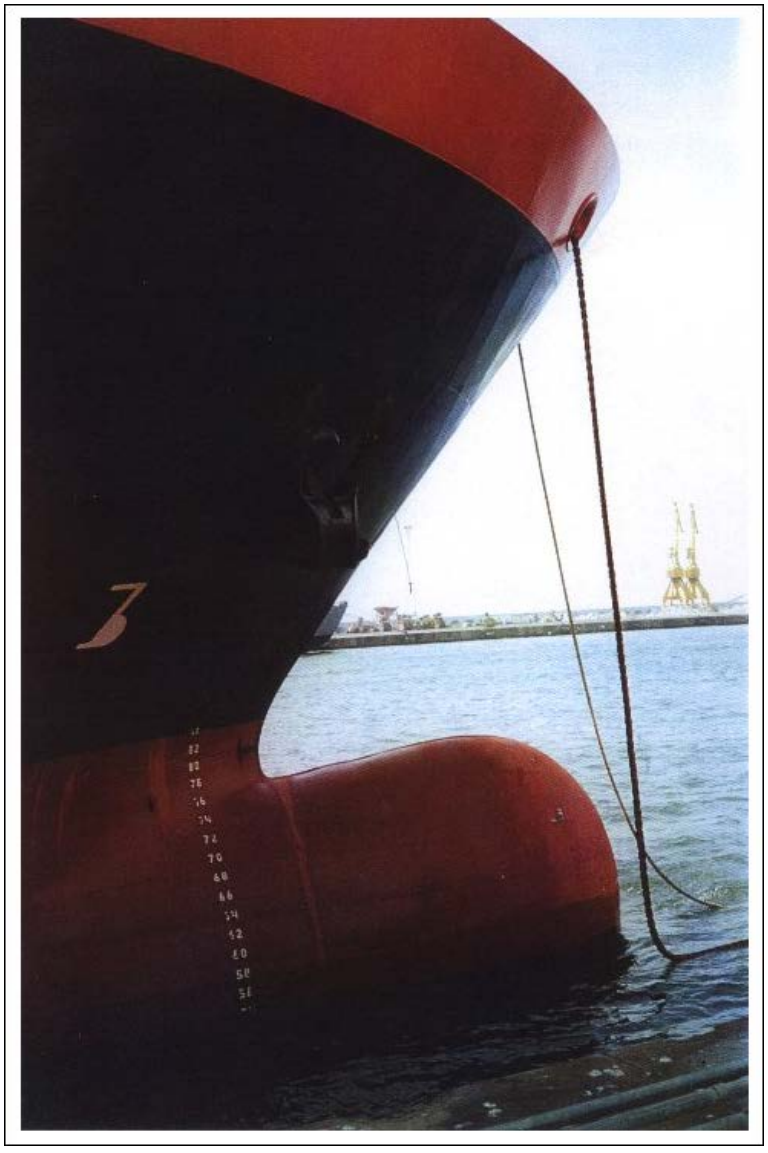
Spanish container ports integration in the maritime network

Arnaud Serry, Ronan Kerbiriou

MARITIME TRANSPORT VIII

Editors:
Francesc Xavier Martínez de Osés
Marcel·la Castells i Sanabra



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MARITIME TRANSPORT '20

Editors:

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PREFACE

Sea transport of goods and passengers is constantly undergoing a meaningful rise due to the globalization of economy, thus provoking a trade speeding up and the specialization of ships and port terminals, with the support of the concept of co-modality and its environmental face eco-modality.

Ports are the decisive and needed connection in the shipment chain and must be considered in the maritime infrastructure providing a smooth change between modes of transport. These aspects shall be framed by the quality and environment-friendliness criteria that administrations and society require.

In this regard, protection of the environment, safety and security have become key points for the development of modern maritime transport. In addition, the influence of human factor on board the ships has to be strongly regarded as a decisive element for safe, secure and clean operations together with e-maritime initiatives.

The MT'20 Conference should be attended by researchers, scientists, academics, professionals, entrepreneurs, and all people involved in shipping and also in maritime training from any country. In its 2020 edition, administrations, institutions and companies will find a forum to meet, to exchange and to discuss their own achievements.

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SPANISH CONTAINER PORTS INTEGRATION IN THE MARITIME NETWORK

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Abstract:

Maritime transport is the backbone of global trade, a component driving globalization. Over 80 % of world trade in volume terms and over 70 % in value terms is done by sea; these proportions are even higher in most developing countries. This unceasing growth in maritime trade raises important questions concerning the development of ports role in worldwide transport. In recent years, container shipping has resulted in a specific network connecting the main ports together and these ports to smaller ones by regular feeder services which tend to use smaller size containerships. The development of the port system is concentrated in large ports, which attract considerable container traffic.

This paper aims to present a survey of the current situation of container shipping in the Spanish ports which, comparing to north western European ports, have quite small markets and limited hinterlands that by consequences reduce attractiveness of ports. It focuses on the integration of ports in the containerization networks and on the organization of regular lines. The research was carried out using mainly Automatic Identification Data (AIS). The data acquired from AIS systems constitute a new means of information which allows to perform multiscale, diachronic and synchronic analyses. A desktop study as well as a statistical analysis which has required the construction of a database are also used. By focusing on vessels, shipping companies and ports, this communication considers the process of containerization in Spanish ports with a special attention on ports' network.

Keywords:

Maritime, port, transport, AIS, network, Spain.

INTRODUCTION

Maritime transport and containerization have undergone rapid growth and important transformations in recent decades. Among those, containerization transformed the configuration of freight routes with innovative services (Rodrigue, 2020), growing ship size or strategic alliances.

Since its introduction in the shipping industry in the 1960s, containerisation has reinforced the expansion of the world economy. The development of liner (containerised) shipping in the last

30 years has exceeded the growth of world trade volumes (Ducruet et Notteboom, 2012). Two factors mostly explain the achievement of containerisation: the productivity gains in cargo handling in ports and a more gradual process which involves the refinement of the container networks of largest container shipping companies (Frémont, 2007). Intense container traffic growth has led to new demand for container terminals.

Historically, on the 7,000 kilometres of coastline, ports in Spain have been at the forefront of shipping in the Mediterranean basin for several centuries but also on the Atlantic side. Due to its position in the transport chain and the importance of sea traffic over 70% of Spanish international trade is transported by sea (Díaz-Hernández, 2007). The Spanish port system consists of 28 port authorities, which transported 563.5 million tonnes of freight and 46 million passengers in 2018 (Bermúdez, Laxe, Aguayo-Lorenzo, 2019).

Even if the maritime traffic in the Spanish ports is relatively diversified, the paper will focus on containerised flows. It aims to deliver an analysis and an empirical study of containerisation dynamics and of the container network. This study is based on a literature review and on the analysis of port traffics. It also contains information about regular lines, frequencies, capacities, and operators obtained using AIS data, as well as some database on ships. Our study is mainly resulting in producing cartographical and graphical representation of the Spanish container port system.

