**Measuring the egyptian container ports' effeciecny: A FUZZY ahp framework**

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## Introduction

Efficiency is a fundamental concept in the field of economics; the concept is basically concerned with the economic use of frim resources for production (Lu and Wang, 2017). Moreover, it is an important contributor to a nation's international competitiveness (Elsayeh, 2015). Merk and Dang (2012) asserted that port efficiency is an important indicator of port performance; more efficient ports mean lower transportation costs.

There is downward pressure on efficiency and productivity in the Egyptian container ports due to a utilization rate of Egyptian container ports 73% (Maersk, 2015), which exceeds the maximum international accepted percent (70%) (Haralambides, 2012). Therefore, it will be important to measure the level of efficiency and quality of service provided in the Egyptian container ports, in order to define obstacles and improve their performance and productivity.

The purpose of this research is to propose a performance measurement framework to assess the level of efficiency of the container ports using Fuzzy Analytic Hierarchy Process (FAHP) approach. To demonstrate the applicability of the proposed framework, an empirical study on the Egyptian container ports was conducted for the period from 2012 to 2016. This framework will help port managers to evaluate the level of efficiency in container ports and define areas that need improvement. The paper starts with literature review in section two, section three will propose the framework, then section four will illustrate the empirical study, and finally conclusion will be presented in section five.

## Literature review

Monitoring a port’s performance in an ever-changing environment is crucial for measuring its efficiency levels as well as its competitiveness (Jimenez et al., 2013). Efficiency is one of the two most important concepts in measuring performance in container ports. Recently, the efficiency of container ports has become more important since it is one of the key factors of survival in the current competitive business environment in the shipping industry and a way to reduce maritime cost. Moreover, container ports are vital to the efficiency of the whole global logistics chain since they act as the connecting link between different transportation modes in the global logistics chain (Wang et al., 2005; Elsayeh, 2015).

Different approaches and techniques have been used to measure, assess, evaluate and benchmark the port efficiency from different perspectives depending on the aim, objective or the hypotheses of the study. Stochastic Frontier Analysis (SFA) technique was used by (Liu, 1995; Cullinane and Song, 2006; Sarriera et al., 2013); Free Disposal Hull (FDH) technique was used by (Cullinane et al., 2005; Herrera and Pang, 2008); Data Envelopment Analysis (DEA) technique was used by (Poitras et al., 1996; Tongzon, 2001; Al-Eraqi et al., 2008; Merk and Dang, 2012; [Kutin](https://www.researchgate.net/profile/Nikola_Kutin) et al., 2017); while other researchers have used integrated approaches combing several techniques such as DEA, SFA, FDH and Malmquist Productivity Index (MPI) (Cullinane et al., 2002; Wang et al., 2003; Cullinane et al., 2005; Wanke et al., 2011; Ding et al., 2015; Serebrisky et al., 2016; Hlali, 2018).

The Analytic Hierarchy Process (AHP) approach has not been utilized by previous studies to assess, evaluate or rank the performance of container ports (Al-Harbi, 2001; Cabała, 2010; Li and Yang, 2010; Sumi and Kabir, 2010; Elgazzar et al., 2010; Kousalya et al., 2012; Muhisn et al., 2015). AHP is a decision making technique for establishing priorities in multi-criteria decision making (Al-Harbi, 2001). AHP is most widely used technique in decision making due to its promising accuracy, simplicity, ability to handle both qualitative and quantitative criteria or tangible and intangible aspects, also, its ability to measure the consistency of judgment of respondents (Muhisn et al., 2015).

Using FAHP as a multi criteria decision making technique can help container ports’ managers to enhance ports’ technical efficiency through identifying the relative importance weight of each dimension of efficiency and define dimensions that are working well and those need improvements. There is no previous research used the FAHP technique to rank the Egyptian container ports. Moreover, limited studies have been conducted to measure the efficiency of the Egyptian container ports (Elsayeh, 2015). In this context, next section will propose a framework to measure the efficiency of container ports using FAHP approach, followed by an empirical study on the Egyptian container ports.

