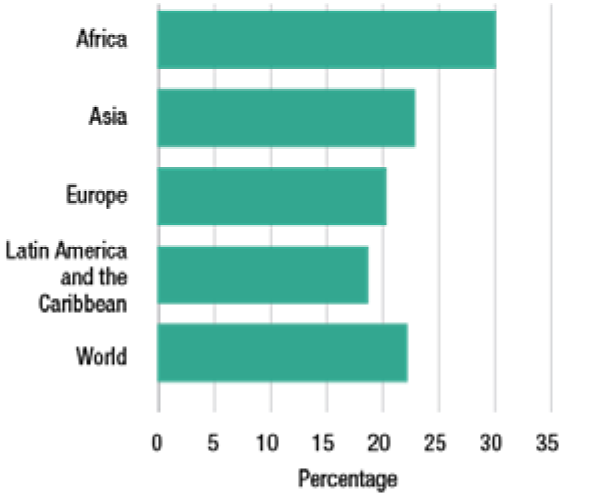
Figure 3.20 Earnings before interest, taxes, depreciation and amortization as a proportion of revenue, 2015–2019
(Percentage)



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network

Abbreviation: Earnings before interest, taxes, depreciation and amortization.

Figure 3.21 Labour costs as a proportion of revenue, 2015–2019



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

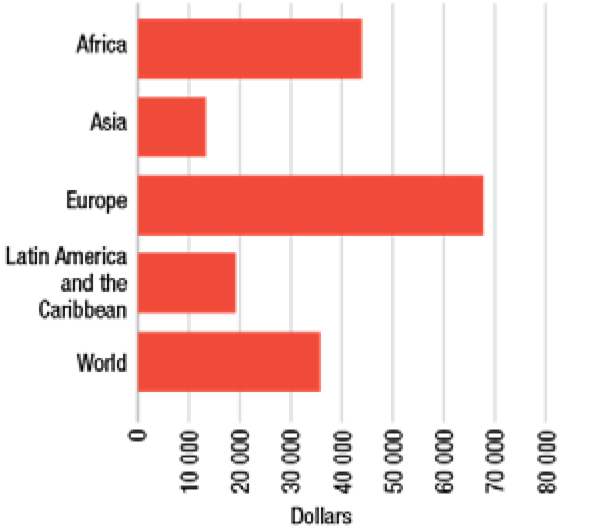
Labour costs have recorded a stable average over the 10 years covered by the port performance scorecard. Values have settled at around 20 to 22 per cent as a proportion of gross revenue (indicator 2). When analysed by region (figure 3.21) and as a proportion of the number of employees, there is a significant range across mean values. For Africa, the value is relatively high and for Latin America and the Caribbean, it is low. It is not clear at this level of data abstraction if this is attributable to rates of pay or employee numbers, which in turn may reflect levels of private supply to port entities as contractors. In the case of Latin America and the Caribbean, the average rate is lower than the global mean, suggesting that ports have relatively high staffing levels (figure 3.22, indicator 10). However, the analysis is less clear with regard to Africa, where labour rates are at the higher end of the spectrum. Europe shows the highest rate per employee – $67,705 per annum.

The average proportion of total capital expenditure on investment in environmental projects (indicator 25) is 7.2 per cent, with 2.3 per cent of operating expenditures reported being devoted to environmental requirements (indicator 26). This is a difficult number to isolate, and therefore the reported benchmarks come with a note of caution. However, throughout the data-collection period, the recorded numbers have been consistent. This suggests a relatively low proportion of total spending, and it will be useful to note any upward trend, should new regulatory requirements be implemented as the effects of climate change increase.

3. Gender participation

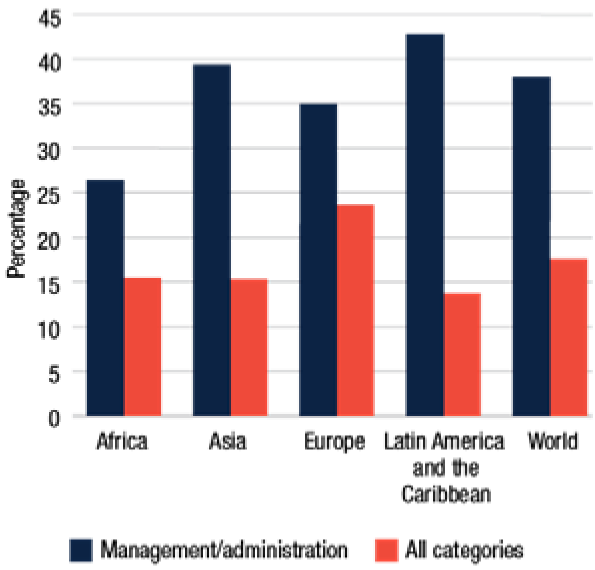
The gender profile remains low in terms of female participation in the port workforce (figure 3.23, indicators 12–12.4). The category that is not very far from a gender-balanced distribution is management

Figure 3.22 Average wages per employee, 2015–2019 (Dollars)