1. CONTAINERISED TRAFFIC IN SPANISH PORTS

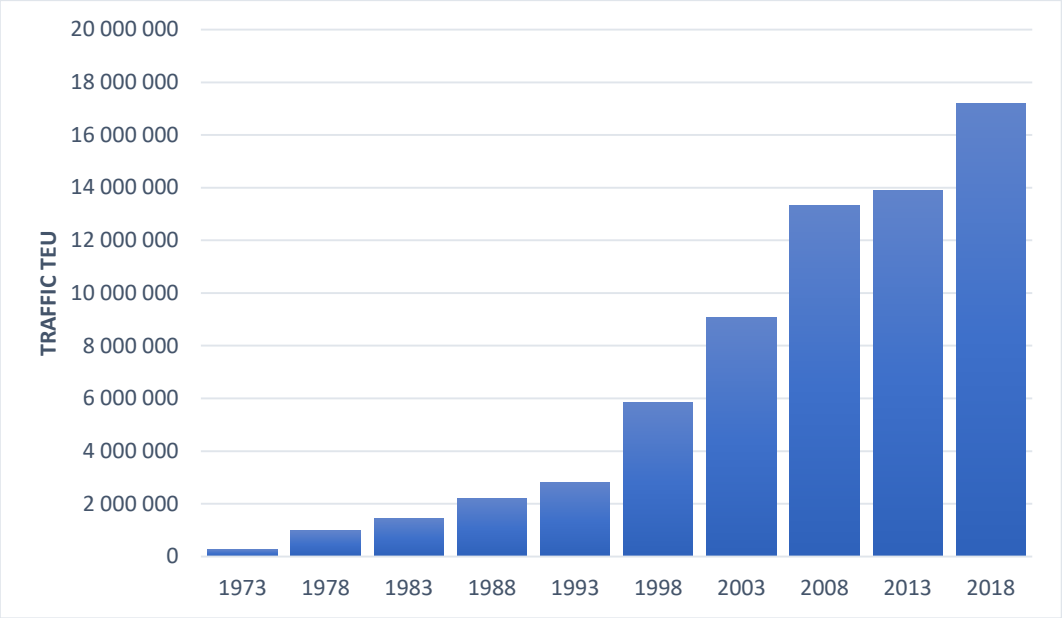
1.1. TRAFFIC EVOLUTION: GROWTH IN A COMPETITIVE ENVIRONMENT

In Spain, maritime transport is the most important transport mode in terms of international trade. The national port system, composed by 28 port authorities that manage 46 ports, includes one of the most important Mediterranean hubs (Barcelona, Algeciras), the largest Mediterranean in container traffic (Valencia), or Bilbao, one of the most important transport and logistics centres in the European Atlantic Arc (Gutierrez et al, 2015). In addition, the State port system's activity contributes nearly 20% of the transport sector's GDP.

Moreover, it generates more than 35,000 direct employments and around 110,000 indirectly. In the last 50 years, the tonnage moved through the Spanish maritime port system was multiplied by 7, reaching more than 500 million tons per year. This rapid growth is also impressive in container traffic going from 270 000 TEU in 1973 to 17 million TEU in 2018 (Cf. Figure 1). Furthermore, during the same period, the Spanish shipping agents handled an annual average of 16,886 exported TEU and 19,356 imported TEU.

In 2012, the overall port system moved 59% of total Spanish exports and 82% of total imports, which represented 53% of Spanish international trade with other EU countries and 96 % of third countries (Núñez-Sánchez, Coto-Millán, 2012).

Figure 1. Containerized traffic in Spain since 1973.



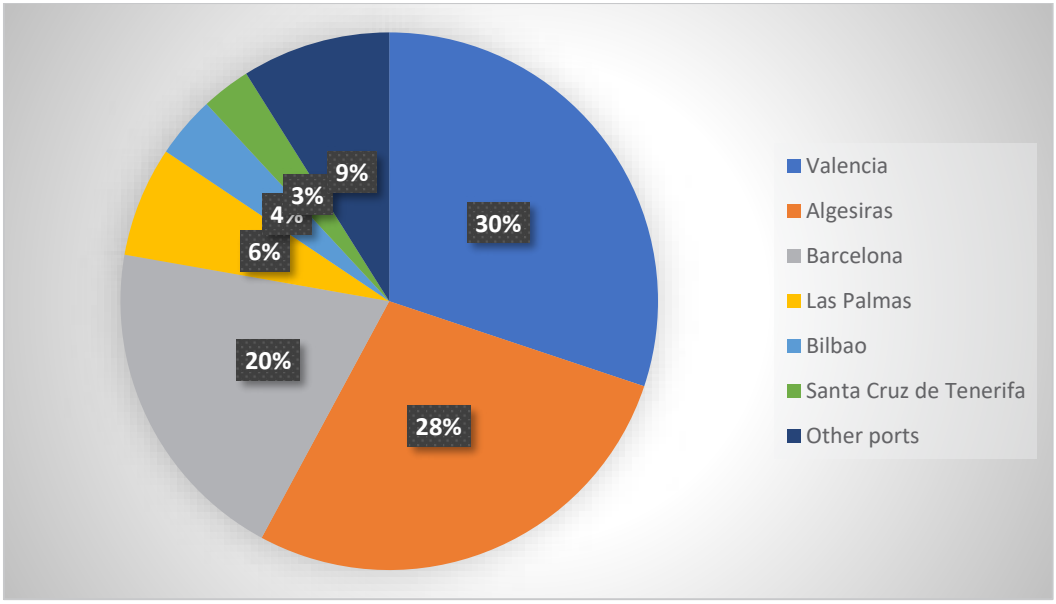
Source: government agency Puertos del Estado, 2020.

This evolution is strongly connected to the development of the world maritime traffic but also to regional specificities. In the Iberian Peninsula ports, proximity to the Mediterranean Sea or to large consumption and production centres has affected container terminal activity by boosting cargo flows (Felicio et al, 2014). Proximity to the Mediterranean Sea influences performance because the Mediterranean Sea marks the Asia–Europe shipping crossing point. The Spanish Mediterranean ports have tried to use their crucial position on the Asia - Europe trades to attract larger throughput by offering transhipment opportunities. The Port of Barcelona, for instance, has met with setbacks in certain infrastructure projects (Van Hassel et al, 2016).

Consequently, some Spanish ports have emerged as intermediary transhipment hubs that connect other continents with northern European ports (Notteboom, 2010). These ports concentrate cargo flows from the hinterland and from feeder ports. They also serve northern European ports, including Atlantic ports, and ports in North America, South America and Africa. So, containerized general cargo is relatively important in Valencia, Algeciras and Barcelona, with percentages larger than 35% ((Núñez-Sánchez, Coto-Millán, 2012).

Even If Spain has some ports on the Atlantic Ocean, according to the government agency Puertos del Estado, the container traffic is highly dominated by the Mediterranean basin which was accounting for more than 90% of the total throughput in 2018 (Cf. Figure 2).

Figure 2. Main Spanish ports' share in the total container traffic in 2018.