## The proposed framework

The paper proposes a framework to rank port efficiency using FAHP technique based on the following four steps:

## Step one: Identifying the criteria used to evaluate the level of efficiency in a container port

A review of previous studies was conducted to define main criteria reflect the level of container port efficiency. The review concluded with five main criteria to measure the container port efficiency; namely: storage capacity, terminal area, berth length, draught and handling equipment (Tongzon, 2001; Cullinane et al., 2005; Cullinane and Wang, 2010; Nwanosike, 2014; Elsayeh, 2015).

## Step two: Developing a FAHP survey to identify the relative importance of the selected criteria

FAHP survey was developed to determine the relative importance weight of the efficiency criteria in a container port based on a pairwise comparison scale ranging from 1 to 9, where 1 denotes equally important, 3 denotes moderately more important, 5 denotes strongly more important, 7 denotes very strongly more important, 9 denotes extremely important (Al-Harbi, 2001; Muhisn et al., 2015). Table 1 illustrates the survey form to prioritise the criteria of a container port's efficiency.

To determine the relative importance weight (W) of the selected criteria, survey will be distributed to group of experts in the field (port authority, shipping companies, shipping agencies, academic experts and other decision-makers in the field).

|  |  |  |
| --- | --- | --- |
| ***With respect to******(Port efficiency )*** | ***Importance or preference of one factor over the frame of******discernment (Decision Alternatives D.A.’s)*** |  |
|  | **Absolutely more important (9) Demonstrably more important (7) Strongly more important (5) Slightly more important (3)****Equally important (1)****Slightly more important (3) Strongly more important (5) Demonstrably more important (7) Absolutely more important (9)** |  |
| Storage capacity | 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Terminal area |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Berth length |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Draught |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Handling equipment |
| Terminal area | 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Storage capacity |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Berth length |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Draught |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Handling equipment |
| Berth length | 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Storage capacity |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Terminal area |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Draught |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Handling equipment |
| Draught | 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Storage capacity |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Terminal area |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Berth length |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Handling equipment |
| Handling equipment | 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Storage capacity |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Terminal area |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Berth length |
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 | Draught |

# Table 1: FAHP Questionnaire Form

Once judgments are entered by the group of experts, the level of consistency of responses will be tested. To verify the consistency of the comparison matrix, consistency index (CI) and consistency ratio (CR) are calculated using Saaty’s method (Saaty and Kearns, 1985).

For any metrics, if the value of the CR is smaller or equal to 10%, the inconsistency is acceptable (Mu and Rojas, 2017); while if the CR is greater than 10%, the pair-wise comparison processes should be repeated until the consistency ratio reaches less than 0.1 (Triantaphyllou and Mann, 1995).

## Step three: Establish a performance rating scale to evaluate each efficiency criterion

A five-point performance rating scale (very poor, poor, good, very good and excellent) is established based on container ship features to evaluate the five efficiency criteria in order to assess the efficiency of a container port. A performance rate (R) is assigned for each criteria (0.2, 0.4, 0.6, 0.8 or 1), where 0.2 denotes very poor performance, 0.4 denotes poor performance, 0.6 denotes good performance, 0.8 denotes very good performance and 1 denotes excellent performance.

## Step four: Calculate the efficiency index of a container port

After determining the performance rate (R) and the relative weight (W) of each criterion, the weighted rate (WR) of each criterion is calculated by multiplying the relative weight of each criterion by its performance rate. Finally, the weighted rates of all criteria are aggregated using a weighted average aggregation method to determine the efficiency index of a container port and rank it compared to indices of other ports.

## Empirical study

Egypt has a primary role in the world supply chain because of its geographic position, being at the intersection of the main maritime flows between East and West of the northern hemisphere. Furthermore, it features some of the major African ports such as Alexandria, Damietta and Port Said (Elsayeh, 2015). Egypt is identified as one of the busiest parts of the continent for maritime trade. The position of countries within global container shipping networks is reflected in the UNCTAD liner shipping connectivity index. In May 2016, Egypt was one of the best-connected countries in Africa (UNCTAD, 2017).