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

Figure 3.23 Female participation rate in the port workforce, 2015–2019



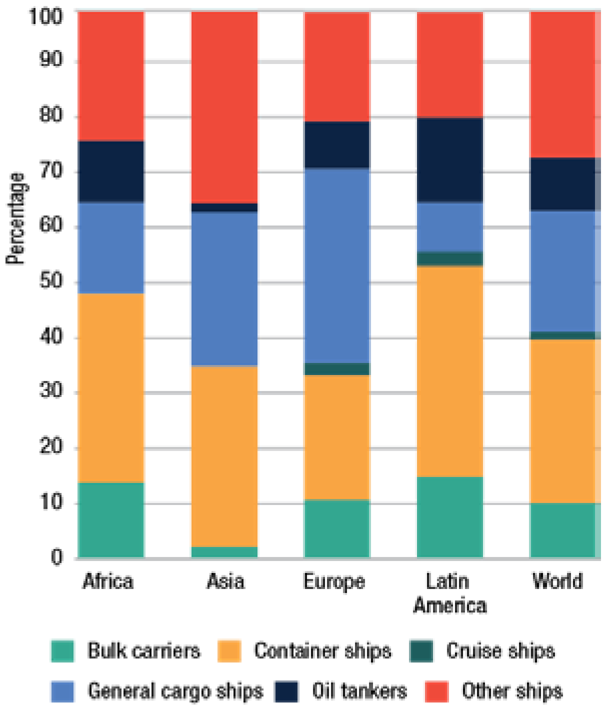
Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

and administration. However, much remains to be done across the participating ports to achieve greater female participation.

4. Vessel and cargo operations

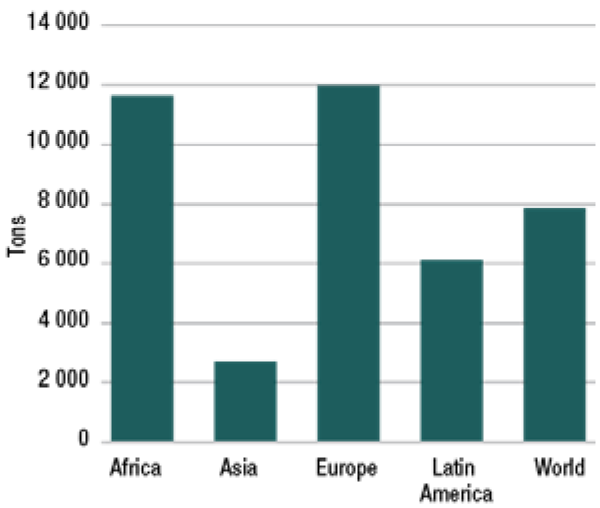
Figures 3.24 and 3.25 illustrate the profile of participating ports in terms of vessel type (indicators 15.1–15.6) and cargo volumes handled (indicator 16). The graphics show once again that there are no two ports with the same vessel and cargo mix. Both Africa and Europe have

Figure 3.24 Share of vessel arrivals, 2015–2019



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

Figure 3.25 Average cargo per arrival or departure, 2015–2019
(Tons)



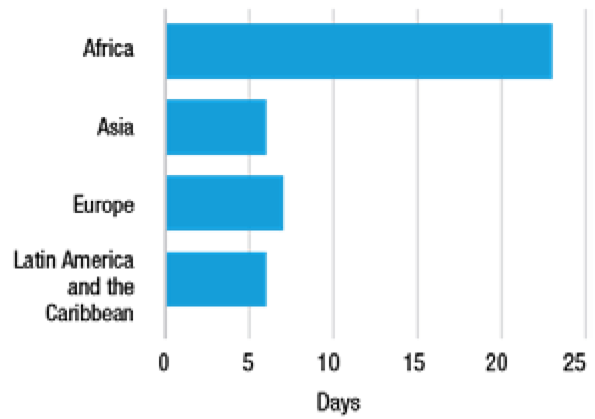
Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

the largest average cargo tons per arrival or departure but arguably for different reasons, given their different vessel mix.

Relating the average time in port to the varied cargo size per vessel can be a useful comparison. There is a tight range of 1.5–2 days in port, on average. Therefore, the larger cargo lots are handled by higher labour and equipment output. With container vessels taking, on average, less time in port (1.2 days), there are higher averages in dry and wet bulk carriers. Dry bulk carriers stay in port 3.5 days on average. Overall, data from the TrainForTrade network show values similar to the global statistics recorded through automatic identification system data (see section A of this chapter).

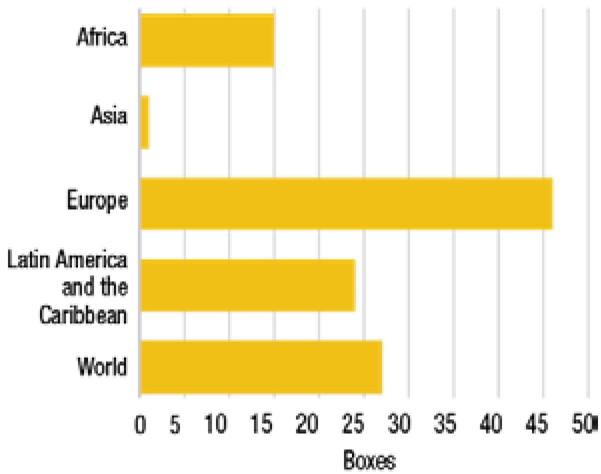
The online port performance scorecard shows little change in waiting times. Figures 3.26 and 3.27 provide some insights into the efficiency of container-handling operations. There are a wide range of values across the standard performance metrics of dwell time and crane lifting rates, and the overall results are in line with the data presented in section 3.C above. Europe has particularly

Figure 3.26 Maximum 20-foot equivalent unit dwell time, 2015–2019
(Days)



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

Figure 3.27 Average box-handling rate, 2015–2019
(Boxes per ship-hour)



Source: UNCTAD calculations, based on data provided by selected member ports of the TrainForTrade network.

higher lifting rates that perhaps reflect equipment capacity rather than labour efficiency (figure 3.27; indicator 19). Figure 3.26 shows the highest dwell time in days for each region (indicator 20). This topic requires sophisticated analysis to identify the reasons for slow processing, for example, customs procedures, storage agreements, port-container stripping, multiple-user facilities and congestion in road network at or near the port.