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THE EVOLUTION OF DEEP SEA SHIPPING CONTAINER ROUTES CALLING AT ITALIAN PORTS IN THE PANDEMIC PERIOD

Summary. In this paper, the resilience of the Italian deep sea shipping (DSS) container routes in situations of severe crisis (in this case, the COVID-19 pandemic), is studied quantitatively, distinguishing gateway and transshipment DSS routes. In addition, DSS container routes in the pandemic period (i.e., from 2020 to 2023), have been compared to those before the pandemic, in particular from 2011 to 2019. The results have shown that while gateway traffic decreased from 2019 to 2023, due to the reduction of the demand connected to the pandemic, transshipment traffic has increased, in contrast to the trend before the pandemic that has shown a considerable reduction from 2011 to 2019. The results also show that the naval gigantism phenomenon increased from 2011 to 2019 but seems to have stopped since 2019. This analysis is highly important in the field of maritime studies, as it covers the two most important phenomena concerning maritime transport that have occurred over the past 10 years (i.e., naval gigantism and the COVID-19 pandemic).

1. INTRODUCTION

Maritime transport is fundamental for international trade, as 90% of intercontinental trade is currently carried out by sea. In particular, containerized transport is the type of maritime transport that, due to the global economy, has registered the greatest development. In recent years, the phenomenon of “naval gigantism” spread owing to the technological development in container ship design and construction, as well as the resulting economy of scale of larger ships, which has reduced transport costs.

Today, specialized cellular containerships are more frequently used to transport containers, many of which can transport more than 20,000 TEUs, while the newest ships have reached a capacity of 25,000-28,000 TEUs. However, the increase in ship sizes has some limitations influenced by factors such as freight demand, port technology and capacity, inland infrastructure, and other logistical costs [1].

As a result, port systems are the main players that have to face the diseconomies of scale that derive from the strong acceleration towards naval gigantism. Naval gigantism requires port operations to constantly become faster and more reliable. The chain effects over the whole port logistics system involve aspects connected to infrastructure investments, deeper drafts, and the internal and back port

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organizational models. Naval gigantism requires interventions on quays to extend their length and increase their draft, investments in new ship-to-shore gantry cranes with longer outreach and higher height, greater speed and complexity in embarkation and disembarkation operations, and better management of transport services to and from ports. These operations require a high degree of computerization related to the use of sophisticated ship and terminal planning software [2].

However, in recent years, and especially in the pandemic period, the increase in the ship dimensions seems to have stopped, at least as it concerns the routes crossing Italian ports.

Another important aspect of maritime transport in recent years concerns the impact of the COVID-19 pandemic. On the one hand, several activities had to stay closed due to sanitary restrictions; on the other hand, hospitals had special needs, especially for medicines and oxygen facilities, due to the large number of hospitalized people. In addition, transport has to comply with the sanitary restrictions in force in the different countries.

In this paper, the sensitivity of deep sea shipping (DSS) container routes that call at Italian ports to the spread of the COVID-19 pandemic is analyzed. In particular, the characteristics of gateway and transshipment traffic, as well as their response to the pandemic, are studied separately. Moreover, the trend of naval gigantism during the pandemic period is analyzed. All DSS route data from the COVID-19 period (i.e., from 2019 to 2023) are compared to those from 2011 to 2019.

The remainder of this paper is organized as follows. In Section 2, a classification of the Italian ports is carried out. In Section 3, an analysis of the container traffic in Italy is provided. In Section 4, the evolution of DSS container services calling at Italian ports from 2011 to 2023 is presented, as well as a global overview of frequencies of DSS routes. Conclusions follow.

2. CLASSIFICATION OF ITALIAN PORTS

Container ports can be categorized based on levels of transshipment incidence [3] in gateways and hubs.

In pure gateway ports, the transshipment incidence is below 25%. These ports are hinterland-focused and handle small sea-sea transshipment flows as a by-product of the gateway cargo loaded and discharged at terminals [4]. The hinterland of a port is defined as “the region through which a significant part of the trade passes across the port.” Gateway ports are characterized by high-quality connections to their hinterland markets through road, rail, and internal waterways networks.

In hub ports, the transshipment incidence exceeds 65%, whereas in pure hub ports, the transshipment is above 90%. The transshipment activity is the main handling and lies at the core of the port’s operational and commercial base. Large mainline vessels serve a limited range of major ports to which cargoes are carried from feeder ports [5]. The most important attributes of a transshipment port are its geographical position, its capability to safely accept large ships, the extension of terminal infrastructures, the efficiency of handling operations of containers, the availability of high-frequency feeder services with the necessary geographical coverage, and competitive cargo terminal handling charges [6]. A hub port is sometimes dissociated from the territory that hosts it, and the connections with the landside are not considered relevant for the development of the port [7].

For Italian ports, the following grouping can be suggested:

1. Ligurian gateway system: this includes the ports of Livorno, La Spezia, Genoa, and Savona/Vado Ligure. It is situated on the southern edge of the Rhine–Alpine corridor.
2. Adriatic gateway system: this is composed of the ports of Venice, Ravenna, Trieste, and Ancona. This system is situated on the southern edge of the Baltic–Adriatic corridor.
3. Campanian gateway system: this system consists of the ports of Naples and Salerno.
4. Italian hub ports system: this system is composed of the port of Gioia Tauro, which is a pure hub port and has been among the greatest Mediterranean transshipment ports for several years. In the past, Taranto (until 2015) and Cagliari (until 2018) also served as transshipment ports. However, many feeder routes to and from the Adriatic Sea choose non-Italian transshipment ports, such as Marsaxlokk, Piraeus, Port Said, Alexandria, and Damietta [7].

The hinterland and transshipment container traffic for Italian ports in 2022 is shown in Table 1. As shown in the table, only the Italian port of Gioia Tauro has a share of transshipment greater than 65%. The only gateway port that shows a remarkable transshipment rate (around 30%) is Trieste.

The majority of DSS container routes are provided by ports that are part of these clusters. However, other ports (Civitavecchia, Bari, Catania, and Palermo) offer some DSS services but are not part of any of these clusters.

The Padan Plain, which is the most significant productive area of Italy, is located in the hinterland of both Adriatic and Ligurian gateway port systems. In addition, the Padan Plain is also considered an ‘island formation’ within the hinterlands of the northern range ports (i.e. northern European ports, between Le Havre and Hamburg) in the hinterlands of Italian ports [10-12]. This is particularly true for the ports of Zeebrugge, Antwerp, Rotterdam, and Hamburg. On the other hand, as stated in [13] and [14], northern Italian ports, especially northern Adriatic ones, are in a favorable position to attract in their hinterland the markets of Central European regions, especially southern Germany and Austria.

Table 1

Share of transshipment traffic on total container moved in Italian ports.
Source: [8]. Traffic is reported in TEUs per year. Year: 2022

Port	Total Traffic	Hinterland Traffic	Transshipment Traffic	% of transshipment
Genoa	2,532,532	2,264,517	268,015	10.58%
La Spezia	1,262,496	1,223,172	39,324	3.11%
Livorno	751,811	642,730	109,081	14.51%
Savona-Vado Ligure	266,591	257,817	8,774	3.29%
Marina di Carrara	101,685	101,685	-	0%
Naples	684,111	661,100	23,011	3.36%
Salerno	361,884	337,524	24,360	6.73%
Trieste	877,805	596,190	281,615	32.08%
Venice	533,991	533,991	-	0%
Ravenna	228,991	226,358	2,077	0.91%
Ancona	165,346	165,346	-	0%
Gioia Tauro	3,380,053	0	3,380,053	100%
Civitavecchia	112,200	112,200	0	0%
Bari	75,729	65,729	0	0%
Catania	51,666	51,666	0	0%
Palermo	13,962	13,962	0	0%
Brindisi	383	383	0	0%

3. OVERVIEW OF CONTAINER THROUGHPUT AT ITALIAN PORTS

In this section, the general container throughput of Italian ports, from 2011 to 2022 is analyzed.

In Table 2, the amount of TEUs handled in each port in the period of study is shown. In the “Total Ligurian gateway” row, the sum of the container throughput of Ligurian ports is presented; this is the sum of the throughputs of Genoa, La Spezia, Livorno, and Savona-Vado Ligure. The same applies to the rows “Total Campanian gateway,” “Total Italian Adriatic gateway,” and “Total Italian Hub ports.” In “Total Italy,” the total container throughput in all the Italian ports is reported.

In Fig. 1, it is shown that the overall container throughput at Italian ports has fluctuated, but a general growing trend can be noticed from 2011 to 2019. In 2020, due to the COVID-19 pandemic, there was a general decrease of almost 200,000 TEUs. However, the gateway traffic has shown a sharp decrease of about 700,000 TEUs, while the transshipment traffic has increased by 500,000 TEUs, especially due to Gioia Tauro. Transshipment traffic is more volatile, while the general decrease in the economy due to the pandemic has significantly affected gateway traffic.

Since 2020, there has been a recovery in the gateway traffic, but pre-pandemic values have not been reached. After a sharp decrease from 2019 to 2020, the Ligurian gateway ports (the most significant

cluster) recorded significant recovery in 2021. However, they did not show further increases, and the pre-pandemic traffic was not reached again.

Instead, the transshipment traffic has shown continuous growth owing to the sharp recovery of the port of Gioia Tauro. Owing to transshipment traffic, the total container throughput of Italian ports is in a state of continuous growth. However, it must be underlined that transshipment traffic is different than gateway traffic. The reason for the growth of Gioia Tauro is probably as follows. Gioia Tauro is the transshipment port, especially in the Italian Adriatic gateway, that is crossed at most by feeder routes due to its unfavorable geographic position. Therefore, during the COVID-19 pandemic, container operators preferred to carry out transshipment at an Italian port because sanitary restrictions were the same throughout the country but were different (and especially occurred in different periods) in other countries.

Table 2

Container throughput of Italian ports, in thousands of TEUs, from 2011-2022. Source: [8]

PORTS	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Genoa	1847.1	2064.8	1988.0	2172.9	2242.9	2297.9	2622.2	2609.1	2669.9	2352.8	2557.9	2532.5
La Spezia	1307.3	1247.2	1300.4	1303.0	1300.4	1272.4	1473.6	1485.6	1409.4	1173.7	1375.6	1262.5
Livorno	637.8	549.0	559.2	577.5	780.9	800.5	734.1	748.0	789.8	716.2	791.4	751.8
Savona-Vado Ligure	170.4	75.3	77.9	85.3	98.0	55.0	44.1	65.3	54.5	146.1	223.3	266.6
Total Ligurian gateway	3962.6	3936.3	3925.5	4138.7	4422.2	4425.8	4874	4908	4923.6	4388.8	4948.2	4813.4
Ancona	120.7	142.2	152.4	168.9	178.5	185.8	168.6	159.1	176.2	158.7	167.3	165.3
Ravenna	215.3	208.2	226.7	222.5	244.8	234.5	223.4	216.3	218.1	194.9	212.9	228.4
Venice	458.4	429.9	446.4	456.1	560.3	605.9	611.4	632.3	593.0	529.1	513.8	534.0
Trieste	393.2	408.0	458.6	506.0	501.2	486.5	616.2	725.4	789.6	776.0	757.3	877.8
Total Adriatic gateway	1187.6	1188.3	1284.1	1353.5	1484.8	1512.7	1619.6	1733.1	1776.9	1658.7	1651.3	1807.5
Naples	526.8	546.8	477.0	431.7	438.3	483.5	509.9	583.4	681.9	643.5	652.6	684.1
Salerno	235.2	208.6	263.4	320.0	359.3	288.6	454.7	453.2	414.2	377.9	419.2	361.9
Total Campanian gateway	762	755.4	740.4	751.7	797.6	872.1	964.6	1036.6	1096.1	1021.4	1071.8	1046.0
Gioia Tauro	2305.0	2721.1	3094.3	2969.8	2546.8	2797.1	2448.6	2328.3	2522.9	3193.4	3209.3	3380.1
Cagliari (*)	603.2	627.6	702.1	717.0	748.6	723.0	463.9	288.8	151.4	68.4	109.7	140.2
Taranto (°)	604.4	263.5	197.3	148.5	-	-	-	-	-	5.5	11.8	26.3
Total hub ports	3512.6	3612.2	3993.7	3835.3	3295.4	3520.5	2912.5	2617.1	2674.3	3267.3	3330.8	3546.6
Civitavecchia	38.2	51.0	54.0	64.4	66.7	74.2	94.4	108.4	112.2	106.7	100.2	112.2
Bari	11.1	29.4	31.3	35.9	60.1	71.6	68.7	68.3	82.6	71.2	70.3	65.7
Catania	17.7	22.1	30.3	33.2	49.6	49.2	50.1	59.8	63.2	62.1	58.5	51.7
Palermo	28.6	22.8	20.6	14.3	12.9	12.2	13.3	16.0	14.1	13.3	14.1	14.0
Total other ports	95.6	125.3	136.2	147.8	189.3	207.2	226.5	252.5	272.1	253.3	243.1	243.6
Total Italy	9520.4	9617.5	10,079.9	10,227	10,189.3	10,538.3	10,597.2	10,547.3	10,743	10,589.5	11,245.2	11,457.1
Total Italy (gateway)	6007.8	6005.3	6086.2	6391.7	6893.9	7017.8	7684.7	7930.2	8068.7	7322.2	7914.4	7910.5
Total Italy (hub)	3512.6	3612.2	3993.7	3835.3	3295.4	3520.5	2912.5	2617.1	2674.3	3267.3	3330.8	3546.6

(*) As of 2017, Cagliari is no longer a hub port, as it deals only with short sea shipping container traffic

(°) In 2015, the Taranto container terminal closed. It reopened in 2020, but the traffic is almost negligible and involves only short sea shipping.

In Table 3, the growth rate of Italian gateway and hub ports from 2011 to 2022 is shown.

From 2011 to 2019, almost all Italian ports recorded growth in their traffic. However, the hub port system has registered a decrease resulting from the loss of transshipment traffic of the hub ports of Cagliari and Taranto. This loss has not been compensated by Gioia Tauro, which has recorded only a slight increase.

Regarding the COVID-19 pandemic (2019–2020), all Italian ports, with a few exceptions (Savona-Vado Ligure +168.07%, Gioia Tauro +26.58%), registered a decrease in container throughput. The port

with the highest reduction was La Spezia (-16.72%). Genoa, the largest Italian port, showed a decrease of about 10%. The only large Italian port that has recorded a positive trend has been Gioia Tauro. However, the transshipment traffic is affected by high volatility: container operators choose the transshipment ports that provide the most favorable conditions. This is not the case for gateway ports because they have a definite hinterland. The increase in the traffic in Savona was due to the opening of the new container terminal (Vado Gateway) at Vado Ligure in 2020. Meanwhile, the traffic at the port of Livorno showed a fluctuant throughput during the pandemic, with a decrease in 2020 and an increase in 2022.

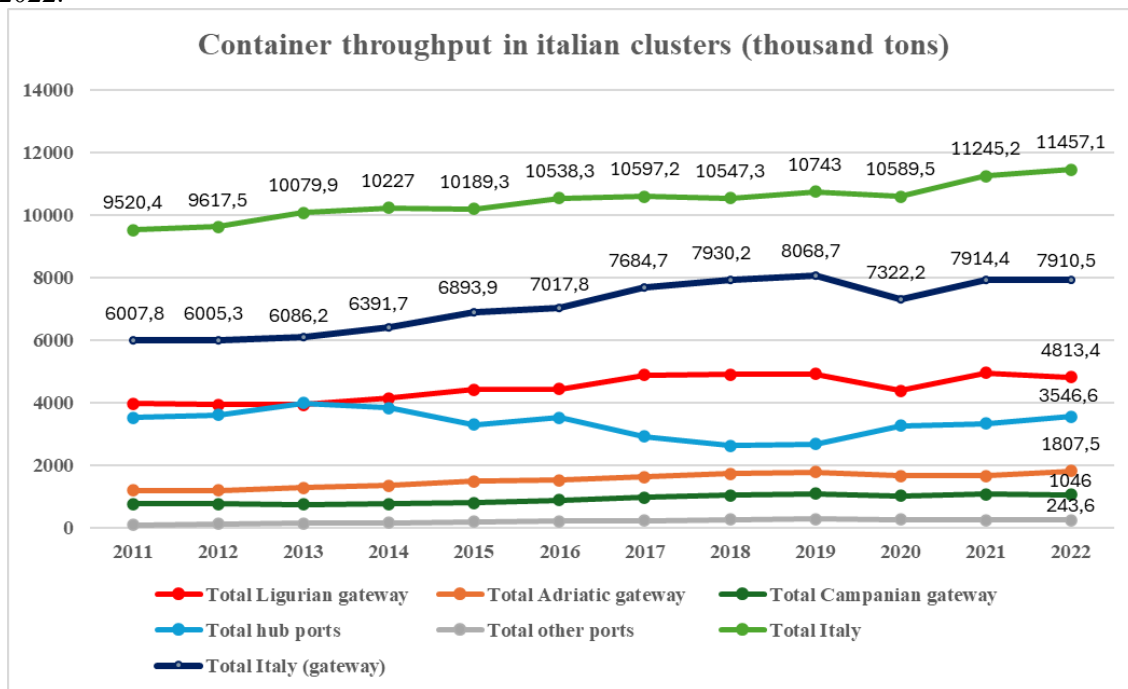


Fig. 1. Container throughput, in thousands of TEUs, at main Italian clusters (Ligurian gateway, Campanian gateway, Adriatic gateway, hub ports, other ports, and total in Italy)

In the period from 2019–2022, the Ligurian gateway traffic showed a slight decrease despite the sharp growth of Savona Vado Ligure, which was due especially to the decrease of La Spezia; growth was also seen in Genoa and Livorno. The Campania gateway showed a decrease, especially Salerno. Adriatic ports had a very slight increase in this period despite the pandemic. As reported in [12], the Adriatic gateway plays a minor role, but it has the greatest prospects for development in the future, especially due to the position of the port of Trieste. This is confirmed by the fact that the largest ships cross the Adriatic gateway ports, as shown in the following of this paper.

The Italian hub port of Gioia Tauro, which has a volume of traffic of approximately 3.38 million TEUs moved in 2022, is the main Italian port in terms of total container throughput. However, as mentioned in [15], the gateway traffic is much more important than that of transshipment from the perspective of added value: the value of a container in transit (transshipped) is 300€, while that for a worked container is 2300€. As such, by multiplying the throughput in the ports in 2022 by the value provided above, we obtain a different view of the importance of the Italian ports according to the added value (see Table 4).

4. EVOLUTION OF DSS CONTAINER ROUTES DEPARTING FROM ITALIAN PORTS: THE EFFECTS OF NAVAL GIGANTISM AND THE COVID-19 PANDEMIC

In the following, the trend of DSS container routes from 2011 to 2023 is analyzed. Data were retrieved in January 2011, August 2014, March 2018, October 2019, June 2022, and September 2023. The main sources of the data were:

- Two journals (“L’avvisatore Marittimo” [16] for data from 2011, 2018, 2019, 2022, and 2023 and “Il Messaggero Marittimo” [17] for 2014 data. These journals provide lists of ship departures from each Italian port.
- The Marinetraffic website [18], which reports the day-by-day position and total capacity of each ship in terms of dead weight tonnage (DWT).
- The websites of major global shipping companies [19].

Table 3

Average annual growth rate of container throughput in the periods from 2011–2022 and 2019–2020 (COVID-19 pandemic) at Italian ports

	Average annual growth rate from 2011 to 2019	Growth rate COVID 19 pandemics (2020 respect to 2019)	Average annual growth rate from 2019 to 2022
Genoa	4.71	-11.88	-1.75
La Spezia	0.94	-16.72	-3.60
Livorno	2.71	-9.32	-1.63
Savona-Vado Ligure	-13.28	168.07	69.75
Total Ligurian gateway	2.75	-10.86	-0.75
Ancona	4.84	-9.93	-2.11
Ravenna	0.16	-10.64	1.55
Venice	3.27	-10.78	-3.43
Trieste	9.11	-1.72	3.59
Total Adriatic gateway	5.17	-6.65	0.57
Naples	3.28	-5.63	0.11
Salerno	7.33	-8.76	-4.40
Total Campanian gateway	4.65	-6.82	-1.55
Gioia Tauro	1.14	26.58	10.24
Total Hub ports	-3.35	26.58	10.24
Civitavecchia	14.42	-4.90	0.00
Bari	28.52	-13.80	-7.35
Catania	17.24	-1.74	-6.48
Palermo	-8.46	-5.67	-0.24
Total other ports	13.97	-6.91	-3.62
Total Italian gateway ports	3.76	-9.25	-0.66
Total Italian hub ports	-3.35	22.17	9.87

Table 4

Values generated by each port in 2022, in million €, based on [15]

PORTS	Gateway Value	Transshipment Value	Total Value
Genoa	5,208.39	80.40	5,288.79
La Spezia	2,813.30	11.80	2,825.09
Livorno	1,478.28	32.72	1,511.00
Savona-Vado Ligure	592.98	2.63	595.61
Total Ligurian gateway	10,092.94	127.56	10,220.50
Ancona	380.30	0.00	380.30
Ravenna	520.62	0.62	521.25
Venice	1,228.18	0.00	1,228.18
Trieste	1,371.24	84.48	1,455.72
Total Adriatic gateway	3,500.34	85.11	3,585.44
Naples	1,520.53	6.90	1,527.43
Salerno	776.31	7.31	783.61
Total Campanian gateway	2,296.84	14.21	2,311.05
Gioia Tauro	0.00	1,014.02	1,014.02
Total hub ports	0.00	1,014.02	1,014.02
Civitavecchia	258.06	0.00	258.06
Bari	151.18	0.00	151.18
Catania	118.83	0.00	118.83
Palermo	32.11	0.00	32.11
Total other ports	560.18	0.00	560.18

4.1. Analysis of DSS container routes departing from Italian ports in 2023

Table 5 lists DSS container services that departed from Italian ports in September 2023. The data represent a single port and are aggregated for the four aforementioned clusters.

The same data, for 2011–2019, are reported in [20], and the data for 2022 are reported in [21].

Table 5 displays the number of services per month and the total and average DWT for each port.

Table 5

A synthesis of the DSS services to and from Italian ports and different world region destinations (number of services per month, total and average DWT in September 2023)

2023	West Africa	Red Sea	East/South Africa	North America	Central America	South America	America/Pacific	Arabic/Persian Gulf	South-East Asia/Far East	Australia/Pacific	TOTAL	Total DWT (thousand tons)	Average DWT (thousand tons)
Genoa	3	18	2	20	18	3	4	10	19	0	66	5319.3	80.6
La Spezia	0	2	0	4	11	0	4	0	8	0	22	1874.7	85.2
Livorno	2	3	0	17	13	3	3	1	1	0	32	2573.3	80.4
Savona-Vado Ligure	0	0	0	1	0	0	0	0	1	0	2	101.7	50.8
Tot. Ligurian gateway	3	18	2	24	26	3	7	10	21	0	77	6245.1	81.1
Trieste	0	4	0	0	1	0	1	0	11	0	12	1703.6	142.0
Tot. Adriatic gateway	0	4	0	0	1	0	1	0	11	0	12	1703.6	142.0
Naples	0	2	0	7	5	0	1	2	2	0	14	1245.6	89.0
Salerno	0	1	2	5	1	0	0	0	1	0	9	522.2	58.0
Tot. Campanian gateway	0	3	2	12	6	0	1	2	3	0	23	1767.8	76.9
Goia Tauro	5	10	0	6	10	0	4	2	17	0	39	4427.8	113.5
Tot. hub ports	5	10	0	6	10	0	4	2	17	0	39	4427.8	113.5
Civitavecchia	0	1	0	0	4	1	4	0	0	0	5	437.6	87.5
Tot. other ports	0	1	0	0	4	1	4	0	0	0	5	437.6	87.5
TOTAL ITALY	5	28	2	25	26	3	7	11	43	0	102	9745.6	95.55

The total DWT for a port is the sum of the capacity (measured in DWT) of all ships departing from the specific port in the month of September 2023. The average DWT of a port is calculated by dividing the total DWT by the number of ships departing from the port. The number of ships departing from a port cluster is equal to the number of ships departing from at least one port of the cluster. For example, if a ship leaves both Naples and Salerno, it is counted once. A similar situation, as for a port cluster, is for “Total Italy”: a ship calling at Gioia Tauro and Livorno, for example, it is counted once for Gioia Tauro, once for Livorno, and once (not twice) for Total Italy. If we take a given row of Table 5 (e.g., the row related to Genoa), the “Total” value is equal to the number of ships departing from the port (in this example Genoa). However, a ship crosses more than one world region: for example, a ship directed to the Far East could cross the Red Sea or the Arabic Gulf. As a result, the sum of the elements of a given row is greater than the “Total” value of the row.

Genoa is the major Italian port in terms of total DWT and number of services per month; meanwhile, the Ligurian port cluster is the most significant, both in terms of total DWT and services per month. However, the largest average DWT is shown by the port of Trieste, which showed the largest average DWT from 2019 to 2023.

In the DSS routes analysis, the classification carried out by “L’Avvisatore Marittimo” for the world regions of destination was used: West Africa, Red Sea, East and South Africa, North America (Atlantic Coast), Central America (Atlantic Coast), South America (Atlantic Coast), America/Pacific (North, Central and South America Pacific Coast), Arabian/Persian Gulf, South-East Asia/Far East, and Australia/Pacific. Table 6 summarizes DSS services from Italian ports towards each world region. “Total

Italy” refers to the “sum of the DWT of all ships departing from Italian ports that are directed to at least one of the world regions.” Because the same ship could cross the ports of more than one world region (e.g., a ship directed to South-East Asia/Far East could call at ports of the Red Sea), the sum of the number of services, the total DWT of all world regions, is greater than the “Total Italy” values.

Table 6

Number of services, total and average DWT from Italian ports to each world region in September 2023

World region	No. of services/month	Total DWT (thousand tons)	Average DWT (thousand tons)
West Africa	5	302.50	60.50
Red Sea	28	3065.57	109.48
East/South Africa	2	67.48	33.74
North America (Atlantic)	25	1829.56	73.18
Central America (Atlantic)	26	1972.27	75.86
South America (Atlantic)	3	262.52	87.51
America/Pacific (North + Central + South)	7	622.51	88.93
Arabian/Persian Gulf	11	1294.58	117.69
South-East Asia/Far East	43	5785.87	134.56
Australia/Pacific	0	0	0
Total Italy	102	9745.61	95.55

The most significant world region for the Italian market is South-East Asia/Far East. This is attributed to the demographic and economic relevance of the countries of this region: India, Malaysia, Singapore, China, Japan, Korea, and Taiwan. The main world container ports are situated in this region: Singapore, Shanghai, Shenzhen, Ningbo-Zhoushan, Busan, Hong Kong, Guangzhou, and Tokyo.

The number of DSS services per month leading to the South-East Asia/Far East route is 43, while the total DWT of ships leading to South-East Asia/Far East from Italian ports is around 5.8 million tons, and the average DWT of the ships is 134,560 tons. This means that the biggest ships operate on the Mediterranean (West Europe)-Far East route. In addition, it should be taken into account that several ships directed to the Far East also call at the Red Sea and Arabic-Persian Gulf. The most important port in the Red Sea is the King Abdullah Port (near Jeddah), while in the Arabic Gulf, it is Jebel Ali (near Dubai).

Another important route for Italian ports is that running towards North and Central America along the Atlantic Coast. The number of DSS services is 25 and 26, respectively, and the total DWT is 1.8 million tons for North America and around 2 million tons for Central America. However, it must be underlined that, in the Central America region, there are some important US ports (Miami, Houston, and New Orleans), as well as Colon and Balboa, which are the two ports situated on the Pacific and Atlantic sides of the Panama Canal. Instead, North America includes Canadian and US ports on the Atlantic Coast, namely in Montreal, New York, Norfolk, and Charleston. America/Pacific comprises the US ports of Long Beach and Los Angeles, the Canadian port of Vancouver, and the Mexican port of Manzanillo. The total DWT for the ships directed to North America is 1.83 million tons, while 1.97 million tons is that towards Central America.

4.2. Comparison of DSS container routes in 2011, 2014, 2018, 2019, 2022, and 2023: The impact of naval gigantism and the COVID-19 pandemic

In Tables 7 and 8, the evolution of DSS services, total and average DWT departing from Italian ports is shown.

In Tables 7 and 8, in “Total Ligurian gateway,” the number of services and the total and average DWT of all ships that cross at least one Ligurian port are reported. For example, a ship that crosses both Genoa and Livorno is counted once in the “Total Ligurian gateway” values. The same applies to Adriatic and Campanian gateway ports, hub ports, and other ports.

Similarly, in “Total Italy” the number of services and the total and average DWT of all ships that cross at least one Italian port are reported. For example, a ship that crosses Gioia Tauro, Genoa, and La Spezia is counted once in the “Total Italy” values.

In general, since 2011, there has been a reduction in the number of monthly services. The total DWT has risen from 2011 to 2019, but it registered a reduction in 2022 and 2023, in comparison to 2019 values. However, the total container throughput did not decrease. Possibly (but this is not the only potential explanation), shipping companies have become more efficient as the occupation factor of the ships has increased. The average DWT has steadily increased, clearly indicating the development of the phenomenon of naval gigantism in container ships from 2011 to 2019. After 2019 it has shown fluctuant values, depending largely on the traffic of Trieste, which is crossed by the largest ships.

This trend is particularly evident in Ligurian gateway ports. From 2011 to 2019, the number of monthly services declined from 120 to 103 (-14%), the total DWT increased by 46%, and the average DWT increased by 71%. From 2019 to 2023, the number of services decreased by another 25% (from 81 to 66), and the total and average DWT showed a decrease of 30% and 7%, respectively.

Regarding the Italian Adriatic ports, the number of monthly services has reduced from 9 in 2011 to 7 in 2019 (-22%). In the same period, the total DWT increased by 121%, while the average DWT increased by 184%. From 2019 to 2023, we observed an increase in the number of monthly services from 7 to 12 (71%), and the total DWT grew by 69% while the average DWT slightly decreased by -1.66%. The hub ports, especially driven by Gioia Tauro, recorded a decrease in the number of services per month of 54% (from 59 to 27) from 2011 to 2019. Total DWT also decreased by 17%, while the average DWT increased by 82%. In 2019–2023 an increase in the number of services from 27 to 39 (44%) and in the total DWT (47%) was observed. The average DWT slightly increased (by 2%). In Tables 9 and 10 and Figures 2–4, the evolution of the number of services and the average and total DWT for the different world regions linked to Italian ports is analyzed. The most important world region linked to Italian ports by DSS routes is South-East Asia/Far East. Connections to this region have demonstrated a significant decrease in the number of services from 2011 to 2018 (-36%), due to naval gigantism, and again from 2019 to 2023 (-17%), due to the COVID-19 pandemic. As regards the total DWT, it has shown a significant increase, of almost 2 million tons (36%) from 2011 to 2019, then a sharp decrease, of almost 2 million tons (-25%), in 2022, and a recovery in 2023, however the DWT of 2023 is over 1 million TEUs less than that of 2019. The average DWT showed a considerable increase until 2019 (102%), then it remained almost constant from 2019 to 2023. Other relevant world regions are the Red Sea and the Arabic/Persian Gulf, which are situated along the Europe-Far East route.

The routes to North America (Atlantic) showed a decrease in the number of monthly departures from 2011 to 2019 (-19%) and then remained almost constant. The number of departures to Central America (Atlantic) has shown fluctuant values: a decrease from 2011 to 2014, an increase from 2014 to 2018, then a decrease from 2018 to 2022, and almost constant from 2022 to 2023. The total DWT of North America, after an initial increase from 2011 to 2014, fluctuated between 1.6 and 2.0 million tons from 2014 to 2023. The total DWT of Central America showed a sharp increase of about 1 million tons from 2014 to 2018. Then, from 2018 to 2023, it showed fluctuating values, between about 2.0 to 2.3 million tons, only slightly affected by the pandemic. The strong increase in DWT in 2018 was due to a shift of some routes that previously crossed North American ports, towards U.S. ports of the Mexican Gulf, which are classified as Central America.

Regarding South America (Pacific and Atlantic), and America/Pacific (North and Central America/Pacific coast), a general increase in the average DWT in the years under consideration was observed. Concerning the general trends of monthly departures and total DWT, very remarkable fluctuations can be observed. This indicates the volatility of these markets. In South America, the total DWT showed a sharp increase from 2011 to 2019 (230%) and a remarkable decrease from 2019 to 2023 (-81%) during the pandemic. This was not the case for America/Pacific, which showed its highest total DWT in 2014 and a relevant decrease in all the following years, with a slight recovery in 2022 and a new decrease in 2023.

Table 7
Comparison of the number of DSS services from Italian ports in
2011, 2014, 2018, 2019, 2022, and 2023

	Number of services per month					
	2011	2014	2018	2019	2022	2023
Genoa	80	80	94	81	70	66
La Spezia	43	48	40	43	21	22
Livorno	40	40	46	41	37	32
Savona-Vado Ligure	10	3	3	5	6	2
Total Ligurian gateway	120	122	117	103	88	77
Trieste	6	11	5	7	4	12
Venice	6	0	6	1	0	0
Ravenna	2	0	0	0	0	0
Ancona	0	0	0	0	0	0
Total Adriatic gateway	9	11	7	7	4	12
Naples	35	16	17	14	8	14
Salerno	8	12	18	13	4	9
Total Campanian gateway	43	27	30	22	12	23
Gioia Tauro	32	37	34	27	18	39
Cagliari	24	15	12	0	0	0
Taranto	3	5	0	0	0	0
Total hub ports	59	57	51	27	18	39
Civitavecchia	0	0	9	7	3	5
Bari	0	0	2	0	4	0
Catania	0	0	2	0	1	0
Palermo	0	0	0	1	0	0
Total other ports	0	0	11	8	6	5
TOTAL ITALY	150	158	132	121	98	102
TOTAL ITALY (GATEWAY)	91	101	81	94	80	63
TOTAL ITALY (HUB)	59	57	51	27	18	39

Table 8
Comparison of total and average DWT of DSS services from Italian ports in 2011, 2014, 2018, 2019, 2022, and
2023

	Total DWT (thousand tons)						Average DWT (thousand tons)					
	2011	2014	2018	2019	2022	2023	2011	2014	2018	2019	2022	2023
Genoa	4005.7	5408.7	7763.6	7972.5	5931.4	5319.3	50.1	67.6	82.6	98.4	84.7	80.6
La Spezia	2572.4	3663.2	4509.9	4252.0	2101.6	1874.7	59.8	76.3	112.8	98.9	100.1	85.2
Livorno	1468.5	2089.7	2910.3	2760.2	2894.1	2573.3	36.7	52.2	63.3	67.3	78.2	80.4
Savona-Vado Ligure	277.4	68.9	90.6	172.9	585.4	101.7	27.7	23.0	30.2	34.6	97.6	50.8
Total Ligurian gateway	6118.0	8131.4	10041.8	8956.3	7608.6	6245.1	51.0	66.7	85.8	87.0	86.5	81.1
Trieste	369.6	693.6	437.1	1011.0	307.3	1703.6	61.6	63.1	87.4	144.4	76.8	142.0
Venice	270.2	0.0	387.4	63.1	0.0	0.0	45.1	0.0	64.6	63.1	0.0	0.0
Ravenna	23.8	0.0	0.0	0.0	0.0	0.0	11.9	0.0	0.0	0.0	0.0	0.0
Ancona	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Adriatic gateway	458.1	693.6	528.4	1011.0	307.3	1703.6	50.9	56.2	75.5	144.4	76.8	142.0
Naples	1949.0	1101.5	1201.2	933.0	539.5	1245.5	55.7	68.9	70.7	66.7	67.4	89.0
Salerno	220.9	519.9	850.7	502.2	199.0	522.2	27.6	43.3	47.3	38.6	49.8	58.0
Total Campanian gateway	2170.0	1583.5	1888.6	1195.3	738.5	1767.7	50.5	58.7	63.0	54.3	61.5	76.9
Gioia Tauro	2242.6	3325.1	3681.1	3006.6	2116.9	4427.8	70.1	89.9	108.3	111.4	117.6	113.5
Cagliari	1130.9	1022.1	685.7	0.0	0.0	0.0	47.1	68.2	57.2	0.0	0.0	0.0
Taranto	235.1	328.5	0.0	0.0	0.0	0.0	78.4	65.7	0.0	0.0	0.0	0.0
Total hub ports	3608.6	4675.7	4569.7	3006.6	2116.9	4427.8	61.2	82.0	89.6	111.4	117.6	113.5
Civitavecchia	0.0	0.0	600.7	284.7	382.9	437.6	0.0	0.0	66.8	40.7	127.6	87.5
Bari	0.0	0.0	94.8	0.0	437.7	0.0	0.0	0.0	47.4	0.0	109.4	0.0
Catania	0.0	0.0	27.9	0.0	134.0	0.0	0.0	0.0	13.9	0.0	134.0	0.0
Palermo	0.0	0.0	0.0	44.6	0.0	0.0	0.0	0.0	0.0	44.6	0.0	0.0
Total other ports	0.0	0.0	681.5	329.3	705.7	437.6	0.0	0.0	62.0	41.2	117.6	87.5
TOTAL ITALY	8073.0	11,281.7	11,075.1	11,683.2	9070.2	9745.6	53.4	71.4	83.9	96.6	92.6	95.5
TOTAL ITALY (GATEWAY)	4464.4	6606	6505.4	8676.6	6953.3	5317.8						
TOTAL ITALY (HUB)	3608.6	4675.7	4569.7	3006.6	2116.9	4427.8						

Table 9
Comparison of the number of DSS services from Italian ports, to each world region in 2011, 2014, 2018, 2019, 2022, and 2023

	Number of services per month					
	2011	2014	2018	2019	2022	2023
West Africa	8	10	10	5	6	5
Red Sea	68	34	35	31	28	28
East/South Africa	5	5	8	7	4	2
North America	32	38	28	26	25	25
Central America	33	26	38	30	25	26
South America	7	19	9	13	5	3
America/Pacific	20	23	11	13	12	7
Arabian/Persian Gulf	35	26	27	37	23	11
South-East Asia/Far East	77	66	49	52	44	43
Australia/Pacific	11	10	10	5	3	0
TOTAL ITALY	150	158	132	121	98	102

Table 10
Comparison of total and average DWT of DSS services from Italian ports, to each world region in 2011, 2014, 2018, 2019, 2022, and 2023

	Total DWT (thousand tons)						Average DWT (thousand tons)					
	2011	2014	2018	2019	2022	2023	2011	2014	2018	2019	2022	2023
West Africa	201.7	364.3	376.0	213.6	354.3	302.5	25.2	36.4	37.6	42.7	59.0	60.5
Red Sea	4372.4	2756.3	3657.5	3172.8	2715.3	3065.6	64.3	81.1	104.5	102.4	97.0	109.5
East/South Africa	277.0	303.9	535.2	567.5	332.7	67.5	55.4	60.8	66.9	81.1	83.2	33.7
North America	1577.6	2033.8	1937.1	1665.7	1873.5	1829.6	49.3	53.5	69.2	64.1	74.9	73.2
Central America	1290.3	1237.6	2331.4	2174.9	2209.7	1972.3	39.1	47.6	61.4	72.5	88.4	75.9
South America	413.0	953.8	886.9	1365.7	549.8	262.5	59.0	50.2	98.5	105.1	110	87.5
America/Pacific	752.0	1667.5	932.1	781.6	933.6	622.5	37.6	72.5	84.7	60.1	77.8	88.9
Arabian/Persian Gulf	2422.0	2247.2	2921.4	4548.9	2675.3	1294.6	69.2	86.4	108.2	122.9	116.3	117.7
South-East Asia/Far East	5082.0	5884.1	5321.4	6917.6	5162.9	5785.9	66.0	89.2	108.6	133.0	117.3	134.6
Australia/Pacific	445.5	628.6	843.2	400.3	255.0	0.0	40.5	62.9	84.3	80.1	85.0	0.0
TOTAL ITALY	8073.0	11,281.7	11,075.1	11,683.2	9070.2	9745.6	53.8	71.4	83.9	96.6	92.6	95.6

The cause of the sharp decrease in services in the Red Sea region from 2011 to 2014, which can be observed in Tables 9 and 10, is the fact that in the 2011 analysis [22], Suez, located on the southern side of the Suez Canal, was considered part of the Red Sea region. As a result, any route leading to Suez was classified as a DSS route. In the subsequent analysis (2014, 2018, 2019, 2022, and 2023), Suez was considered a Mediterranean port.

West Africa, East/South Africa, and Australia/Pacific are world regions with a limited number of monthly services; however, the comparison of data from 2011 to 2023 reveals that these regions also experienced the phenomenon of naval gigantism.

5. CONCLUSIONS

This paper analyzed the impact of the COVID-19 pandemic and naval gigantism on DSS container routes calling at Italian ports. In order to carry out this analysis, the evolution of these routes from 2011 to 2023 was investigated. In particular, the spread of naval gigantism took place from 2011 to 2019, while the effects of the pandemic were analyzed from 2020 to 2023. This analysis is highly important in maritime studies, as it deals with the two most important phenomenons that showed a strong impact on the maritime intercontinental market (especially the pandemic). As for naval gigantism, from 2011 to 2019, this phenomenon recorded a decrease in the number of services and an increase in the average DWT.

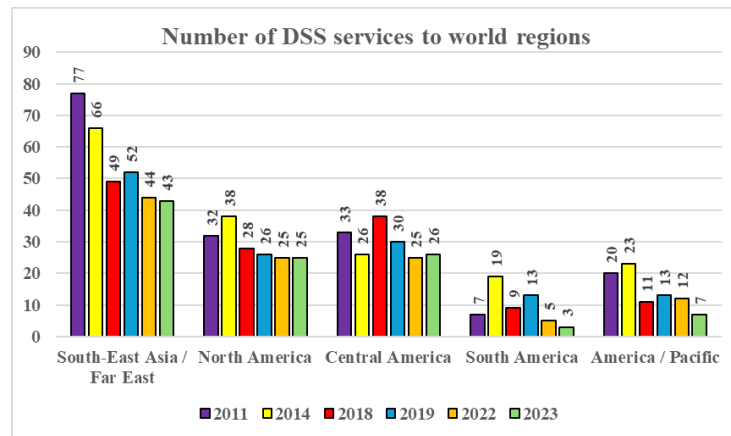


Fig. 2. Number of DSS services from Italian ports to the most important world regions (Asia and America) in 2011, 2014, 2018, 2019, 2022, and 2023

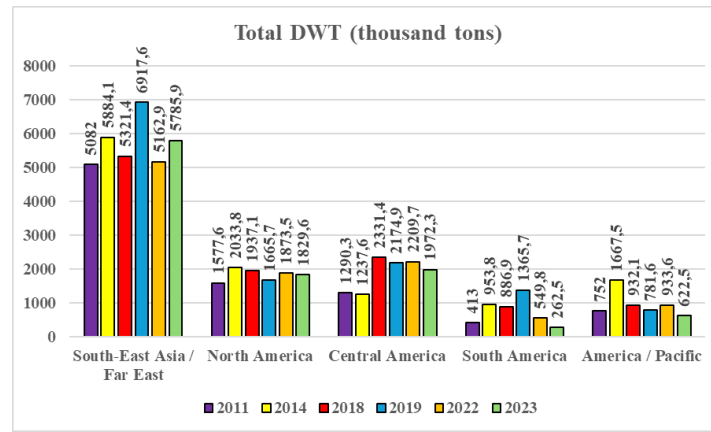


Fig. 3. Total DWT of DSS services from Italian ports to Asian and American regions in 2011, 2014, 2018, 2019, and 2023

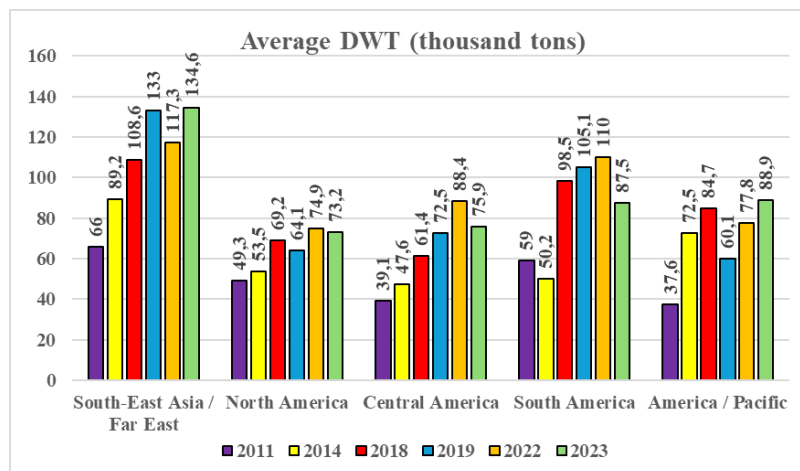


Fig. 4. Average DWT of DSS services from Italian ports to Asian and American regions in 2011, 2014, 2018, 2019, and 2023

Naval gigantism first took place on the most important routes (i.e., those to the Red Sea, the Arabic Gulf, South-East Asia, the Far East, and North and Central America). For these routes, the decrease in the number of services and the increase in the average DWT was already visible from 2011 to 2014. Routes to South America, Africa, and Australia were affected by naval gigantism a second time in 2018 and 2019. After 2019, naval gigantism seems to have stopped, as the average DWT of ships has remained almost constant. To raise the shipload factor, in 2014 and especially in 2018 and 2019, ships tended to

cross a larger number of ports and world regions. A typical example is the case of the routes to East Africa that have been prolonged to the Far East. As for Italian ports, the Ligurian gateway is the most important, while the Adriatic gateway is crossed by a limited number of DSS routes. However, the largest ships call at the north Adriatic port of Trieste. In any case, Adriatic ports, due to their unfavorable position on the sea side (but not on the land side) are crossed by only a limited number of DSS routes and are mostly connected to Mediterranean (not necessarily Italian) hub ports by feeder services.

However, before the pandemic, a relevant decrease in the hub traffic at Italian ports took place, and two Italian hubs ceased their transshipment traffic: Taranto and Cagliari. In the years before the pandemic, transshipment ports for the Adriatic gateway were mostly Marsaxlokk (Malta) for the American routes and the East Mediterranean ports of Piraeus (Greece), Port Said, Alexandria, and Damietta (Egypt) for the routes to the Far East.

This situation changed during COVID-19 for two reasons: the reduction of activities due to sanitary restrictions, and the different restrictions in transportation in force in the various countries. The reduction of activities has led maritime operators to try to further increase the load factor of ships. This is evident when comparing the total gateway traffic with the total DWT of Italian gateway ports. Indeed, the total DWT, which is equal to the total capacity of ships calling at Italian gateway ports (independently from the traffic), strongly decreased after 2019 and only slightly recovered in 2022 and 2023, while the Italian gateway port traffic remarkably recovered in 2022, although the pre-pandemic values were not reached again. In addition, maritime operators have invested heavily in major routes, such as those to the Far East and North and Central America, that were seen as the most productive, while some minor routes (e.g., those to Australia/Pacific) were abandoned.

Finally, the pandemic had a positive impact on Italian transshipment traffic. Indeed before the pandemic, the transshipment ports utilized for the Adriatic gateway were very often non-Italian ports, while during the pandemic the transshipment was carried out at most at the Italian transshipment port of Gioia Tauro. However, it must be remarked that the transshipment traffic is volatile and depends on the “strategic” choices of container operators.

The reason for the growth of Gioia Tauro during the pandemic is probably sanitary restrictions: indeed sanitary restrictions are the same throughout Italy, and specifically in Gioia Tauro and northern Adriatic ports; instead sanitary restrictions are different, and are in force in different periods, in the other Mediterranean countries. As a result, if transshipment takes place at Gioia Tauro, and the origin or the destination of containers is Trieste, container operators are subject only to Italian restrictions, whereas if transshipment takes place, for example, at Piraeus, they are subject to both Italian and Greek restrictions.

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