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Marino LUPI*, Antonio PRATELLI, Cecilia LICANDRO, Alessandro FARINA

University of Pisa

Largo Lucio Lazzarino 2, 56126 Pisa, Italy

*Corresponding author. E-mail: marino.lupi@unipi.it

THE EVOLUTION OF DEEP SEA CONTAINER ROUTES: THE ITALIAN CASE

Summary. In this study, an analysis of deep sea shipping (DSS) container services, calling at Italian ports, is carried out. A comparison with analogous sets of data collected in the years 2011 and 2014 has been performed. The most important Italian port system is the Ligurian one, which includes the main Italian port, Genoa, which is the main access gate to the Padan Plain, the most productive area of Italy. However, other ports are also important: the Ligurian port of La Spezia and the hub port of Gioia Tauro. The comparison, with 2011 and 2014 data, has shown that while the number of DSS departures, from Italian ports, did not increase, the dimensions of the ships, which call at Italian ports, increased relevantly: this is in line with the current trend in container ship gigantism.

1. INTRODUCTION

In Notteboom [1], a gateway has been defined as a network point which acts as an entrance to another network. Often there is more than one port which plays the role of gateway node for a specific inland transport network (which, therefore, gives access to a specific region by sea) (Notteboom [2]). Gateway ports can be grouped into “multi-port gateway regions”: for these ports, the hinterland overlaps substantially. The hinterland of a port has been defined as “the area of which the greater part of the trade passes through the port” (Notteboom and Rodrigue [3]). The hinterland of a port can be distinguished between the “fundamental hinterland” and the “competitive hinterland” (Rodrigue [4]). The fundamental hinterland is the port core market and consists of the port captive market, i.e., the areas which mainly, or exclusively, belong to the port market: it is usually formed by regions which are the closest to the port. The “competitive hinterland” is the external area of the port hinterland, which is overlapped with the hinterland of other ports.

Notteboom (Fig. 3 of [5]) identified, in Europe, the major “multi-port gateway regions” with regard to container handling. Among gateway ports, there are those that also handle a relevantly transshipment traffic (for example, the port of Valencia: its transshipment share has been 60% in 2017 (Source: Puertos del Estado [6])) and therefore can be distinguished from those that can be defined as, instead, “nearly pure gateway” ports.

Basing on the classification of Notteboom [5], the Italian container port system can be divided into the following systems:

- Ligurian multi-port gateway system: it consists of the ports of Savona, Genoa, La Spezia, and Livorno. This gateway system is located on the southern edge of the Rhine–Alpine corridor;
- Northern Adriatic gateway multi-port system: it consists of the ports of Ravenna, Venezia, and Trieste and of the non Italian ports of Koper (Slovenia) and Rijeka (Croatia). This gateway system is located on the southern edge of the Baltic–Adriatic corridor;

- Campanian gateway system: it consists of the ports of Napoli and Salerno;
- Italian hub ports system: it consists of the ports of Gioia Tauro and Cagliari. In particular, the port of Gioia Tauro has been, for several years, among the greatest Mediterranean transshipment ports, and it is devoted almost exclusively to this function (nearly pure hub port). In the past, among the Italian hub ports, there was also the port of Taranto: in 2018, it discontinued operating container traffic after the closure of the container terminal.

The majority of deep sea shipping (DSS) container routes are offered by ports belonging to the above-mentioned clusters. Three other ports, which do not belong to any one of the aforementioned clusters, offer some DSS services: Civitavecchia, Bari and Catania. In March 2018, Civitavecchia was crossed by 9 DSS container ships, while Bari and Catania by 2.

The Padan Plain, which represents the most productive area of Italy, is in the hinterland of Ligurian and Northern Adriatic gateway port systems. However, the Padan Plain indeed constitutes also an “island formation” of the hinterlands of northern range ports (i.e. northern European ports, between Hamburg and Le Havre), especially Zeebrugge, Rotterdam, Antwerp and Hamburg, in the hinterlands of Italian ports (Van Klink and Van Der Berg [7], Fig. 3; Ferrari et al. [8]). On the other hand, as stated in Acciaro et al. [9], northern Italian ports, in particular northern Adriatic ones, are in a favorable position to attract in their hinterland Central European countries, especially Austria and southern Germany.

In this paper, first, an analysis of DSS container services to/from Italian ports, operated in March 2018, is performed. Later, 2018 data are compared with those collected in January 2011 and August 2014, reported, respectively, in Lupi et al. [10, 11].

The paper is organized as follows. Section 2 focuses on the trend of the overall container traffic at Italian ports. In Section 3, details on container deep sea shipping services, at major Italian ports, in the year 2018, are provided. In Section 4, a comparison between data in the year 2018, 2014 and 2011 is carried out and conclusions follow.