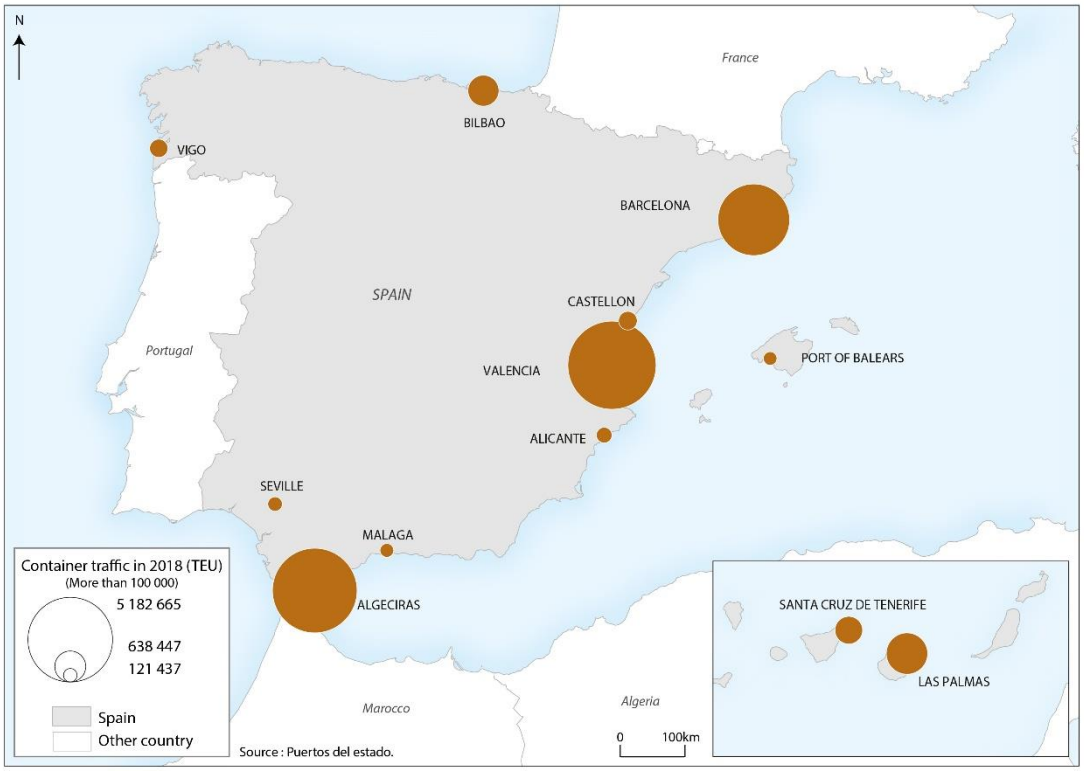
Source: government agency Puertos del Estado, 2020.

Nowadays, container ports are competing to become transhipment hubs as part of major shipping lines and feeder networks, while greater inland transport accessibility has allowed ports to spread further inland (Felicio et al, 2014). In reality, the basin of the Mediterranean Sea has become a significant focus of container traffic. Two functions are represented by this activity: one, the transhipment of containers involved in global networks; and, subsequently the intra-regional distribution of containers. This trade is revitalising port activity in many parts of the basin. Most striking has been the emergence of new hub ports, many of which now eclipse old-established port cities. The revitalisation offers prospects for a third function: the possibility of becoming the southern gateway of Europe (Ridolfi, 1999).

1.2. TRAFFIC CONCENTRATION IN SOME MEDITERRANEAN PORTS

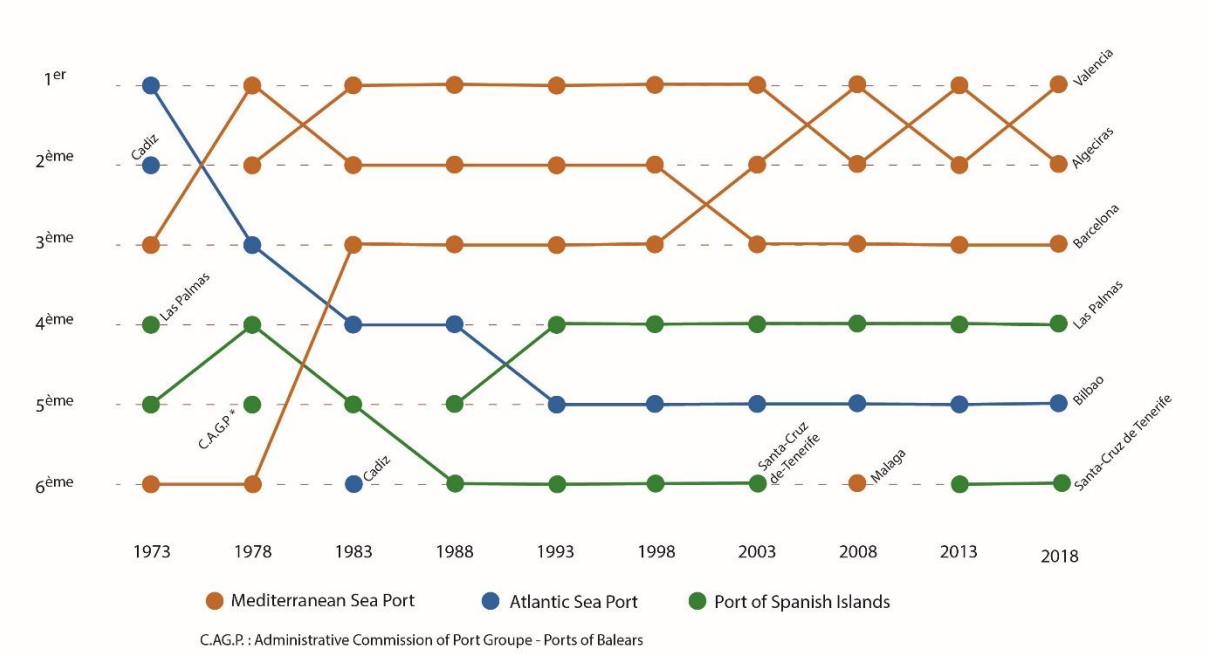
In the paper, we decided to focus on the main Spanish container ports which top 6 is composed of three Mediterranean ports (Valencia, Algeciras and Barcelona) and three Atlantic ones (Las Palmas, Bilbao and Tenerife) (Cf. Figure 3). But, throughput volumes of Barcelona, Algeciras and Valencia dominate the market, while Las Palmas, Bilbao or Tenerife Port lag much behind.

Figure 3. Spanish container ports in 2018.



Located on the Bilbao Abra bay in Biscay, in the North Atlantic Ocean, the Port of Bilbao is currently the 5th busiest port in Spain for the container traffic with 619 000 TEU's in 2018. In 2019, Bilbao port has completed a project for the expansion of its container terminal, which has involved an investment of €10 million by CSP Iberian Bilbao Terminal. But, as we can see in figure 4, its traffic remains quite small compared to Spanish Mediterranean container ports. The main problem for Bilbao is its lack of connectivity and very often, transhipment is needed via ports in Northwest Europe (Veldmann, Garcia-Alonso, Vallejo-Pinto, 2013).

