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MARITIME SERVICES IN ADRIATIC SEA AND WORLDWIDE STRATEGIES OF CONTAINER SHIPS OPERATORS

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ABSTRACT

The AIS is a tracking system used on ships to provide information on surrounding traffic situation and supplements marine radar as a collision avoidance device. The data acquired from AIS systems also constitute a new means of information for the maritime community, or the wider public. This part of the analysis is based on a database constructed using the IHS maritime database (<https://maritime.ihs.com/>) and with collected data from AIS Hub, a data sharing service which provides access to real time ship positions for vessel tracking systems. This paper proposes an analysis based on AIS signals (2016, 2018 & 2020 periods) to study the strategy of Shipping Container Companies. This communication proposes a starting point for the analysis of the interconnection between the global trades maritime services (deep-sea containers shipping lines) and feeder and Short Sea Shipping services in the Adriatic Sea. This work jointly implements Data Mining (Principal Components Analysis), Mapping and some Graph Theory tools (entire graph structure) applied both to maritime global and local networks and to the strategies of Container Carriers and their linked local partners.

Keywords: AIS, Container shipping, Adriatic Sea

1. INTRODUCTION

The AIS is a tracking system used on ships to provide information on surrounding traffic situation and supplements marine radar as a collision avoidance device. AIS devices are mandatory on all large vessels according to the IMO SOLAS Convention (SOLAS Convention, 2004). The data acquired from AIS systems also constitute a new means of information for the maritime community, or the wider public. This part of the analysis is based on a database constructed using the IHS maritime database (<https://maritime.ihs.com/>) and with collected data from AISHub, a data sharing service which provides access to real time ship positions for vessel tracking systems. Above all, broadcasting AIS data in real-time makes a tangible contribution to the scientific community. The automatic character of transmitting vessel positioning signals and its generalization provide an opportunity to track and analyze the vessels' itineraries. Once this source of information has been properly checked through matching it with external data with regard to vessels and ports, it opens the way to reasoning on a global scale as well as on the scale of port approaches, in real-time as well as long term. The method, founded on a spatial analysis within a geographical information system (GIS) combined with a database server, makes it possible to reconstruct each vessel's trajectory in such a way as to identify the navigation lanes then to match the daily traffic in its temporal and quantitative dimensions. It is then relevant to analyze the maritime networks. As AIS data is "Big Data", it requires specific techniques for data handling and processing which has

limited its use. We create a platform to develop capacity and methods for better use of this massive source of maritime data. It has to receive, decode, clean, store and analyze AIS messages.

This paper proposes an analysis based on AIS signals (2016, 2018 & 2020 period) to study the maritime service of the port of the Adriatic Sea and the strategy of Global Carriers Shipping Companies.

This study is a continuation of previous work that we have already presented in international conferences. In a first presentation, we studied the strategy of Global Carriers Shipping Companies of new generation container large Post Panamax, New Post Panamax and triple E ocean going vessels. These large container ships, giants of the seas, structure the world maritime traffic and more particularly the Europe-Asia trade. During a second conference, we studied the maritime service calling at Baltic Sea ports. During our presentation, we will use analytics from these two early communications.

2. MODEL AND DATA

2.1. A work based on AIS data

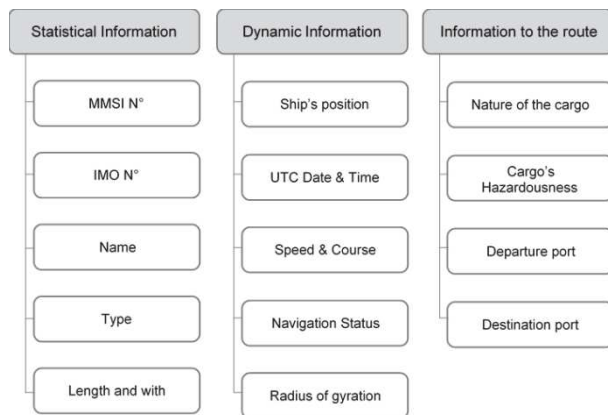
This work is based on a database constructed using the IHS maritime database (<https://maritime.ihs.com/>).

AIS data is accessible through several ways such as collaborative websites, own receivers or subscription to commercial data suppliers, providing sometimes free-of-charge access to vessel identification and positioning in real-time the world over. It contains a lot of significant information, which is a precious resource for



research. AIS data analysis provides insight in ship traffic and forms the basis of the network analysis. So, it can produce improved and optimized maritime traffic information like density maps, maritime routes (lanes), a network of maritime routes: nodes, hierarchy... Speaking about our study, AIS data appear as a source of information about strategies of containerships operators.

The AIS is a tracking system used on ships to provide information on surrounding traffic situation and supplements marine radar as a collision avoidance device. AIS devices are obligatory on all large vessels according to the IMO SOLAS Convention (SOLAS Convention, 2004). AIS presents advantages for maritime transportation actors: improvements in safety, progresses in fleet management and navigation. The data acquired from AIS systems also constitute a new means of information for the maritime community, or the wider public (See Fig 1).



Source: Adapted from Le Guyader, Brosset, Gourmelon, 2011.

Figure 1: Nature of AIS data

2.2. Study framework

For this paper and within the framework of this international conference, we will study the maritime service of the Adriatic space. We have thus selected all the ports of the Adriatic Sea carrying out containerized traffic. At first, we will present the containerized service of the ports of the Adriatic then we will study their interconnections between them and with the other ports in particular of the Mediterranean Sea. For this we will use tools from graph analysis and statistical studies that we will combine. To have an evolutionary study, we have chosen three reference years for analysis: 2016, 2018 and 2020. These years are studied because they mark stages in the evolution of the strategies of world maritime operators. To cope with this new environment, shipping companies have joined forces in alliances since 2015 with the aim of exchanging space on board. But many shipping companies have not been able to resist this combination of low freight rates and transport overcapacity. From December 2015 with the acquisition of the company NOL by CMA CGM, we have therefore witnessed the acquisition or merger between operators. The latest is the acquisition of NILE DUTCH by HAPAG LLOYD in March 2021. Between

2015 and 2020, we went from 16 operators organized in 4 alliances to 9 operators in 3 alliances. With the tightening of shipping companies, the three new alliances are: 2M, Ocean Alliance and The Alliance. Three alliances, bringing together 9 maritime operators, representing more than 20 million TEUs of transport capacity or 80% of the total capacity of the global maritime fleet of container ships. And more particularly, they account for 95% of maritime transport capacity on East-West trades. Today, the world's main ports are highly dependent on the service offers of these operators and in particular on the major global trades linking East Asia, Europe and North America.

In the meantime, it can also be noted that the container ship fleets have experienced exponential growth in their transport capacities. Since the 2000s, the size of container ships has evolved exponentially. This has increased from a maximum transport capacity of 8000 TEUs in 2000 for vessels measuring 300 metres in length to transport capacities of up to 24000 TEUs. Transport capacity has increased 3-fold in the space of 20 years. These developments in the strategic organization of shipping companies that operate on the main world trades have an impact on the maritime service of secondary areas including the ports of the Adriatic Sea.

2.3. Combined methodology

This paper jointly implements Data Mining (Principal Components Analysis), Mapping and some Graph Theory tools applied both to maritime global networks and to the strategies of Global Carriers (operators) in the Adriatic Sea port and their connection with the others ports.

We use Principal Components Analysis (PCA) to discover hidden structures, and reach an objectivity which is difficult to attain with classical techniques. In our case, the graph theory is used to allow the study of the maritime networks of the operators of large container ships and thus to highlight their structures. Several methods exist to simplify a graph whose objective is to remove certain vertices or links. We have retained the method of dominant flows. This method has the advantages of being easy to use, easily understandable by an uninformed reader and makes it possible to highlight the deep structure of the maritime network studied. The principle of this method is to define a threshold and to keep all the superior relations. The threshold of 50 connections was retained for our network analysis, which corresponds to at least one weekly connection

3. RESULTS

To cope with this new environment, shipping companies have joined forces in alliances since 2015 with the aim of exchanging space on board. With the tightening of shipping companies, the three new alliances are: 2M, Ocean Alliance and The Alliance. In the Adriatic Space, there are also 31 independent containership operators.



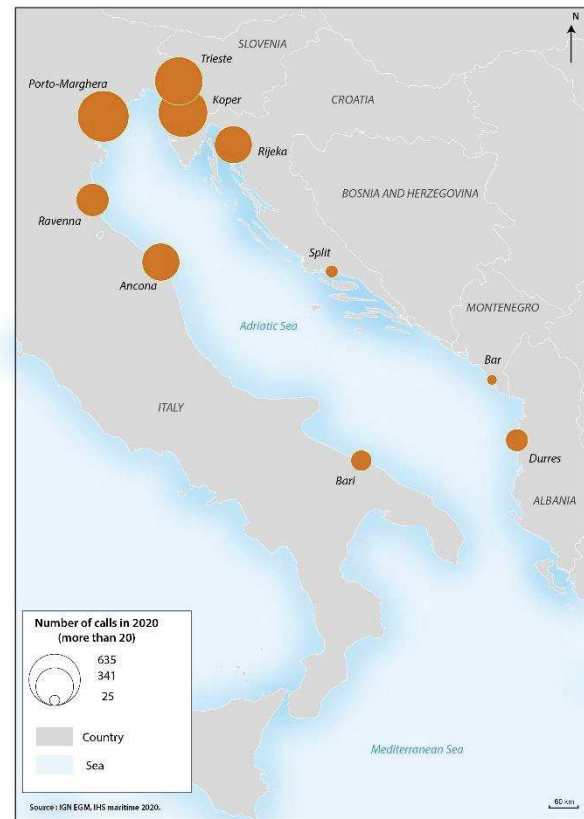
Figure 2: Maritime alliances and independent operators in the Adriatic Sea in 2020

The place of containerized traffic in the Adriatic Sea is relatively modest. In 2020, container traffic was 3.2 million TEU, the equivalent of Haropa Port. This traffic is mainly concentrated in 4 ports which are located in the North of the Adriatic Sea: Koper (945,000 TEU), Trieste (776,000 TEU), Porto Marghera (529,000 TEU) and Rijeka (344,000 TEU). Container traffic in the southern Adriatic Sea is almost nil. The Adriatic Sea, being a dead end sea, is on the fringes of the main international maritime trades. This maritime space is mainly served by transshipment in a hub port. The port statistics approach is classic in transport geography in order to compare port areas with each other. The purpose of this paper is not to compare ports with each other but to position them more broadly in the regional and global maritime network by studying their interconnections between them and with other ports. This analysis of maritime connections will make it possible to highlight the main existing maritime relations between the Adriatic ports and also to study the crossing points of container ships and therefore of goods before serving the Adriatic Sea. What are the port hubs that serve the Adriatic ports?

In the presentation of our results, we will first analyze the stopovers. Then, via a graph analysis, we will study the intra and extra Adriatic connections. Finally, via a statistical analysis using principal component analysis tools, we will carry out an approach by maritime operators to study their strategies.

Table 1: Number of calls by ports in 2016, 2018 and 2020

Port	Number of calls 2020	Number of calls 2018	Number of calls 2016
Ancona	341	428	447
Bakar	1		
Bar	25	14	34
Bari	104	102	142
Brindisi	2		28
Chioggia	1	7	4
Durres	122	127	133
Koper	585	671	675
Monfalcone	5	2	8
Monopoli	1		
Ortona	5	3	
Ploce	7	1	
Porto Marghera	635	760	664
Porto Nogaro	3	4	11
Pula		2	2
Ravenna	409	539	533
Rijeka	328	287	344
Sibenik	1	1	1
Split	37	49	46
Trieste	557	581	575
TOTAL	3169	3578	3647



Source: IHS maritime

Figure 3: Calls of containerships in the ports of Adriatic Sea in 2020

Table 2: Capacity of TEU by ports in 2016, 2018 and 2020

Port	Capacity TEU 2020	Capacity TEU 2018	Capacity TEU 2016
Ancona	546 624	603 209	612 044
Bakar	523		
Bar	29 917	14 965	36 540
Bari	100 501	91 174	150 355
Brindisi	1 046		31 522
Chioggia	372	2 970	1 562
Durres	131 741	137 720	152 879
Koper	1 979 116	2 130 894	2 022 681
Monfalcone	2 361	880	3 217
Monopoli	411		
Ortona	2 093	1 065	
Ploce	6 916	925	
Porto Marghera	1 024 063	1 274 642	1 049 725
Porto Nogaro	1 085	1 897	5 064
Pula		1 031	744
Ravenna	615 476	686 038	722 261
Rijeka	1 292 078	1 203 537	1 183 654
Sibenik	190	1 033	465
Split	27 000	44 195	44 663
Trieste	2 200 311	1 931 887	1 564 486
TOTAL	7 961 824	8 128 062	7 581 862

We propose a typology of container terminal ports in the Adriatic based on the choices made by alliances and independent operators. Three configurations are observed. 9 out of 19 ports, which are small or medium-sized ports, are served almost exclusively by small independents. 7 other larger ports are served mainly by the 2M alliance. 3 ports have a shared service offer.



Table 3: Typology of Adriatic ports per operator's categories based on TEU's capacities in 2020

Typology	Adriatic Ports
Independent Operators	Bakar
	Brindisi
	Chioggia
	Monfalcone
	Monopoli
	Ortona
	Porto Nogaro
	Sibenik
	Split
2M Alliance	Bari
	Durres
	Koper
	Ploce
	Ravenna
	Rijeka
	Trieste
Shared by all Operators	Ancona
	Bar
	Porto Marghera

In this study, we have chosen to express the Adriatic seaports in the space of container ship operators. This allowed us to characterize the ports of call according to the strategies implemented by these same operators. Over the three-year period studied, it appears that the geographical positioning of the 2M alliance operators is different from that of the other two alliances (Ocean Alliance and The Alliance) and the other independent operators. We observe that in 2020 some ports are placed by the 2M alliance on an equal footing in terms of calls: Bar, Bari, Durres, Ploce, Porto-Marghera, Ravenna. The PCA 2020, carried out using port capacities, also highlights a completely different configuration of port calls, this time involving two small independent operators: Lyndon Marine Ltd and Mednav Chart SAL, which distribute their calls evenly over three secondary ports (Bakar, Brindisi and Porto-Nogaro). This shows a great heterogeneity in the organization of port calls of container ships in the Adriatic area in 2020 (continuation of the trend observed since 2016).

From 2016 to 2020, the number of stopovers seems to stabilize. On the other hand, the transport capacity offered in stopovers in its ports has increased from 7.58 million TEUs in 2016 to nearly 8 million TEUs in 2020, i.e. a 5% increase in the capacity offered. This means that the average size of container ships calling has increased significantly following the global trend. The average size of container ships calling was 1300 TEU in 2016 and in 2020, 2500 TEU. The average size of container ships has almost doubled in just 4 years. The ports of the Adriatic Sea are benefiting from the effect of cascading and the tightening of supply around a few global operators.

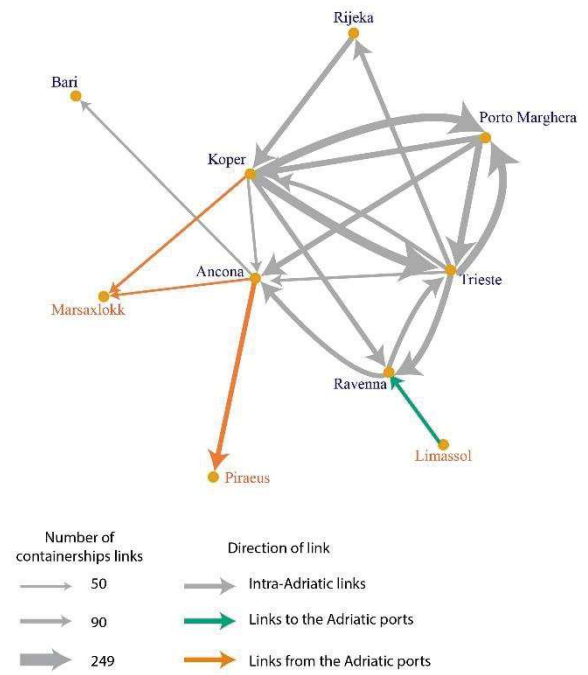


Figure 3: Links-graph of maritime connection of ports of Adriatic Sea in 2016 (over of 49 connections)

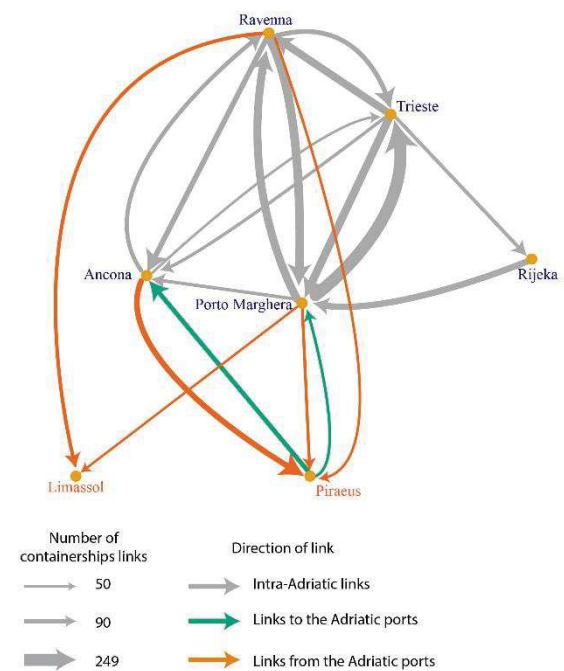


Figure 4: Links-graph of maritime connection of ports of Adriatic Sea in 2018 (over of 49 connections)

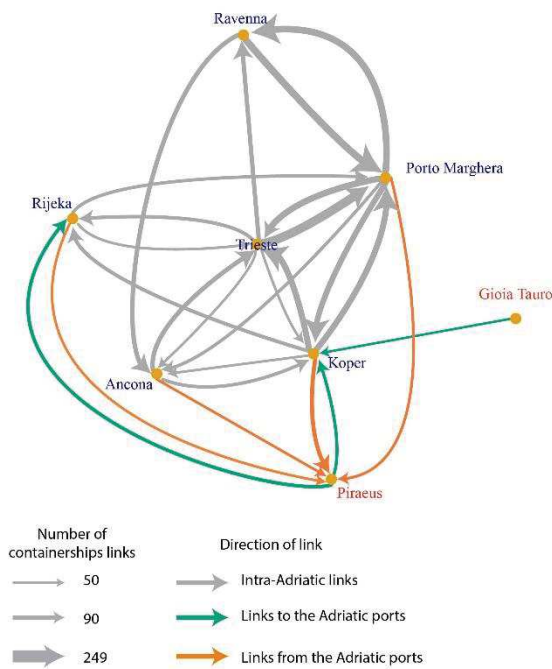


Figure 5: Links-graph of maritime connection of ports of Adriatic Sea in 2020 (over of 49 connection)

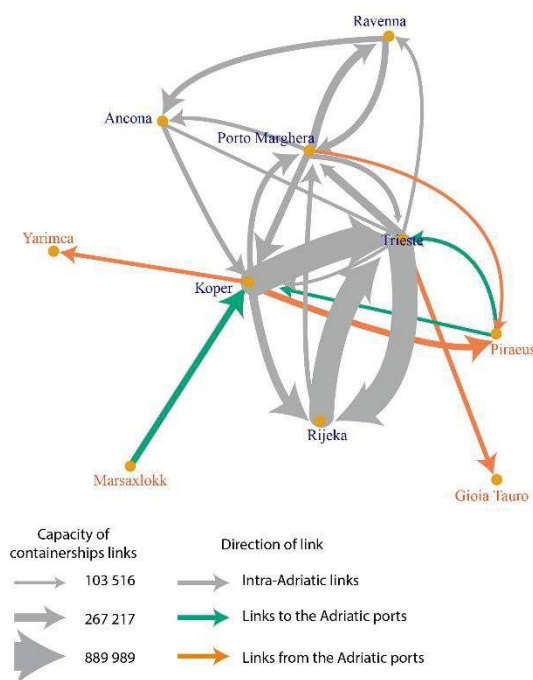


Figure 6: Capacity-graph of maritime connection of ports of Adriatic Sea in 2020 (over of 100 000 TEU)

Table 3: Number of calls and maritime connection of Adriatic Sea Ports in 2016, 2018 and 2020

	2016	2018	2020
Number of calls	2770	2750	2970
Number of maritime connection	3581	3531	3766
Share of intra-Adriatic	45%	46%	40%
Share of extra-Adriatic	55%	54%	60%

Table 4: Mains ports of maritime connection of Adriatic Sea Ports in 2016, 2018 and 2020

	2016	2018	2020
Piraeus	331	520	632
Gioia Tauro	291	243	340
Limassol	89	161	109
Marsaxlokk	280	59	106
Yarimca	5	2	14
Augusta	12	322	5

The graphs produced illustrate the dominant flows highlighting the general structure of the maritime network between the ports of the Adriatic Sea and the connection with the other ports. Between 2016 and 2020, there is a significant change in the structure of the network. In 2016, in number of routes, the network focused on routes connecting ports internally in the Adriatic Sea. Connections with other Mediterranean ports were relatively weak. The number of connections between the ports of Koper, Porto-Marghera, Trieste ... were about 200 per year, which represents one ship every two days. On the contrary, the connections with the other ports were about a single weekly connection. In 2018 and 2020, the graph shows a significant increase in connections with other ports. In 2016, the connections between the Adriatic ports were rather balanced. In 2020, the port of Trieste seems to be establishing itself as the hub port of the region, in particular with the development of links with the port of Piraeus. This is even more striking when analyzing transport capacities between ports. The transport capacity between Trieste and Rijeka is very high (around 900,000 TEUs of transport capacity between its two ports). Ships have a very high transport capacity between these two ports.

4. CONCLUDING REMARKS

This preliminary work presented in the framework of this ICTS 2022 conference, on the spatialized strategies of container ship operators present in the Adriatic space, will be put in perspective with identical work on two other cul-de-sac seas: the Baltic Sea and the Black Sea. The aim is to link the strategies of the large container ship operators structuring the major globalized maritime trade routes with the practices of local and/or independent operators or subsidiaries specialized in feeding and short sea shipping. At the international level, the fluctuating strategies of global carriers sometimes appear to be a-spatialized (with no real link to the local service of the markets). Pure competition seems to be taking place between the global carriers, linked to an oligopolistic situation that is in the process of stabilizing. The analyses show a real similarity in the strategies observed in the Baltic and



Adriatic areas in the evolution of regional maritime networks and the strategies of maritime operators. In the Adriatic, as specified, the port of Trieste seems to be establishing itself as a regional hub in connection with the port of Piraeus (Greece), as does the port of Gdansk (Poland) in direct connection with the port of Bremerhaven (Germany). These two links are operated mainly by an international operator (MSC for the Adriatic and Maersk for the Baltic) and offer significant transport capacity (large container ships).

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