2. THE TREND OF CONTAINER TRAFFIC IN ITALIAN PORTS

In Table 1, the development of containerized traffic in Italian ports, from 2007 (the pre-crisis year) to 2017, is reported. In the year 2000, the overall Italian throughput increased until the years 2007-2008, when the maximum throughput, of 10.5–10.6 million TEUs, was reached. After 2008, a long period of crisis followed, in correspondence with a general crisis in the Italian economy, which resulted: in a severe decrease of traffic in 2009, a slight increase in 2010, fluctuations from 2010 to 2015, around the value of 10 million TEUs, and finally a slight increase in 2016 and 2017. In any case, the pre-crisis traffic, 2007 traffic, has been caught up with only in 2017. The average growth rate of Italian throughput, considering the total (that is: DSS + SSS (Short Sea Shipping)) container traffic, from 2011 (the first year of analysis of DSS routes) to 2017 has resulted in being +1.88%.

The main port in the Ligurian gateway system, but also in the whole Italian port system, is Genoa, which has been the only Italian port to register an almost constant increase in the container throughput in the last years: in 2017, Genoa overcame 2.6 million TEUs. It must be noted that in 2017, Genoa recorded even higher throughput than Gioia Tauro, which in the preceding years was the Italian port with the highest container traffic. Gioia Tauro is a hub port, while Genoa is a gateway port: as reported in Iannone [12] (p. 22, Table 3), the added value of a transshipped container is not comparable to the added value of a container in import or export. Other two important ports in the Ligurian gateway system are La Spezia and Livorno. The Ligurian system throughput (DSS + SSS) has seen an average growth rate of 3.51% from 2011 to 2017.

The north Adriatic multiport gateway system is made up by the following ports: the Italian ports of Ravenna, Venice, and Trieste; the Slovenian port of Koper; the Croatian port of Rijeka. The most important Italian ports are Venice and Trieste, which registered over 600,000 TEUs in 2017: the great majority of this container traffic refers to short sea shipping (SSS) services. The port of Koper experienced an important increase of throughput in the last years: it has become the first container port of the North Adriatic multi-port system with a container throughput of over 900,000 TEUs in 2017.

Rijeka instead recorded a much smaller throughput, around 200,000 TEUs, almost the same throughput as Ravenna, the third Italian northern Adriatic port. The average growth rate of northern Adriatic container traffic (DSS + SSS) has been higher than that of the Ligurian ports. The average growth rate, from 2011 to 2017, of the Italian northern Adriatic ports has been 5.2%; the average growth rate of non-Italian Adriatic ports (that is Koper and Rijeka), from 2011 to 2017, has been 7.8%; the average growth rate of all (Italian and non-Italian) northern Adriatic ports, from 2011 to 2017, has been 6.31%. The majority of container traffic of northern Adriatic ports refers to SSS services.

Table 1

Container throughput at Italian ports, in thousands of TEUs, in the period 2007–2017. The average growth rate has been calculated from 2011 (the first year of analysis of DSS routes) to 2017.

Source: Assoporti [13, 14]

PORTS	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average growth rate 2011-2017
Genoa	1855.0	1766.6	1533.6	1758.9	1847.1	2064.8	1988.0	2173.0	2242.9	2297.9	2622.2	6,01%
La Spezia	1187.0	1246.2	1046.1	1285.2	1307.3	1247.2	1300.4	1303.0	1300.4	1272.4	1473.6	2,02%
Savona	242.7	252.8	196.3	196.4	170.4	75.3	77.9	85.3	98.0	54.6	44.1	-20,17%
Livorno	745.6	778.9	592.1	628.5	637.8	549.0	559.2	577.5	780.9	800.5	734.1	2,37%
Total Ligurian gateway	4030.3	4044.5	3368.1	3869.0	3962.6	3936.3	3925.5	4138.8	4422.2	4425.4	4874.0	3,51%
Ravenna	206.8	214.3	185.0	183.6	215.3	208.2	226.7	222.6	244.8	234.5	223.4	0,62%
Venice	329.5	379.1	369.5	393.9	458.4	429.9	446.5	456.1	560.3	605.9	611.4	4,92%
Trieste	265.9	335.9	277.0	281.6	393.2	408.0	458.6	456.1	560.3	605.9	611.4	7,63%
Total Italian north Adriatic gateway	802.2	929.3	831.5	859.1	1066.9	1046.1	1131.8	1134.8	1365.4	1446.3	1446.2	5,20%
Napoli	460.8	481.5	515.9	534.7	526.8	546.8	477.0	431.7	438.3	438.5	509.9	-0,54%
Salerno	385.3	330.4	269.3	234.8	235.2	208.6	263.4	320.0	359.3	388.6	454.7	11,61%
Total Campanian gateway	846.1	811.9	785.2	769.5	762.0	755.4	740.4	751.7	797.6	827.1	964.6	4,01%
Gioia Tauro	3445.3	3467.8	2857.4	2852.2	2305.0	2721.1	3094.3	2969.8	2546.8	2797.1	2448.6	1,01%
Cagliari	547.3	307.5	737.0	629.3	603.2	627.6	702.1	717.0	748.6	723.0	463.9	-4,28%
Taranto	755.9	786.7	741.4	581.9	604.4	236.5	197.3	148.5	-	0.4	-	-100%
Total hub ports	4748.5	4562.0	4335.8	4063.4	3512.6	3585.2	3993.7	3835.3	3295.4	3520.5	2912.5	-3,07%
TOTAL ITALY	10609.1	10549.9	9514.7	9778.0	9526.8	9618.7	10082.0	10224.7	10190.6	10573.4	10651.4	1,88%
Koper (SLO)	305.6	353.9	343.2	476.7	589.3	570.7	600.4	674.0	790.7	844.8	911.5	7,54%
Rijeka (HR)	145.0	168.8	130.7	137.0	150.7	171.9	169.9	192.0	200.1	214.3	250.0	8,80%
Total non-Italian Adriatic gateway	450.7	522.6	473.9	613.8	740.0	742.7	770.4	866.0	990.8	1059.1	1161.5	7,80%
Total Adriatic gateway: Italian + non Italian	1252.9	1451.9	1305.4	1472.9	1806.9	1788.8	1902.2	2000.8	2356.2	2505.4	2607.7	6,31%