Egypt has six main container ports as clarified in Egyptian Maritime Data Bank (EMDB) (2015): Alexandria port, El Dekheila port, Damietta port, Port Said port, East Port Said port and Sokhna port. Alexandria port is situated on the western end of the Nile Delta between the Mediterranean Sea and the Mariut Lake. It is considered the main port in Egypt and handles over three-quarters of Egypt’s foreign trade. El Dekheila port is a natural extension of Alexandria port. Damietta port is located at about 10 Km west of the Nile River and about 70 Km west of Port Said port. Port Said port is located on the northern entrance of the Gulf of Suez. It is considered one of the most important Egyptian ports on the Mediterranean Sea due to its geographical site where it is located on the Eastern entrance of the Suez Canal. East Port Said port has ranked number 41 of the top 50 world container ports in 2015 with 3.60 million TEUs ([worldshipping.org,](http://www.worldshipping.org/) 2018). Sokhna port is located on the western coast of the Gulf of Suez.

This paper focuses on the six main container ports in Egypt to conduct the empirical study. To demonstrate the applicability of the developed framework, it has been applied on the six main Egyptian container ports based on port capacity data between 2012 and 2016 collected from Egyptian Maritime Data Bank.

The FAHP survey was carried out to determine the relative importance weight (W) of efficiency criteria in the Egyptian container ports. The survey was conducted with a group of 52 experts and decision- makers in the field from: (Egyptian navy, Egyptian Port Authority, shipping companies, shipping agencies and Academic experts in the field). After removing the invalid surveys, responses were analysed using Microsoft Excel Spreadsheets and PopTools add-in (version 3.2 (build 5)) to determine the relative importance weight of each criterion (Hood, 2010).

Table 2 illustrates the relative importance weights of the five main criteria based on survey responses. The results revealed that draught has the highest relative importance weight since draft is a significant factor limiting navigable waterways, especially for large vessels which require deeper draft to attract bigger ships. Handling equipment had the second priority with relative importance weight 29% since effective handling equipment reduces time in port and increases ships call numbers. Storage capacity was placed in the third position with 17% relative importance weight, while both terminal area and berth length approximately had the same relative importance weight presenting the fourth priority.

|  |  |
| --- | --- |
| ***Criteria*** | ***Priority*** |
| Storage capacity | 17% | 3 |
| Terminal area | 11% | 5 |
| Berth length | 11% | 4 |
| Draught | 32% | 1 |
| Handling equipment | 29% | 2 |

# Table 2: Relative Importance Weights of the Container Port Efficiency Criteria

To verify the consistency of responses, CR and CI were calculated. As illustrated in table 3, the results revealed CR 0.02 which is lower than the maximum accepted Consistency Ratio (0.1) and ensures the consistency of the survey findings.

|  |
| --- |
| ***Consistency test table*** |
| **EIGENVALUE** | **N** | **CI** | **RI** | **CR** |
| 5.090550009 | 5 | 0.0226375 | 1.12 | 0.020212056 |