Figure 4. Evolution of container traffic in top 6 Spanish container ports.



Source: government agency Puertos del Estado, 2020.

Las Palmas Port (located in Gran Canaria) is fourth in Spanish container port classification and the main ports in the Canary Islands (1.1 million TEU's), with S.C. Tenerife Port (located in Tenerife). They are managed by different Port Authorities. Cargo transported in these ports, summed up to more than 88% of the Canary Islands total freight. Las Palmas is using its good port connectivity to become a major logistic platform between Europe, Africa and America and it offers many advantages to ocean-going vessels such as a recognized technical and commercial maritime community and competitiveness in supplies and repair services. Its location between main commercial trade routes makes it a cargo hub (over 19 million tons from loading, unloading and transhipments) (Tichavska, Tovar, 2015).

In 2018, the port of Valencia Spain's second-busiest port (76 millions of tons), overtaking the other Spanish port for the container traffic (5,182 million TEU's). It also appeared at the fifth raw in the European container port ranking. Like Rotterdam and Antwerp, Valencia, the largest container port in the Mediterranean, present a healthy throughput increase (Notteboom, 2019).

Its importance is mainly due to the fact that about 50% of the Spanish's GDP is generated within a 350-km radius of the port, as is half of the country's employment. So the port of Valencia is strongly connected to the national economy. The hinterland of Valencia port has experienced the best evolution over the last decade in comparison with the other main Spanish container ports (Martínez-Pardo, Garcia-Alonso, 2014). Moreover, the port of Valencia is the first and last port of call for some shipping routes between the Western Mediterranean and the Atlantic. So, Valencia, is combining its gateway function with relevant transhipment flows (Cardoso Alves, 2016). From a transhipment incidence of almost 20% in 2004, Valencia, achieved in 2012, a transhipment incidence of 50% (Notteboom, Parola, et Satta, 2014).

Due to its locational characteristics, Algeciras placed itself as the western gateway to the Mediterranean basin (Ridolfi, 1999). In 2018, Algeciras was the largest port in Spain (107

millions of tons) and the third largest on the Mediterranean, but it was the behind the port of Valencia for the container traffic (4,773 million TEU's). Algeciras get benefits from being chosen by *Maersk* as a global hub. But, the monopolistic situation of the port of Algeciras for container traffic was disrupted by the arrival of a strong competitor on the other bank of the Starit of Gibraltar, the Moroccan port of Tangier-Med, and by a situation of saturation of the Andalusian port's infrastructure (Marei, 2012).With new container terminal capacity becoming operational, Tanger Med is a major competitor for European hubs in the region around the Straits of Gibraltar, such as Algeciras or Valencia (Notteboom, 2019). Tangier-Med and Algeciras are similar ports, which can be classified as hubs. They are characterized by an extremely high transshipment rate: more than 88% in 2018 for the port of Algeciras (source: government agency Puertos del Estado, 2020) and almost 96% for the port of Tangier-Med (Marei, 2012).

In fact, competition is omnipresent in the region and five container ports, near the Strait of Gibraltar can be identified in a transhipment traffic map for the Mediterranean container ports: Sines and Valencia (transhipment share in 2018 was about 55%); Algeciras, Malaga and Tangier (transhipment share is around than 90%) (Monteiro, 2013).

The port of Barcelona is Spain's third-largest port, managing 67 million tons of cargo each year, the port handles four different types of cargo, of which containers is the most important with a share of more than 40%. So, Barcelona is, after Valencia and Algeciras, the third largest container port in Spain (3,182 million TEU's).

Barcelona is the largest port in the region of Catalonia, which produces 18% of the country's GDP. Barcelona is well located to serve other parts of Spain as well as the South of France. However, traditionally the port community and the port authority focused on Catalonia (Van den Berg Peter, De Langen, 2011). In fact, Barcelona's immediate hinterland has reduced its importance (Garcia-Alonso, 2017) and has been going down in the national container port ranking since the beginning of the 80's (Cf. Figure 4).

The case of Spanish container ports illustrates one recent trend of maritime industry evolution: the integration and specialization of several routes with feeder ships converging at major maritime intermediate hubs. We can see that the most dynamics ports in Spain are those connected to this trend: Valencia and Algeciras but also Las Palmas.

2. CASE STUDY: SPANISH CONTAINER PORTS IN 2019 USING AIS DATA

Thanks to the AIS data and in relationship with external databases, we determined all container ships that called at Spanish port in 2019.

2.1. METHODOLOGY

This part of the analyse 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.

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.

Above all, broadcasting AIS data in real-time makes a tangible contribution to the scientific community (Serry, 2017). The automatic character of transmitting vessel positioning signals and its generalisation provide an opportunity to track and analyse 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 possible to analyse the maritime networks (Faury et al., 2019).

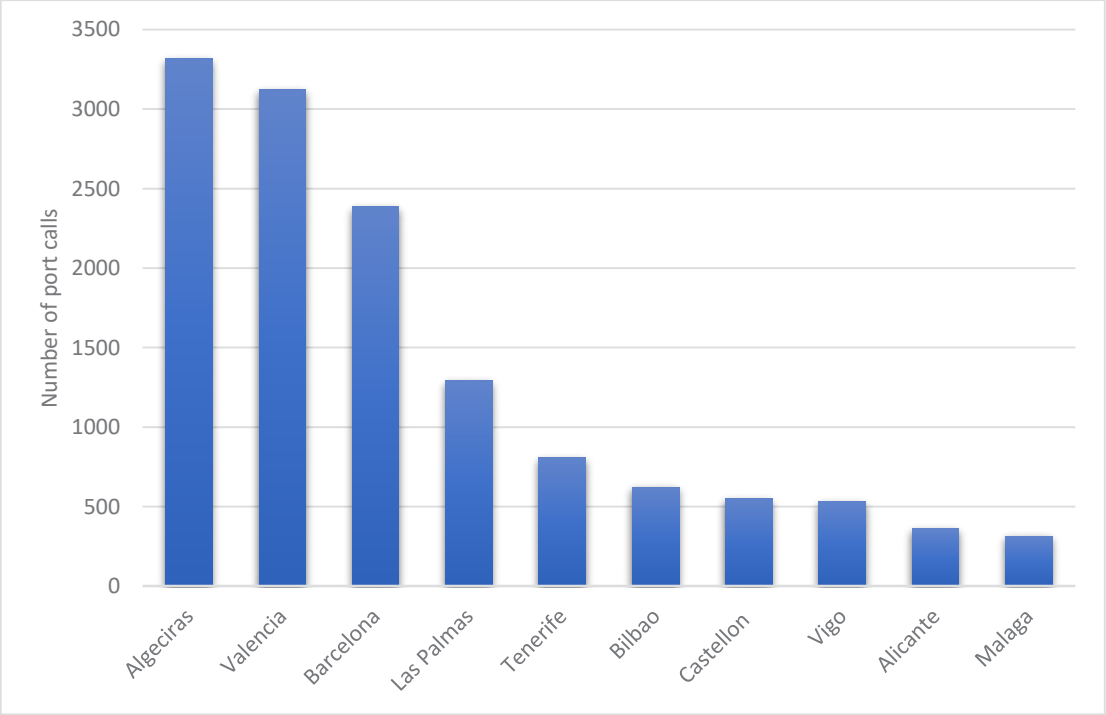
As AIS data is "Big Data", it requires specific techniques for data handling and processing which has limited its use. We create a platform to develop capacity and methods for better use of this massive source of maritime data. It has to receive, decode, clean, store and analyse AIS messages.