As far as the Campanian gateway ports are concerned, a slight reduction of the container traffic of Napoli and a consistent increase of the container traffic of Salerno can be observed. The average growth rate of total (DSS + SSS) container traffic, of the Campanian gateway, from 2011 to 2017, has been 4%, and it is completely due to the growth of Salerno traffic.

Regarding the Italian hub ports, i.e., Gioia Tauro and Cagliari (Taranto used to be an Italian hub port), it can be underlined that Gioia Tauro has been characterized, for the last years, by the highest container throughput in Italy. Its maximum traffic was recorded in 2008 with about 3.5 million TEUs. But in the following years, this port registered a serious decrease, in particular, in 2011, 2015 and 2017 (in 2017, Genoa became the first Italian port throughput: without distinguishing between gateway traffic and transshipment traffic). Taranto instead displayed a severe decrease from 2011 (over 600,000 TEUs) to 2012 (around 260,000 TEUs), then its container traffic has been reduced to zero since 2015. The Italian hub ports have shown a general decrease in their container traffic. Indeed,

they are the only Italian grouping to show a negative trend: the average growth rate, from 2011 to 2017, has been -3.07%.

3. ANALYSIS OF DEEP SEA SHIPPING CONTAINER ROUTES, CALLING AT ITALIAN PORTS, IN THE YEAR 2018

This research has been accomplished through a collection of data from:

- two journals: *L'Avvisatore Marittimo* [15] and *Il Messaggero Marittimo* [16], where the list of ship departures from each Italian port is provided;
- *Marinetraffic* website [17], which provides day by day the exact position of a ship, as well as, for each ship, DWT and draught;
- the major global shipping companies websites.

Table 2 depicts DSS container departures from Italian ports, separated in the four clusters mentioned above. In the table, for each port, data regarding the number of departures per month, the total and average DWT, the average and maximum draught of the ships calling at the given port have been shown.

The total DWT of a port is equal to the sum of the capacity (DWT) of all ships calling at the port. The draught of a ship depends on the ship load: if the ship is full, the draught is greater (the draught for a full ship load is the “declared draught”), and if the ship is almost empty, the draught is smaller. In this survey, the draught for a full ship load (declared draught) has been taken into account, but it must be remarked that it is, generally, greater than the “real” draught of the ship when entering at the port.

Genoa is the port that shows the maximum number of departures per month and total DWT, but the biggest ships cross La Spezia. In addition, La Spezia has a slightly lower number of departures than Livorno, but its total DWT is definitely greater: Livorno is crossed, on the average, by smaller ships. Currently, the container terminals of the port of Livorno show a relevant problem of depths and spaces for ship maneuvers, but the 2015 port regulatory plan provides the development of a new container terminal, called “Piattaforma Europa,” which will be able to accommodate container ships with a capacity of around 15,000 TEUs.

The most important Italian ports, as far as the number of DSS services calling at the port are concerned, are: Genoa, Livorno, La Spezia, and Gioia Tauro. If instead we consider the total DWT of the ships that operate DSS services, the placement is the following: Genova, La Spezia, Gioia Tauro, and Livorno.

Considering the four groupings of Italian ports, the Ligurian multi-port gateway system is by far the most important in Italy, both in terms of departures per month and total DWT. Also, the Campanian multi-port gateway system and the hub ports register a relevant number of DSS departures and total DWT. The least important port grouping, regarding DSS direct services, concerns the northern Adriatic gateway system, with only 7 departures per month, but northern Adriatic ports register relevant SSS traffic (see Lupi et al. [10] and Danesi et al. [18]).

Three other ports offer some DSS departures: Civitavecchia, Bari, and Catania. These ports have been listed as “other ports” in Table 2.

In the collection of DSS routes, world regions have been classified as suggested by “*L'Avvisatore Marittimo*”: North America (Atlantic coast), Central America (Atlantic coast), South America (Atlantic and Pacific coast), America/Pacific (i.e., the Pacific coast of North and Central America), West Africa, East and South Africa, Red Sea, Arabic/Persian Gulf, South-East Asia/Far East, Australasia/Pacific. The South America region includes also the Pacific coast, but ships departing from Italy call only at ports in the Atlantic coast and not at ports in the Pacific coast of South America.