\*Where N presents the number of criteria

# Table 3: Consistency Test Results

A five-point performance rating scale was established to evaluate the efficiency criteria based on the features of "the Triple E container ship" which is the biggest container ship that can be handled in the Egyptian container ports. Finally, the weighted rates of all criteria in each port were calculated and aggregated to determine the efficiency index of each port. Table 4 shows the efficiency index of the Egyptian container ports based on the aggregated weighted rates of the five efficiency criteria.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Egyptian container ports/Criteria | Storage capacity | Terminal area | Berth length | Draught | Handlingequipment | effici ency index | Rank |
| W | R | WR | W | R | WR | W | R | WR | W | R | WR | W | R | WR |
| Alexandria | 0.17 | 0.2 | 0.03 | 0.11 | 0.2 | 0.02 | 0.11 | 0.4 | 0.05 | 0.32 | 0.4 | 0.13 | 0.29 | 0.2 | 0.06 | 0.287 | 6 |
| El-Dekheila | 0.17 | 0.4 | 0.07 | 0.11 | 0.4 | 0.04 | 0.11 | 0.6 | 0.07 | 0.32 | 0.2 | 0.06 | 0.29 | 0.4 | 0.12 | 0.359 | 5 |
| Damietta | 0.17 | 0.2 | 0.03 | 0.11 | 0.4 | 0.04 | 0.11 | 0.4 | 0.05 | 0.32 | 0.6 | 0.19 | 0.29 | 0.6 | 0.17 | 0.488 | 3 |
| East PortSaid | 0.17 | 0.8 | 0.13 | 0.11 | 0.8 | 0.09 | 0.11 | 0.8 | 0.09 | 0.32 | 0.6 | 0.19 | 0.29 | 0.8 | 0.23 | 0.736 | 1 |
| Port Said | 0.17 | 0.2 | 0.03 | 0.11 | 0.4 | 0.04 | 0.11 | 0.2 | 0.02 | 0.32 | 0.4 | 0.13 | 0.29 | 0.6 | 0.17 | 0.401 | 4 |
| El-Sokhna | 0.17 | 0.2 | 0.03 | 0.11 | 0.4 | 0.04 | 0.11 | 0.4 | 0.05 | 0.32 | 0.8 | 0.25 | 0.29 | 0.4 | 0.12 | 0.494 | 2 |

# Table 4: The Efficiency Index of the Egyptian Container Ports

The results revealed that East Port Said port has the highest score in the efficiency index (0.736), El- Sokhna port took the second position, Damietta port took the third position, Port Said port took the fourth position, El-Dekheila port took the fifth position and finally Alexandria port took the sixth position with the lowest efficiency index (0.287). The index can be disaggregated to identify criteria that need improvement in the Egyptian container ports.

## Conclusions

The paper proposed a framework to measure the efficiency level in container ports. An empirical study was conducted on the Egyptian container ports for the period between 2012 and 2016.

This paper considered the first empirical study that assesses the efficiency of the Egyptian container ports using FAHP technique. The proposed framework presented in this research can be used in assessing, evaluating and ranking any container port around the world since the efficiency criteria used in this research are the most common criteria used in evaluating a container port. However, the relative importance weight of each criterion can be varied from one port to another, which can be adjusted using the FAHP survey. For further research, the new world container ships can be used to set higher performance rating scale. For example, OOCL Hong Kong which requires 32.5 m draught and 399.87 m berth length at least (Network, 2018), can be considered as a benchmark to establish international performance rating scale to assess any container port around the world in order to compete globally.