2.2. SHIPS ET OPERATORS

The results of AIS data analysis concern different types of studies like port performance analysis (duration of call and ship size…), shipping companies' strategies, maritime network study or regional markets analysis.

At first, we can analyse the number of port calls in 2019 (Cf. Figure 5). The three leading container ports are clearly more often touched by containerships and the gap with the other Spanish ports is important as there are 4 less port calls in Bilbao (rank 4 in the classification) than in Barcelona (rank 3 in the qualification).

Figure 5. Number of containership port call in 2019.

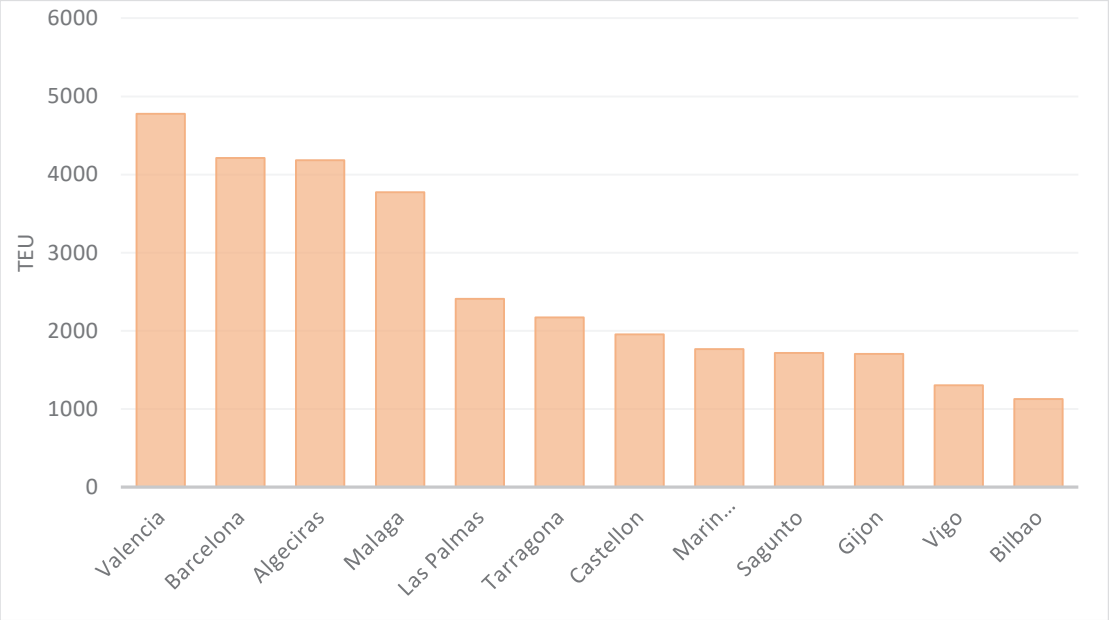


Source: IHS Maritime, 2020.

Those results clearly show the hierarchy in the port system dominated by the ports located near the Strait of Gibraltar and Barcelona while the other ports with a lower container traffic are less connected to the maritime network.

Secondly, we can have a look to containerships' size in the ports of Spain (Cf. Figure 6). In that field, the situation is similar to the number of port calls but the impact of Gibraltar Strait's proximity seems to be stronger as we can see that Malaga also attract biggest ships. Gibraltar is one of the two points of entry the Mediterranean Sea which have significant transhipment activity (Rodrigue, 2020).

Figure 6. Average containerships' size in 2019.

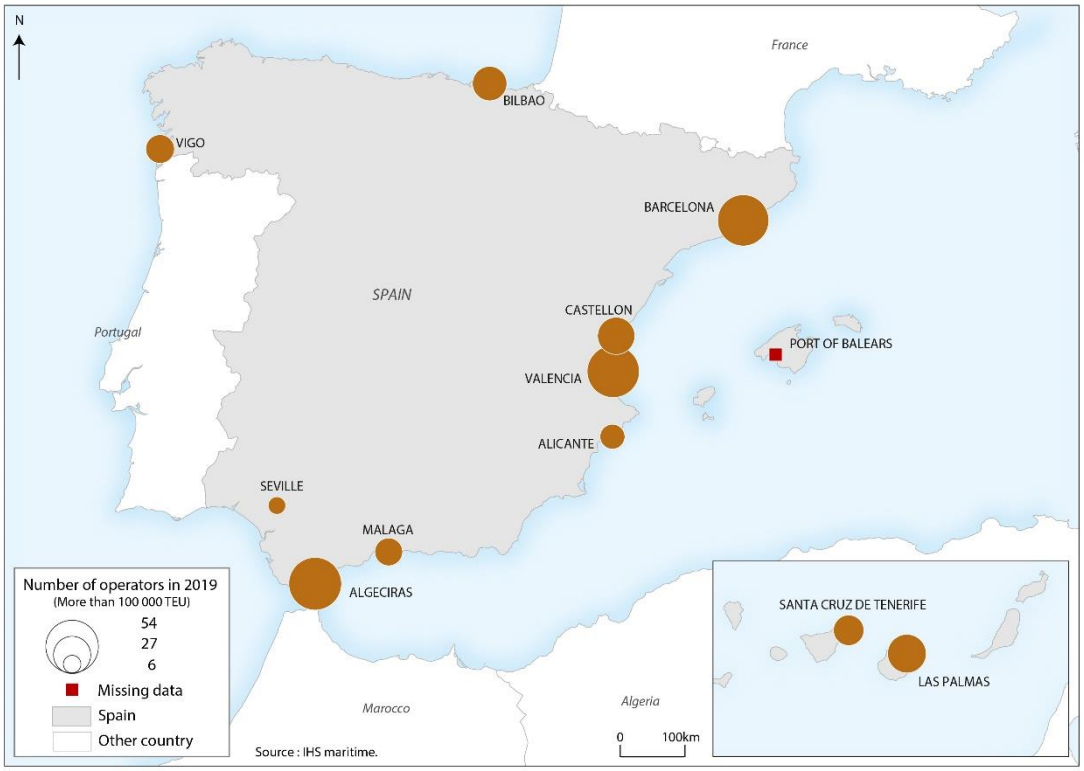


Source: IHS Maritime, 2020.