In Table 2, details about connections to the world regions are reported. South-East Asia/Far East is the most important world region, regarding the number of connections, of course due to the economic and demographic relevance of the countries belonging to it: India, Malaysia, Singapore, China, Japan, and Korea. In this region, the most important container ports of the world are located: Shanghai (37.1 million TEUs in 2016), Singapore (about 31 million TEUs), Shenzhen (24 million TEUs), Ningbo (21.6 million TEUs), Hong Kong and Busan (between 19 and 20 million TEUs), Guangzhou and

Qingdao (between 18 and 19 million TEUs in 2016) (source: [19], P. 65, Table 4.2). Apart from Singapore and Busan, all these ports are Chinese.

The total DWT of the ships directed to this region is around 5.5 million tons (Table 4), while the average DWT of the ships is 108,600 tons and the average draught is 12.2 m. The Red Sea and Arabic Gulf are along the DSS route between Mediterranean and Far East. Along this route, the biggest ships operate. The most important port of Red Sea is Jeddah, while the main port in the Arabic Gulf is Port Qasim in Pakistan.

Table 2

A synthesis on the DSS container services to/from Italian ports, distinct by destination region, in terms of: number of services by month, total and average DWT, and average and maximum draught. Data refer to March 2018

2018	West Africa	Red Sea	East / South Africa	North America	Central America	South America	America / Pacific	Arabic / Persian Gulf	South-east Asia / Far East	Australasia / Pacific	TOTAL	Total DWT (thousand tons)	Average DWT (thousand tons)	Average draught (m)	Max. draught (m)
Genova	9	9	4	23	25	9	6	19	32	5	94	7763.6	82.6	11.2	15.7
La Spezia	0	7	4	6	9	0	5	14	21	5	40	4509.9	112.8	12.2	15.5
Savona	0	0	0	0	3	0	0	0	0	0	3	90.6	30.2	9.1	9.6
Livorno	5	0	2	19	23	6	5	0	0	0	46	2910.3	63.3	10.4	14.3
Tot. Ligurian gateway	9	27	8	26	37	9	11	24	38	10	117	10041.8	85.8	11.3	15.7
Ravenna	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
Venice	1	5	0	0	0	0	0	0	6	0	6	387.4	64.6	11.8	13.5
Trieste	0	4	0	1	0	0	0	1	5	0	5	437.1	87.4	12.3	13.2
Tot. Adriatic gateway	1	5	0	1	0	0	0	1	7	0	7	528.4	75.5	12.0	14.2
Napoli	0	3	4	5	6	0	0	2	2	5	17	1201.2	70.7	10.8	14.2
Salerno	1	1	0	9	11	1	1	1	0	0	18	850.7	47.3	10.1	12.3
Tot. Campanian gateway	1	4	4	14	13	1	1	3	2	5	30	1888.6	63.0	10.7	14.6
Gioia Tauro	0	7	4	10	6	5	4	9	10	5	34	3681.1	108.3	11.8	14.6
Cagliari	0	0	0	4	9	1	3	0	0	0	12	685.7	57.2	9.9	12.5
Tot. hub ports	1	8	4	19	17	6	6	10	10	5	51	4570.0	89.6	11.3	14.6
Civitavecchia	0	0	0	1	9	1	4	0	0	0	9	600.7	66.8	10.5	13.5
Bari	0	1	0	0	1	0	0	1	1	0	2	94.8	47.4	10.6	13
Catania	0	2	0	0	0	0	0	2	2	0	2	27.9	13.9	7.5	8.1
Tot. other ports	0	2	0	1	9	1	4	2	2	0	11	681.5	62.0	10.3	13.5
TOTAL ITALY	10	35	8	28	38	9	11	27	49	10	132	11075.1	83.9	11.3	15.7

Source: L'Avvisatore Marittimo [15], Il Messaggero Marittimo [16], Marinetraffic [17], and shipping companies websites [23].

The routes between the Mediterranean and the American continent are operated by smaller ships, than those operating on the Far East – Europe route. Actually, the average DWT of the ships directed to America ranges between 61,400 t (for those directed to Central America) and 98,500 t (for those directed to South America) (see Table 4). The total DWT of the ships is equal to: around 1,940,000 t for those directed to North America, 2,330,000 t for those directed to Central America, 887,000 t for those directed to South America, and 932,000 t for those directed to America/Pacific. The average draught is equal to around: 10.7 m for North and Central America, 11.8 m for South America, and 11.5 m for America/Pacific.

DSS routes, directed to the American continent, cross mainly the ports of New York, Norfolk, Savannah, and Charleston in North America (Atlantic coast); Miami, Port Everglades, Houston,

Veracruz, and Panama in Central America (Atlantic coast); Los Angeles/Long Beach in the America/Pacific region (which comprises North and Central America, Pacific coast); and Rio de Janeiro and Santos in South America (South America, according to "L'Avvisatore Marittimo," includes both Atlantic and Pacific coasts; these two ports are located both on the Atlantic). The most important port in the American continent, as far as the total container throughput is concerned, is the system Los Angeles + Long Beach (these two ports are adjacent), with, respectively, 8.9 and 6.8 million TEUs in 2016 [19]; these ports are located in the America/Pacific region, routes connecting Italian ports to America/Pacific cross the Panama Canal.