## Reference

* Al-Eraqi, A. S., Mustafa, A., Khader, A. T. and Barros, C.P. (2008) “Efficiency of Middle Eastern and East African Seaports: Application of DEA Using Window Analysis”, European Journal of Scientific Research, 23, pp. 597-612.
* Al-Harbi, K.M.A. (2001) “Application of the AHP in project management”, *International Journal of Project Management.* 19 (1), pp.19-27.
* Cabała, A. (2010) “Using The Analytic Hierarchy Process in Evaluating Decision”. *Operations Research and Decisions.* 1. pp. 5-23.
* Cullinane, K., Song, D-W and Gray, R. (2002) “A stochastic frontier model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures”, *Transportation Research,* Part A 36, pp. 743-762.
* Cullinane, K., Song, D-W and Wang. T-F. (2005) “The application of mathematical programming approaches to estimating container port production efficiency”. *Journal of Productivity Analysis.* 24. pp. 73-92.
* Cullinane, K. and Song, D-W. (2006) “Estimating the relative efficiency of European container ports: a stochastic frontier analysis”, Port Economics*, Research in Transportation Economics.* 16, pp. 85-115.
* Cullinane, K. and Wang, T-F. (2010) “The efficiency analysis of container port production using DEA panel data approaches”. REGULAR ARTICLE (2010) 32. pp. 717-738.
* Ding, Z-Y.; JO, G-S.; Wang, y. and Yeo, G-T. (2015) “The Relative Efficiency of Container Terminals in Small and Medium-Sized Ports in China”, The Asian journal of shipping and logistics, 31, pp. 231-251.
* Elgazzar, S., Tipi, N.S., Hubbard, N.J. and Leach, D.Z. (2010) “Incorporating fuzzy AHP in SCOR model for measuring supply chain operations performance: a case study of an Egyptian natural bottled water company”. In: Proceedings of the 15th Annual Logistics Research Network Conference (LRN 2010), Harrogate, UK, 8-10 September 2010, pp.180-187.
* Elsayeh, M. (2015) “*The impact of port technical efficiency on Mediterranean container port competitiveness”,* PhD Thesis. University of Huddersfield.
* EMDB, 2015. “*Maritime Ports Guide (commercial and specialized)”.* EMDB management & operation project. Arab Republic of Egypt. Ministry of transport. Maritime transport sector.
* Hood, G. M. (2010) PopTools version 3.2.5. [on line] Available at: [http://www.poptools.org](http://www.poptools.org/)
* Haralambides, E. H. (2012) “Ports: engines for growth and employment”, European Ports Policy Review,Availablefrom:[https://www.researchgate.net/publication/294872325\_Ports\_Engines\_for\_Growth\_and\_Employment.](https://www.researchgate.net/publication/294872325_Ports_Engines_for_Growth_and_Employment)
* Hlali, A. (2018) “Efficiency Analysis with Different Models: The Case of Container Ports”. *Journal of Marine Science: Research & Development.* 8 (2).
* Herrera, S. and Pang, G. (2008) “Efficiency of Infrastructure: The Case of Container Ports”, *EconomiA.* 9 (1), pp. 165-194
* Jimenez, Z. I., Gutiérrez, A. and Ortiz, C. (2013) “Port Efficiency in APEC”, *México y la Cuenca del Pacífico,* 3, pp. 41-74.
* Kousalya, P., Reddy G. M., Supraja, S. and Prasad V. S. (2012) “Analytical Hierarchy Process approach – An application of engineering education”, *Mathematica Aeterna.* 2 (10), pp. 861-878.
* [Kutin,](https://www.researchgate.net/profile/Nikola_Kutin) N., [Nguyen,](https://www.researchgate.net/researcher/2111572852_Thanh_Thuy_Nguyen) T., H. and [Vallée,](https://www.researchgate.net/researcher/2130387366_Thomas_Vallee) T. (2017) “Relative Efficiencies of ASEAN Container Ports based on Data Envelopment Analysis*”, Asian Journal of Shipping and Logistics*. 33 (2), pp. 67-77.
* Li, T. G. and Yang, B. (2010) “Study on Green Logistics Operation System of Port Based on AHP-fuzzy
* Comprehensive Evaluation”. *2nd International Conference on Industrial and Information Systems.*
* Liu, Z. (1995) “The comparative performance of public and private enterprises”. *Journal of Transportation Economics and Policy.* September. pp. 263-274.