Even if vessels deployed in the Mediterranean region tend to be smaller than is some smaller areas, it is in part due to draft restrictions at some of these ports. But, some of the Spanish ports like Valencia, Barcelona and Algeciras are accommodating large container vessels (Van Hassel et al., 2016).

We can also use AIS data to study shipping companies and operators' strategies. There is an evident correlation between the container traffic, the number of calls and the number of operators present in the ports: the biggest ports are interesting more shipping companies (Cf. Figure 7).

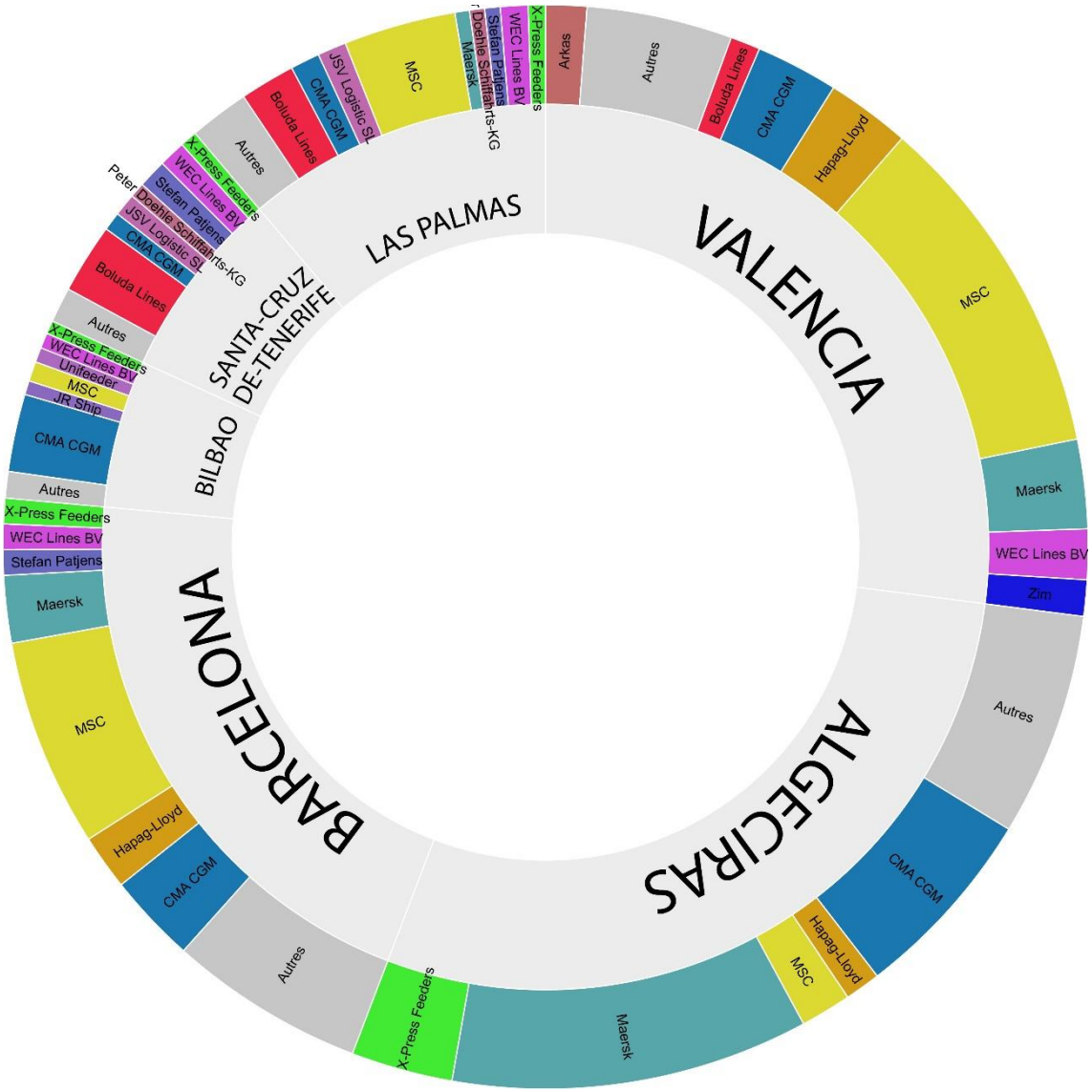
Figure 7. Shipping companies in ports of Spain in 2019.



Source: IHS Maritime, 2020.

In 2019, 95 different operators were offering services to the Spanish ports and three major shipping companies, *Maersk*, *MSC* and *CMA CGM*, were dominating the markets. At the fourth and fifth places, *X-Press Feeders* and *WEC Lines* are showing the transhipment activity in the region and the role of companies specialised in feeder services.

Figure 8. Shipping companies in the top 3 ports in 2019.



Source: IHS Maritime, 2020.

The figure 8 shows that stakeholders are different in the ports. For instance, Algeciras is strongly connected to *Maersk* when *MSC* is the leading company in Valencia, Barcelona and in Las Palmas. Once again, the role of transhipment hub of Algeciras is lightened by the position of *X-Press Feeders*. We can also state the absence of *COSCO shipping* in Spanish ports which can be explained by its alliance with *CMA CGM* which is present in the leading container ports in Spain (Cf. Figure 8). The French shipping company is toughly active in the smaller ports like Bilbao which, like Tenerife, is often included in services offered by shipping companies specialised in feeder services. At least, in these smaller ports, there is less hierarchy between the different shipping companies.

2.3. MARITIME NETWORK ANALYSIS

As seen previously, the main Spanish container ports are Valencia, Barcelona and Algeciras and all 3 together, they account for 77% of Spanish container traffic. SO they are the main Spanish nodes of the international maritime network.

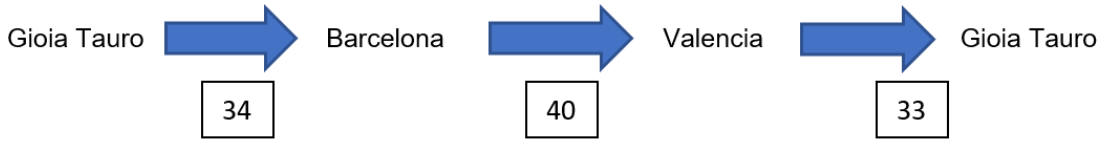
To analyze the integration of these ports into the global maritime network, we focus on container ships with a capacity over 15,000 TEU's. These container ships, giants of the seas, are exclusively positioned on the Europe-Asia trade connecting the major Chinese commercial ports to the European consumption markets. The ports of Valencia, Barcelona and Algeciras receive this type of containerships but they are not served in the same way.

2.3.1. THE MARITIME NETWORK OF THE PORTS OF VALENCIA AND BARCELONA

The ports of Valencia and Barcelona have many similarities. Indeed, these two ports belong to the same maritime service. Thus, in 2019, the same 27 containerships over 15,000 TEU'S called at Barcelona and Valencia ports.

In 2019, for this category of containerships, both ports were exclusively touched by the 2M alliance ships consisting of *MSC* and *Maersk*. For instance, 5 ships from *Maersk* and 22 from *MSC* called in both ports for 48 and 45 stops respectively for Barcelona and Valencia. They belong, therefore, to the same maritime service for which the rotation of port of call in the Mediterranean Sea for previously identified vessels respects a well-defined loop (Cf. Figure 9). Dominant connections can be stated, mainly in connection with the port of Gioia Tauro (Italy). Thus, in Barcelona, 71% of the containerships came from Gioia-Tauro when 40 container ships (83 %) went directly to Valencia. These containerships were then returned mainly to Gioia Tauro (33 of the 44 calls in Valencia). Then, the ships leaved this Mediterranean loop via Port Said and the Suez Canal.

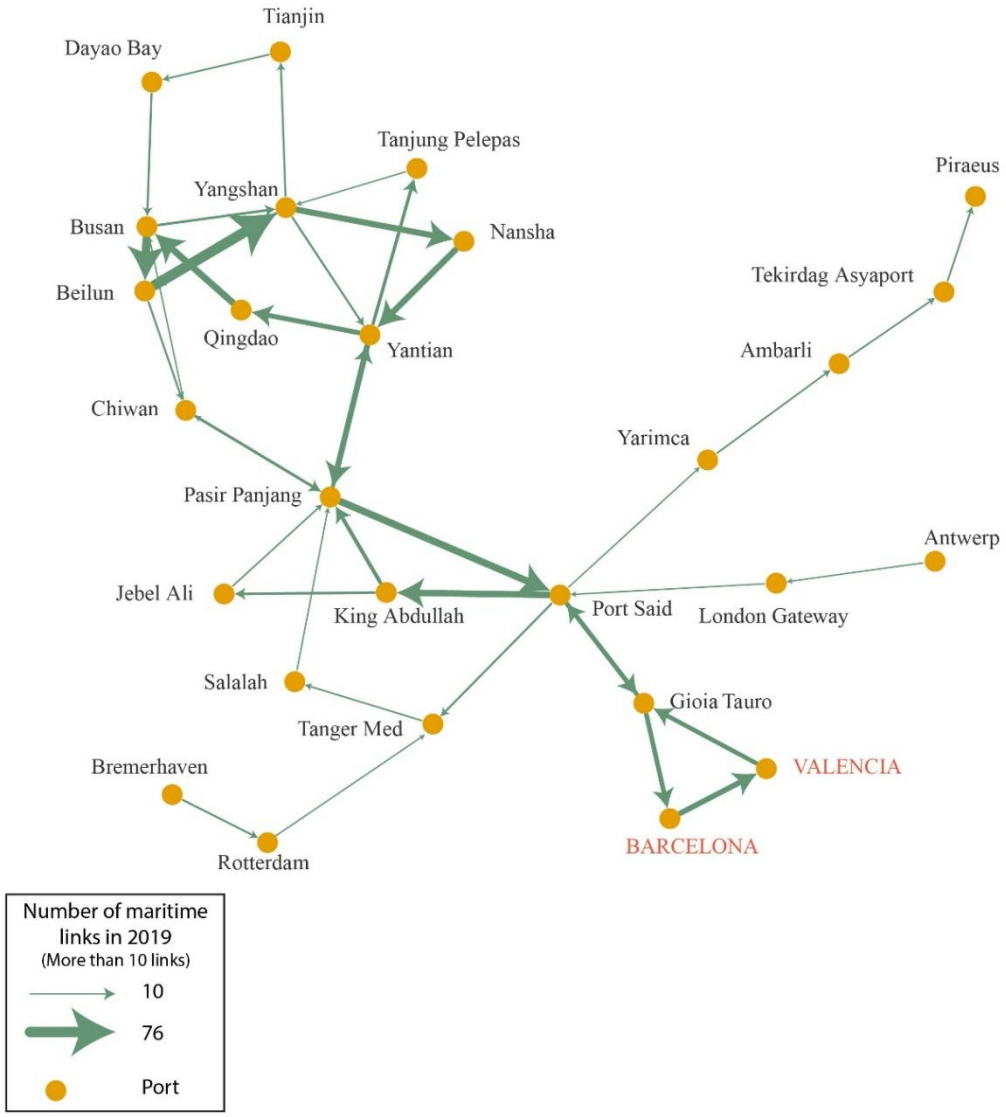
Figure 9. Typical Mediterranean loop calling in the Spanish.



Source: IHS Maritime, 2020.

The ports of Barcelona and Valencia are therefore served by a single maritime service of the 2M alliance. This service is the "AE11 Eastbound" which provides a maritime connection from Spain to Chinese ports (Ningbo, Yantian, Qingdao, ...) and with the port of Singapore. This organization clearly appears in the scheme below (Cf. Figure 10). It is representing the maritime network of the 27 previously identified container ships with at least 10 relations and permits to visualize the place of the ports of Valencia and Barcelona.

Figure 10. Spanish container ports in the maritime network.



Source: IHS Maritime, 2020.

2.3.2. ALGECIRAS: A DIFFERENT PORT, IN A DIFFERENT NETWORK

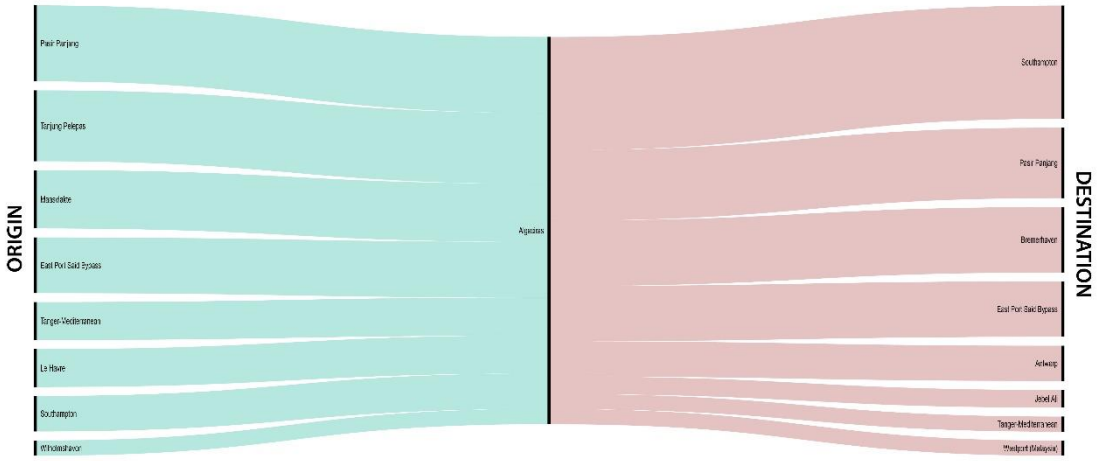
The port of Algeciras is not part of the same maritime network as the ports of Valencia and Barcelona. In 2019, 68 different containerships over 15,000 TEU's called Algeciras for a total of 164 calls.

In 2019, the insertion of the port of Algeciras into the global maritime network is more important than for other Spanish ports. This is largely justified by its hub function. One indicator confirms this situation: it is the highest diversity of maritime shipping companies serving the port of Algeciras with the *CMA CGM* (62 calls), *APL* (9 calls), *MSC* (22 calls) and *Maersk* (71 calls).

The direct origins and destinations to and from Algeciras are also very diverse (Cf. Figure 11). We can see some maritime links with northern European ports (Southampton, Bermerhaven,

Rotterdam, Le Havre, ...), Asia (Pasir Panjang, Tanjung, ...) or Even Mediterranean ports (Port Said).

Figure 11. Direct connections between Algeciras and some other ports.



Source: IHS Maritime, 2020.

Algeciras is thus strongly integrated in the global maritime network positioning itself as a major node in the organization of the shipping lines of the major operators. However, this position as a hub at the intersection of the Mediterranean and the Atlantic is threatened by the development of the port of Tangier-Med, which saw a 38% growth of its containerized traffic in 2019 and is now approaching the 5 million TEU's per year.

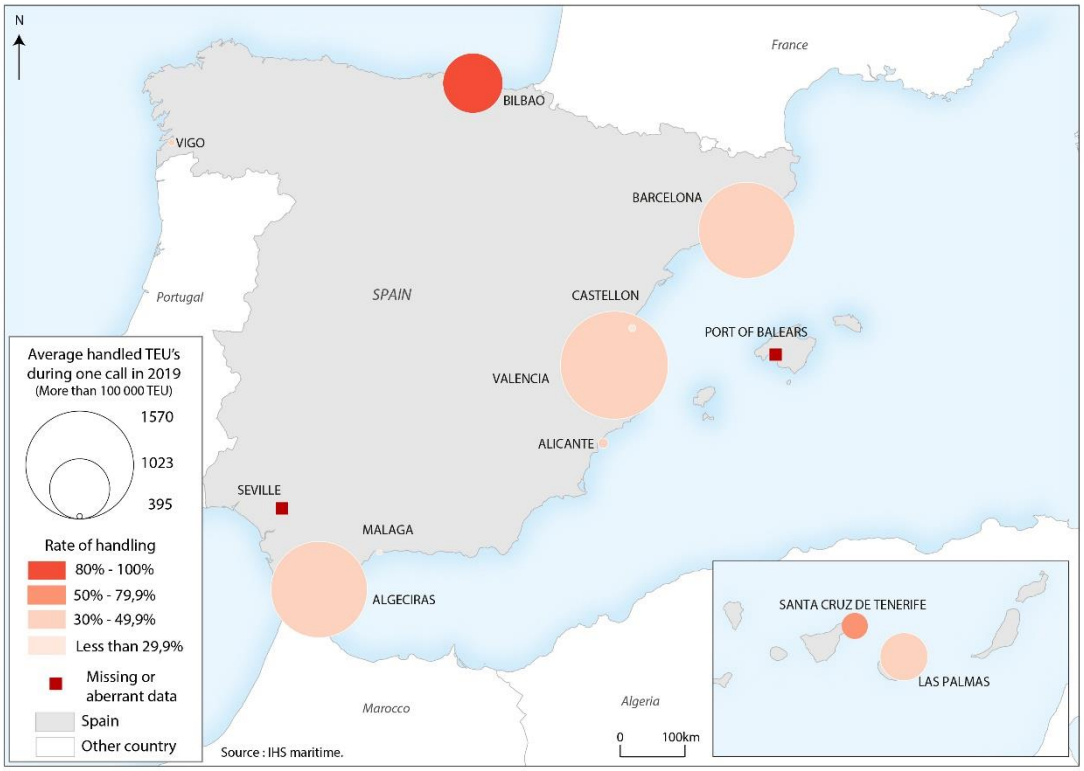
2.4. APPROACH OF PORT EFFICIENCY

AIS data allows us to analyze the efficiency of ports through the development of different indicators. By linking this AIS data with a ship database and port traffic, it is possible to calculate a theoretical handling rate per call (Cf. Figure 12). This rate means that, for example, for a container ship with a capacity of 10,000 EVP, an average of 3400 TEUs (loading and unloading) are handled.

Concerning the studied ports, we note that the three main ports that are Algeciras, Barcelona and Valencia have an identical handling rates of 34%. If we compare to western European ports this rate is better than in Le Havre where only 18 % of containers are loaded / unloaded but smaller than in Antwerp (46 %) and Hamburg (65 %) (Serry, 2018): it means that during one call, in average, less containers are handled in the studied ports than in northern European ports.

On the other hand, the port of Bilbao has the highest handling rate at 91%. That seems to show that Bilbao which is touched by smaller ships is in fact served by dedicated feeders.

Figure 12. Port performance regarding container handling rate.



Source: IHS Maritime, 2020.

This handling is also including the average number of containers loaded and unloaded during a call in each port. Once again, the three main ports, Algeciras, Barcelona and Valencia, are very similar results, with respectively1437, 1435 and 1570 TEU's handled. Thanks to this figure, we can see that the position of hub for the port of Algeciras is all the more threatened. In fact, European hubs handle more containers during a stopover: in 2017, in Europe, they handled more than 2000 TEUs (Serry, Kerbiriou, Montier, Méjane, 2019).

Regarding the Spanish ports, we can furthermore analyse port efficiency using the duration of port calls offered by AIS data. By integrating the port traffic in the research process, it is also possible to estimate the average duration of handling operations of one TEU in each port (Cf. Figure 13). Such an analysis could be more precise with the number of cranes used in each terminal for instance. Despite these few restrictions, the results are remarkable and give an interesting order of magnitude (Serry, 2019).

Figure 13. Port performance regarding container handling duration in 2019.

Source: IHS Maritime, 2020.

Barcelona appears to be the most efficient port in Spain but the other leading ports in the container market offer similar speed even if handling operations in Las Palmas are slowest. The situation in Bilbao is quite different because it seems to take three times more times to operate one TEU in Bilbao than in Barcelona.

3. CONCLUSIONS

The competitiveness of the Spanish container ports is driven by both initiatives undertaken at a global level (for instance alliances between shipping companies) and by their relative position in comparison to other European port concentrations. The expansion of international trade has equally led to an increase in the container turnover in the Spanish ports. The competition between ports is obvious, as can be seen between Algeciras and Valencia (or Tangier-Med). In that case, calls of large container ships confirm the ability of ports in Spain, On the Mediterranean coast as well as in the Canaries islands, to compete as hubs in international transport networks. The competition between the ports on the Mediterranean side also consists of ports which can handle container ships and the distribution of goods to close markets.

In this paper, from a methodological point of view, the huge potential of AIS data has been exploited to set up a platform to integrate the data and to offer new possibilities of analyses of the Spanish container ports' network.

Our study enhances that situation by presenting the strong differences between the Atlantic and the Mediterranean cost. It also shows the complementarity at the national levels between the main ports like Algeciras, Valencia or Barcelona and feeder ports playing at a regional or local level (Bilbao, Vigo…).

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