The number of connections to North and Central America (Atlantic) is equal to, respectively, 28 and 38 departures per month. South America (Atlantic + Pacific) registers a lower number of connections, namely 9 departures per month.

It could be observed that Ligurian ports are connected to all world areas. In particular (Table 2), Genoa shows the highest number of departures to South-East Asia/Far East and to North, Central, and South America. Instead, La Spezia is connected, in particular, to South-East Asia/Far East, Red Sea and Arabic/Persian Gulf, while Livorno is connected, in particular, to North, Central, and South America.

As far as northern Adriatic ports are concerned, nearly all connections have as destinations: Red Sea, Arabic Gulf, and South-East Asia/Far East.

Campanian gateway ports are crossed mainly by routes directed to North and Central America.

Regarding hub ports, there is a relevant gap between Gioia Tauro, which shows 32 ship calls per month, and Cagliari, whose ship calls per month are only 12. In addition, while Gioia Tauro is connected to all world areas, in particular, to South-East Asia/Far East and to the American Continent, Cagliari is connected only to the American continent. Furthermore, Gioia Tauro is crossed by bigger ships: the average DWT of Gioia Tauro is above 100,000 tons, while the average DWT of Cagliari is slightly less than 60,000 tons.

4. COMPARISON OF 2018 DEEP SEA SHIPPING SERVICES WITH DATA RECORDED IN THE YEARS 2011-2014

The data about DSS services calling at Italian ports, collected in March 2018, have been compared with the analogous data collected in August 2014 and January 2011. The compared data are shown in Table 3, where the number of departures per month, the total and the average DWT, and the average draught are reported.

The overall Italian data show that the number of departures per month, after an initial increase from 2011 to 2014, has decreased by 16.5% from 2014 to 2018. On the other hand, the total DWT has increased by 40% from 2011 to 2014, then it decreased by only 2% from 2014 to 2018. In addition, the average DWT is, in 2018, equal to 83,900 tons, with an increase of 57.1% with respect to the 2011 average, which was equal to 53,400 tons. This means that the dimension of ships calling at Italian ports has increased relevantly in the years, in line with the ship gigantism phenomenon. Because the container traffic did not increase relevantly, the increase in the ship dimensions has resulted in a decrease in departures. Also, the average draught has increased, from 10.4 m in 2011 to 10.6 m in 2014 and to 11.2 m in 2018.

The most important Italian port cluster is definitely, as to DSS services, the Ligurian multi-port gateway system; its traffic has shown a constant growth in the years, in terms of total DWT. It has remained almost constant as far as departures per month are concerned; on the other hand, the average DWT has shown impressive growth, from 51,000 t (in 2011) to 85,800 t (in 2018), that is by 68.2%; this in line with the total Italian data reported above. The average draught has increased from 10.2 to 11.3 meters. A relevant gap could be observed between the Ligurian and the northern Adriatic multi-port gateway systems. The number of departures per month of direct DSS services from Adriatic ports, in the last years, has fluctuated between 7 (in 2018) and 11 (in 2014), and the total DWT between 458,000 t (in 2011) and 618,600 t (in 2014). The average DWT has increased relevantly, as for all the Italian system, from 50,900t (in 2011) to 75,500t (in 2018), that is, by 48.3%. The traffic of the

northern Adriatic gateway system, currently, is mainly based on indirect connections (i.e. with transshipment). Indeed, as shown in Table 1, Italian northern Adriatic ports have registered, including both DSS and SSS traffic, a container throughput between 1.1 and 1.4 million TEUs, in the years 2011-2017, with a growth rate, from 2011 to 2017, of over 5%. The growth rate of Ligurian ports, from 2011 to 2017, has been 3.51%; the growth rate of all (Italian + non Italian) northern Adriatic ports has been 6.31%. In Casciello [20], an analysis of containerized SSS services in Mediterranean is reported; the collected data refer to April and May 2016. Northern Adriatic ports were crossed by 86 ship calls per month: among them, 34 concerned feeder services, 44 concerned non feeder services, while 8 departures per month concerned DSS routes which accept cargo having both origin and destination in the Mediterranean Sea. Campanian gateway ports have decreased their ship calls, from 43 in 2011 to 27 in 2014, but later they increased to 30 in 2018. The total DWT has varied from around 2.2 million tons in 2011 to 1.6 million tons in 2014 and to 1.9 million tons in 2018. The average DWT has shown an increase, from 50,500 t in 2011 to 63,000 t in 2018, that is, by 24.75%, but it has been less impressive than in the case of other port clusters.

Table 3

Comparison between DSS container services in 2011, 2014, and 2018. In the table, details for each Italian port and port cluster are provided. The table shows the number of departures per month, the total DWT, the average DWT and the average draught in the years 2011-2018

	no. of departures per month			Total DWT (thousand tons)			Average DWT (thousand tons)			Average draught (m)		
	2011	2014	2018	2011	2014	2018	2011	2014	2018	2011	2014	2018
Genova	80	80	94	4005.7	5408.7	7763.6	50.1	67.6	82.6	10.2	11.2	11.2
La Spezia	43	48	40	2572.4	3663.2	4509.9	59.8	76.3	112.8	10.7	10.9	12.2
Savona	10	3	3	277.4	68.9	90.6	27.7	23.0	30.2	8.86	9.3	9.1
Livorno	40	40	46	1468.5	2089.7	2910.3	36.7	52.2	63.3	9.41	10.4	10.4
Total Ligurian gateway	120	122	117	6118.0	8131.4	10041.8	51.0	66.7	85.8	10.2	10.9	11.3
Ravenna	2	0	0	23.8	0	0	11.9	0	0	6.9	0	0.0
Venice	6	0	6	270.2	0	387.4	45.1	0	64.6	9.1	0	11.8
Trieste	6	11	5	369.6	693.6	437.1	61.6	63.1	87.4	10.4	10.5	12.3
Total northern Adriatic gateway	9	11	7	458.1	618.6	528.4	50.9	56.2	75.5	9.82	10.5	12.0
Napoli	35	16	17	1949.0	1101.5	1201.2	55.7	68.9	70.7	10.7	11.0	10.8
Salerno	8	12	18	220.9	519.9	850.7	27.6	43.3	47.3	9.15	9.3	10.1
Total Campanian gateway	43	27	30	2170.0	1583.5	1888.6	50.5	58.7	63.0	10.0	10.3	10.7
Gioia Tauro	32	37	34	2242.6	3325.1	3681.1	70.1	89.9	108.3	11.2	11.0	11.8
Cagliari	24	15	12	1130.9	1022.1	685.7	47.1	68.2	57.2	10.3	11.2	9.9
Taranto	3	5	0	235.1	328.5	0	78.4	65.7	0	13.2	11.4	0.0
Total hub ports	59	57	51	3608.6	4675.7	4569.7	61.2	82.0	90.0	11.0	11.1	11.3
TOTAL ITALY	150	158	132	8073.0	11281.7	11075.1	53.4	71.4	83.9	10.4	10.6	11.2

Sources: Lupi et al. [10, 11]; L'Avvisatore Marittimo [15], Il Messaggero Marittimo [16], Marinetraffic [17], and shipping companies websites [23].

Regarding hub ports, the number of departures per month has slightly and constantly decreased, from 59 in 2011 to 51 in 2018. On the other hand, the total DWT has increased by 29.6% from 2011 to 2014, then slightly decreased, by 2.3%, from 2014 to 2018; on the other hand, the average DWT has increased relevantly, from 61,200 t (in 2011) to 90,000 t (in 2018), that is, by 47.5%. It must be noted, also, that it is the Italian port cluster crossed, on the average, by the biggest ships. Until 2014, three hub ports were in operation in Italy, namely Gioia Tauro, Cagliari, and Taranto, while, currently, the Taranto container terminal is no longer in operation.

Table 4 depicts the trend of connections between Italian ports and the world regions, in 2011, 2014, and 2018.

The most important world region is South-East Asia/Far East. But a decrease in connections, in the years under analysis, can be observed: the number of departures per month has decreased from 77 in 2011 to 66 in 2014 and to 49 in 2018. It is clear that the trade on this route has been affected by the Italian economic crisis, but the average dimension of the ships has also registered a relevant increase. Indeed, despite the decrease of departures, from 2011 to 2014, the total DWT has increased by 65%, while from 2014 to 2018, the total DWT has decreased only marginally, i.e., by 5.8%. The average DWT has increased from 66,000 t (2011) to 80,600 t (2014) and then to 108,600 t (2018), with an increase of 64.55% with respect to 2011.

The Red Sea and Arabic/Persian Gulf regions are on the way between Mediterranean and Far East. Regarding the Red Sea region, the comparison of the 2018 data can be performed only with the 2014 ones (and not with 2011 ones). Indeed, in the 2011 analysis, Suez was taken into account as part of the Red Sea region; instead in 2014 and 2018, it has been considered as a Mediterranean port, because of its position, on the southern edge of the Suez channel. Comparing the data of 2014 and 2018, the number of departures per month has remained almost the same, while the total and the average DWT show a relevant increase: by 44% regarding the total DWT and by 43% regarding the average DWT. The average draught has increased from 11.8 to 12.2 m. The increase in the total DWT is due to the fact that the quota of ships, directed to Far East and calling at Red Sea ports, has increased. This is another consequence of the naval gigantism: currently, routes cross a greater number of ports than in the past, in order to serve a greater number of markets and increase the ships load factor.

Table 4

Comparison between DSS container services in 2011, 2014, and 2018. In the table, details for each world region, connected to Italian ports, are provided. The table shows the number of departures per month, the total DWT, the average DWT and the average draught in the years 2011-2018

	n° departures per month			Total DWT (thousand tons)			Average DWT (thousand tons)			Average draught (m)		
	2011	2014	2018	2011	2014	2018	2011	2014	2018	2011	2014	2018
West Africa	8	10	10	201.7	292.3	376.0	25.2	36.4	41.8	9.2	9.3	9.0
Red Sea	68	34	35	2572.7	2756.3	3970.8	64.3	73.1	104.5	10.7	11.8	12.2
East / South Africa	5	5	8	277.1	303.9	601.9	55.4	60.8	66.9	9.2	11.2	11.3
North America	32	38	28	1182.9	2033.8	1937.1	49.3	52.3	69.2	10.2	10.6	10.7
Central America	33	26	38	1251.2	991.6	2331.4	39.1	49.6	61.4	9.7	10.3	10.7
South America	7	19	9	412.8	653.0	886.9	59.0	50.2	98.5	10.9	10.8	11.8
America / Pacific	20	23	11	714.8	1641.1	932.1	37.6	72.5	84.7	9.4	11.4	11.5
Arabic / Persian Gulf	35	26	27	1660.5	2247.2	3029.4	69.2	66.7	108.2	10.7	11.4	12.1
South-East Asia / Far East	77	66	49	3566.4	5884.1	5541.1	66.0	80.6	108.6	10.8	11.7	12.2
Australasia / Pacific	11	10	10	446.0	628.6	843.2	40.5	62.9	84.3	10.3	12.0	12.0
TOTAL	150	158	132	8073.0	11281.7	11075.1	53.4	71.4	83.9	10.4	10.6	11.2

Sources: Lupi et al. [10, 11], L'Avvisatore Marittimo [15], Il Messaggero Marittimo [16], Marinetraffic [17], and shipping companies websites [23].

As far as the Arabic/Persian Gulf region is concerned, departures per month have shown an initial decrease from 2011 to 2014, but from 2014 to 2018, they remained almost constant. The total DWT has almost doubled, from 2011 (1.66 million tons) to 2018 (3 million tons), while the average DWT has increased by 56.5%, from 69.2 thousand tons in 2011 to 108.2 in 2018. The growth in the total DWT is due to the fact that a greater quota of ships, directed to Far East, call at the ports of this region.

As far as North and Central American destinations are concerned, the number of departures per month to North America (Atlantic) has increased from 32 in 2011 to 38 in 2014 and decreased to 28 in 2018, while the number of departures to Central America (Atlantic) has decreased from 33 in 2011 to 26 in 2014 and increased to 38 in 2018. The total DWT of North America (Atlantic) has increased by

72% from 2011 to 2014 and decreased by 4.7% from 2014 to 2018; the total DWT of Central America (Atlantic) has decreased by about 21% from 2011 to 2014 and increased by 135% from 2014 to 2018. The average DWT has shown an increase of 40.4% for North America (Atlantic), from 49,300 tons (2011) to 69,200 tons (2018), and an increase of 57% for Central America (Atlantic), from 39,100 tons (2011) to 61,400 tons (2018). Regarding the America/Pacific region, the number of departures per month has increased from 2011 to 2014, then it has shown a severe decrease from 2014 to 2018. The total DWT has shown a similar trend. But the average DWT has increased relevantly, from 37,600 tons (2011) to 72,500 tons (2014) and then to 84,700 tons (in 2018): 125% in the period 2011-2018.

Ships operating on the routes to the American continent are, in general, smaller than those operating on the routes to Far East; however, the phenomenon of naval gigantism can be clearly recognized also in the routes to the American continent.

The North and Central America regions (Table 4), according to “L’Avvisatore Marittimo”, comprise only the ports located on the Atlantic coast. The Central America region includes not only the U.S. ports placed on the Mexican Gulf, for example, Houston (Texas), Miami, and Port Everglades (Florida), but also the Atlantic ports of Mexico, the ports of the Caribbean, of other Central American countries, and of Panama. The America/Pacific region comprises the ports of North and Central America located on the Pacific Coast. Although along the Pacific coast there are the most important ports of the American continent, only a few connections are in operation between them and Italian ports. Indeed, although the new Panama Canal was opened in 2016, the operation of bigger ships from the geographical position of Pacific ports of U.S.A. is less favorable, than that of Atlantic ports, for routes from/to the Mediterranean Sea.

The relevant increase of connections from Italy to Central America (Atlantic coast), from 2014 to 2018, could be related with the decrease of connections from Italy to North America (Atlantic coast). Indeed the great majority of routes, departing from Italy and calling at Central American ports, cross U.S. ports, especially Houston and the ports of Florida. Therefore, this trend could be a consequence of a general modification of the routes between Italy and U.S.A., and it is not necessarily related to a decrease in the maritime trade between Italy and U.S.A. and to a high increase in the maritime trade between Italy and Central American countries.

The relevant decrease of connections to the America/Pacific region in 2018 could be explained by the following. Indeed, Panama, which is on the Pacific side of the Canal, in 2011 and 2014 was considered, by “L’Avvisatore Marittimo”, part of the America/Pacific region, while in 2018, it was considered part of the Central America (Atlantic) region. Some ships, departing from Italy, call at the ports of Mexican Gulf, cross the Panama Canal, call at Panama port, then they return back to the Mexican Gulf, without calling at any other Pacific port: these ships in 2011 and 2014, were counted in both Central America (Atlantic) and America/Pacific regions, while in 2018, they were counted only in the Central America (Atlantic) region. Therefore, 2018 data, of America/Pacific region, are not comparable with those of the previous years (2014 and 2011).

The South America region includes both ports located in the Atlantic and in the Pacific coasts. However, South American ports located in the Pacific coast are not connected to Italy. The number of connections, after an initial increase from 7 in 2011 to 19 in 2014, has shown a relevant decrease to 9 in 2018. But this could be explained by a sharp increase in the ships dimensions: the average DWT increased by 66.9% in the period 2011-2018, from 59,000t (2011) to 98,500 t (2018). Indeed, the total DWT, from 2011 to 2018, has also increased, from 412,800t to 887,000t, that is, by 115%.

5. CONCLUSIONS

In this paper, an analysis of DSS container services calling at Italian ports has been carried out. The data about departures from Italian ports were collected in March 2018; a comparison with an analogous set of data collected in 2011 and 2014 has been performed.

The accomplished survey shows clearly that the main DSS container routes are those not only connecting Italian ports to South-East Asia/Far East, and crossing Red Sea and Middle East ports, but also routes to North and Central America.

Among Italian ports, the most important cluster, as far as direct DSS services are concerned, is definitely the Ligurian multi-port gateway system. The Ligurian port of Genoa is by far the main Italian port, regarding not only ship calls per month, but also the total DWT. Genoa is the main access gate to the Padan Plain, the most productive area of Italy, and it is also an access gate to the Rhine–Alpine corridor. A reason for the importance of Ligurian ports is their geographical position on the sea side, because they are crossed by the Far East–Europe route, which calls at the most important Mediterranean ports: Port Said (Egypt), Piraeus (Greece), Marseilles–Fos (France), Barcelona, Valencia, Algeciras (Spain), and Tanger Med (Morocco). Furthermore, Ligurian ports are in a more favorable position, on the sea side, than Adriatic ports, as far as routes to the American continent are concerned.

Also, the hub port of Gioia Tauro is crossed by several DSS routes.

Northern Adriatic Italian ports instead play only a minor role in direct (that is without transshipment) services. But, as reported in Section 4, several feeder services call at Adriatic ports, with transshipment at the hub ports of Gioia Tauro, Marsaxlokk (Malta), Piraeus (Greece), and Port Said (Egypt). It must be underlined that in the last years, the northern Adriatic cluster has shown a more significant growth than the Ligurian one, as far as the total container throughput is concerned: 3.51% has been the average growth rate of Ligurian ports from 2011 to 2017, while the growth rate of northern Adriatic ports has been 5.2% considering only Italian ports, and 6.31% considering also the non Italian ports of Koper and Rijeka.

The most important DSS routes are those connecting Italian ports with Far East, Red Sea, and Middle East. Italian ports are currently in competition with northern range ports as to container arriving/going to these regions. Nowadays, Italian ports are capable of attracting Central European countries into their hinterland only marginally; moreover, the Padan Plain, the most productive region in Italy, is, although only partially, an “island formation” of the hinterland of northern range ports. As pointed out in Musso et al. [21], Italian ports are disadvantaged with respect to northern range ones, regarding the following important aspects in port competition: price for port operations, freight rates of shipping companies, port capacity, productivity of port terminals (e.g. number of crane moves per hour), and competition among companies operating in the port.

However, Italian ports are in a more favorable position, than northern range ones, for destinations in Central Europe, as to the South-East Asia/Far East route: the navigation time from Far East to Italian ports is about five days less than the navigation time from Far East to northern range ports. Ligurian gateway ports are favored, on the land side, for Switzerland, while Adriatic ports are the most convenient, among Mediterranean ports, for southern Germany and Central-Eastern Europe (Acciaro et al. [9]). Northern Italian ports are already making several attempts to improve their competition, as stated in Lupi et al. [22]: a whole network of rail connections, transporting maritime containers, is based on the port of Trieste and links this port to several destinations in Austria, Germany, and Hungary, while another network of rail connections is based on the port of La Spezia, linking this port to several destinations in Switzerland and Germany.

An increase of direct (i.e., without transshipment) DSS connections between northern Adriatic ports and Far East is possible if they succeed in beating the competition of northern range ports, in the whole logistic chain (considering therefore not only maritime but also inland parts), for Central-Eastern European destinations.

Finally, the research results clearly show the evolution of the container ship gigantism phenomenon: the dimension of ships has increased relevantly in the years, while the number of ship calls at Italian ports has decreased. In particular, the average DWT has peaked from 2011 to 2018. This is clearly shown not only by the results about the routes to South-East Asia/Far East, Red Sea, and Middle East, but also by the results concerning the routes to the American continent. In addition, routes have become longer and cross a higher number of ports; for example, the routes to Australasia, currently, cross also other world regions, before Australasia, for example, South-East Asia or East

Africa, while a greater quota of ships, directed to Far East, call at Red Sea and Middle East ports, which are on the way from Mediterranean to Far East.

The total DWT of deep sea container ships calling at Italian ports has not only shown a relevant increase from 2011 to 2014, but it has also shown a slight decrease from 2014 to 2018. On the other hand, the total container throughput (SSS+DSS) at Italian ports has slightly increased (see Table 1). Probably, DSS operators have chosen to reduce the frequency of the routes in order to supply a total DWT which is just sufficient to satisfy the transport demand. In this way, these operators reduce the quality of the service, because they not only reduce the frequencies, but they also maximize their earnings, because they maximize the ships load factor.

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