* Lu, B. and Wang, S. (2017) *Container Port Production and Management.* 1st ed. Beijing.
* Tongzon, J. L. (2001) “Efficiency measurement of selected Australian and other international ports using data envelopment analysis”. *Transportation Research.* Part A 35. pp. 107-122
* Maersk (2015) Maersk Home Page, 1 August 2015, Available from: [https://www.maersk.com/-/media/press/trade-reports/africa/egypt/connecting-markets---the-suez-view\_large-version.ashx.](https://www.maersk.com/-/media/press/trade-reports/africa/egypt/connecting-markets---the-suez-view_large-version.ashx) [Accessed: 1st December 2017].
* [Mu,](https://scholar.google.com.eg/citations?user=VriJlW4AAAAJ&amp;hl=en&amp;oi=sra) E. and [Rojas,](https://scholar.google.com.eg/citations?user=G-omchcAAAAJ&amp;hl=en&amp;oi=sra) M. P. (2017) “Understanding the Analytic Hierarchy Process”. Practical Decision Making using Super Decisions. pp. 7-22.
* Muhisn, Z. A. L., Omar, M., Ahmad, M. and Muhisn, S. A. (2015) “Team Leader Selection by Using an Analytic Hierarchy Process (AHP) Technique”, *Journal of Software,* 10 (10), pp. 1216-1227.
* Merk, O. and Dang, T. T. (2012) “Efficiency of world ports in container and bulk cargo (oil, coal, ores and grain)”. *OECD Regional Development Working Papers.* 2012/09.
* Nwanosike, F. O. (2014) “*Evaluation of Nigerian Ports Post-concession Performance”.* PhD Thesis. University of Huddersfield.
* Network, M. (2018). 10 World’s Biggest Container Ships in 2017. [online] Marine Insight. Available at: [https://www.marineinsight.com/know-more/10-worlds-biggest-container-ships-2017/.](https://www.marineinsight.com/know-more/10-worlds-biggest-container-ships-2017/)
* Poitras, G., Tongzon, J. and Li, H. (1999) Measuring Port Efficiency: An Application of Data Envelopment Analysis. *Department of Economics and Statistics,* National University of Singapore.
* Saaty, T. L. and Kearns, K. (1985) “*Analytical Planning; The Organization of Systems”,* Oxford: Pergamon Press.
* Sarriera, J. M., Araya, G., Serebrisky, T., Briceñogarmendía, C. and Schwartz, J. (2013) “Benchmarking Container Port Technical Efficiency in Latin America and the Caribbean”, *The World Bank Latin America and the Caribbean Region Sustainable Development Department.* Policy Research Working Paper 6680.
* Serebrisky, T., Sarriera, J. M., Suárez-Alemán, A., Araya, G., Briceño-Garmendía, C. and Schwartz, J. (2016) “Exploring the drivers of port efficiency in Latin America and the Caribbean”. *Transport* Policy. 45. pp. 31-45.
* Sumi, R. S., and Kabir, G. (2010) “Analytical Hierarchy Process for Higher Effectiveness of Buyer Decision Process”. *Global Journal of Management and Business Research,* 10 (2). pp. 1-9.
* Triantaphyllou, E. and Mann, S. H. (1995) “Using The Analytic Hierarchy Process for Decision Making in Engineering Applications: Some Challenges”. *Inter’l Journal of Industrial Engineering: Applications and Practice*,2 (1). pp. 35-44.
* UNCTAD (2017) Review of Maritime Transport. United Nations. New York.
* Wanke, P. F., Barbastefano, R. G. and Hijjar, M. F. (2011) “Determinants of efficiency at major Brazilian port terminals”, *Transport Reviews.* 31 (5), pp. 653-677.
* Wang, T. F., Song, D. W. and Cullinane, K. (2003) “Container Port Production Efficiency: A Comparative Study of DEA and FDH Approaches”. *Journal of the Eastern Asia Society for Transportation Studies.* 5. pp. 698-713.
* Wang, T. F., Cullinane, K. and Song, D. W. (2005) “[*Container Port Production and Economic*](http://www.bookmetrix.com/detail/book/a41ffbaa-dae9-4c16-84e2-f0396e281cba) [*Efficiency*](http://www.bookmetrix.com/detail/book/a41ffbaa-dae9-4c16-84e2-f0396e281cba)*”.* Palgrave Macmillan, Basingstoke, Hampshire; New York. DOI. [10.1057/9780230505971.](https://doi.org/10.1057/9780230505971)
* Worldshipping.org. (2018*). Top 50 World Container Ports | World Shipping Council.* [online] Available at: [http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports.](http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports)