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Trabajo de Fin de Grado

**Comercio marítimo. Comparativa entre los puertos de España y
Bélgica**

(Maritime trade. Comparison between the ports of Spain and
Belgium)

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ABSTRACT

Maritime trade represents over 80% of global trade. This increasing trend has led to higher collection, storage, and distribution needs. On occasions, it has caused jamming of goods in some ports. This is the reason why the importance of maritime trade is highlighted. The main objective of this Final Degree Project is to find points of improvement in Spanish ports. For this purpose, a comparative study is made between the main Spanish and Belgian ports. The comparison has been carried out through a SWOT analysis that can contribute to improving the competitiveness of our ports.

RESUMEN

El comercio marítimo representa más del 80% del comercio mundial. Esta tendencia creciente ha provocado un aumento de las necesidades de recogida, almacenamiento y distribución, provocando en ocasiones atascos de mercancías en algunos puertos. Es por ello que se resalta la importancia del comercio marítimo a nivel mundial. El objetivo principal de este Trabajo de Fin de Grado es encontrar puntos de mejora en los puertos españoles. Para ello, se elabora un estudio comparativo entre los principales puertos españoles y los principales puertos belgas. La comparativa se ha llevado a cabo a través de un análisis DAFO que pueda contribuir a mejorar la competitividad de nuestros puertos.

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1.- Introduction

Even being one of the oldest ways of transport, maritime shipping is still increasing its importance in the world trade scenario. Indeed, it is the backbone of international trade and the global economy. Over 80% of the volume of international trade in goods is carried by sea (UNCTAD, 2021).

The main benefit is that the price of the transport route is low compared to other modes of transport. There is a big capacity of ships used for transport, with many materials transported at one time and the sea does not require any substantial investments in infrastructure. There is no country, but those with a compromised geographical location, not using maritime shipping for trade with the world (Medium, 2020).

Maritime shipping is less harmful to the environment than other means of transport. The shipping industry focuses on developing fuel-efficient engines for the ships resulting in reduced emissions of greenhouse gases. Carbon dioxide emissions reduce when ships travel further distances with the same amount of fuel (Medium, 2020).

By taking advantage of their locations, many countries gain a strategic advantage in diplomatic relations with other countries. All the countries have economic interests associated with maritime trade. It influences the overall economy of a country and industries are directly or indirectly linked to maritime transport (Medium, 2020).

But, despite all these benefits, recent incidents like the accidental blockade of the Suez Canal or the COVID-19 blockade of the Port of Shanghai have shown that maritime transport has one key point to watch out for: the ports.

In 2021, a huge container ship blocked the Suez Canal maritime route. This incident left 369 ships unable to pass through the canal on either side of the blockage. Around 12% of global trade, one million barrels of oil and almost 8% of liquefied natural gas pass through the canal every day, meaning that during the blockage there was a 14-15 million dollar decrease in revenues. Moreover, according to Allianz, annual trade growth decreased by 0.20 to 0.40%. Effects were even more noticeable in Egypt, where passing through the Suez Canal contributes to 2% of the country's GDP, according to Moody's. Domestic transport providers, retailers, supermarkets, and manufacturers were also impacted (BBC, 2021).

Due to the restrictions, the Chinese government stopped the spread of COVID-19, and a blockade in Shanghai's port happened. This port is one of the most important internationally, since it has represented 17% of container traffic in China, and 27% of Chinese exports and is the biggest port in the world. However, because of the enclosure the city of Shanghai had,

fewer trucks were arriving by road. It caused a container accumulation in the port area and a decrease of 30% in productivity, according to Mike Kerley (investment manager of Janus Henderson), vessels were accumulating in front of the shore and surroundings, and also a large volume of containers were stacked in the port, putting at risk the supplies global chain when it was supposed to start recovering. Eventually, the consequences showed a slower import process, higher inflation, and tighter supply chains (BBC, 2022).

Several studies show that the efficiency of port operations has a direct impact on the efficiency of the whole logistics chain along domestic and international freight corridors. Efficient ports have shorter turnaround (loading and unloading) times and lower handling costs. Port efficiency is a determinant of transportation costs: doubling port efficiency reduces costs as much as reducing to half the distance between countries. Besides, a 0.10 increase in port efficiency decreases maritime transport costs as much as from 0.90 to 3.80% (Micco and Pérez 2002; Clark, Dollar, and Micco 2004; Wilmsmeier, Hoffman, and Sanchez 2006; Bionigen and Wilson 2008; Herrera Dappe, Serebrisky, and Suárez-Alemán, 2021).

Countries that want to become more competitive in global markets tend to jump to the conclusion that they need to invest more in infrastructure, specifically in transport sectors such as ports. Although developing countries face significant infrastructure gaps, massive new investments are not the only way to improve competitiveness. Improving the performance of existing ports allows them to handle larger levels of cargo with the same facilities and in less time. The performance of these infrastructures at a country level, and in comparison with competing countries, is a vital determinant of global competitiveness and growth (Herrera Dappe, Jooste and Suárez-Alemán, 2017).

This way, countries like Spain can benefit from increased efficiency in the use of existing container port facilities. Its estimated potential gains help policymakers assess the importance of improving port performance and prioritising interventions (Herrera Dappe, Jooste and Suárez-Alemán, 2017). In 2020, Pérez, González and Trujillo published a study on the efficiency of Spanish ports according to their size and degree of specialisation. It concludes that in Spain specialisation in the products handled by ports improves their efficiency. Likewise, large ports are more efficient than small ones.

In this paper, we want to look for further factors that may help to improve the efficiency of large Spanish ports. To this end, we have looked at the characteristics of the four largest Spanish ports (Algeciras, Valencia, Barcelona and Bilbao) and compared them with the characteristics of two of the main Belgian ports (North Sea Port and Antwerp-Bruges). The comparison has been made through a SWOT analysis. The reason is that the objective of this

work is not only to highlight the differences that exist but to look for a way to improve. The SWOT analysis allows us to do this because it states the principal strengths, weaknesses, opportunities and threats identified in Spanish ports concerning Belgian ones. Once these factors are explained, conclusions can be easily withdrawn and results could be used by policymakers to assess the importance of improving port performance and prioritising interventions, joint or individual, to help to improve the competitiveness of our major ports. Following this objective, the paper begins by showing, in point two, the importance of ports in the logistic and economic system of Spain. Point three begins describing the functioning of the main Spanish port authority *Puertos del Estado*. The four Spanish ports under analysis are described using the following variables: terminals, type of cargo and intermodal split. Point four describes the North Sea Port and Port of Antwerp-Bruges, using the same variables used for the Spanish ports to facilitate the comparison. Finally, the conclusions present the SWOT analysis and the main recommendations.

2.- Significance of the logistics in the Spanish economy

In 2019, the logistics sector represented 6% of Spanish GDP, which amounts to approximately 74,685.42 million euros, according to employer estimates. However, this figure increased throughout 2020. A report from BNP Paribas Real Estate estimates that the volume of investment registered in logistics in the second quarter of 2020 stood at 279 million euros, remaining a “safe, stable and attractive” asset. Indeed, it was one of the few sectors of the Spanish economy, along with the agri-food sector, that experienced growth during the worst months of the pandemic (Grupo Autotrans, 2021).

Logistics is considered a “support” sector of the Spanish economy, since it has gone from contributing 11.56% of total employment to 18.06%, mainly because of online commerce. According to Social Security affiliation data, there has been a growth in employment in the second quarter of 2020: 6,139 new affiliates were registered in July, 2,505 in August, and 6,600 in September (Grupo Autotrans, 2021).

2.1 Importance of the port system in Spain

Maritime transport is a very important system for the socio-economic development of Spain since resources like energy are imported through it, while agricultural products or finished products are exported. Moreover, the European Union, through the policy of maritime highways or short sea shipping, has stimulated the use of this means of transport for decades.

It presents higher economic and environmental efficiency rates, especially when compared to the road (Atlas Nacional, 2019).

The importance of ports as links in the logistics and transport chains is supported according to the following data: 60% of exports and 85% of imports pass-through ports, which represents 53% of Spanish foreign trade with the European Union and 96% with third countries (Puertos del Estado, n.d.).

Furthermore, the activity of the State port system contributes, almost, 20% of the GDP of the transport sector, amounting to 1.10% of Spanish GDP. Likewise, it generates direct employment of more than 35,000 jobs and 110,00 indirectly (Puertos del Estado, n.d.).

The port systems of the Spanish State are made up of 28 port authorities that manage 46 maritime ports of general interest, under the coordination of the public entity *Puertos del Estado* (Atlas Nacional, 2019).

The most important ports are on the Mediterranean slope and in both archipelagos. The largest floating surfaces, and the largest movement of ships and merchandise, are located there. More than one-third of the movement of merchandise is in the port authorities of the Bay of Algeciras and Valencia (Atlas Nacional, 2019).

From the point of view of passenger traffic, the archipelagos stand out with almost 50% of the movement of passengers. 30% takes place in the ports that support the Operation Crossing the Strait (Bay of Algeciras, Ceuta, Melilla), remarking the importance that this mode of transport has where there is no territorial continuity, like in the connections with the Peninsula. This determines that, in these last-mentioned territories (and because of their smaller dimensions of national traffic), the total gross tonnage of ships registered in these ports, mainly in the Balearic Islands, is comparatively higher if international movement is also considered (Atlas Nacional, 2019).

In the traffic of goods, it is necessary to differentiate between exports and imports. Particularly noteworthy in products exported are the port authorities of the Bay of Algeciras and Valencia, with a purely international projection, followed by the port of Barcelona with similar characteristics. There must be a balance between exported and imported goods in these port infrastructures, unlike the ports specialising in crude oil refining, such as Tarragona, Cartagena, and A Coruña, where imports predominate to transform the oil in nearby refineries. The same happens in the archipelagos: the lack of raw materials and large industries turn the ports of these territories into large supply infrastructures. The unloading of merchandise from abroad is very important for *Puertos del Estado*. It reaches almost 90% of the ports that register the most merchandise traffic (Algeciras Bay, Valencia, and Barcelona).

National disembarkation in island ports (Ceuta, Melilla, and Motril) indicates the supply function of these spaces (Atlas Nacional, 2019).

Container traffic has experienced a significant expansion in recent decades (more than 71% of all general merchandise that moves through Spanish ports does it in containers). Ports like the Bay of Algeciras and Valencia have had an important transformation. To achieve this traffic over the last years requires a high degree of specialisation in the terminals. Important works have been undertaken for the expansion of esplanades intended for the transit of containers. The installation of various machinery stands out, with almost thirty container and gantry cranes in the port of Valencia and more than double in the Bay of Algeciras (Atlas Nacional, 2019).

These ports carry out, mainly, a transshipment function between the vessels that connect Europe with Asia and America, besides Africa with Europe. The strategic location of the port of Algeciras, at the confluence of the Atlantic Ocean with the Mediterranean Sea, has favoured the fact that many shipping companies have their routes scheduled a few miles from this port so that the detour on their transcontinental route is minimal. This fact is combined with the quality of its infrastructures (for instance, the port of Algeciras Bay is now able to accommodate the new generation of mega-ships with a capacity of more than 18,000 TEUs), together with the high efficiency of these ports within a cost-benefit context, which has positioned them among the top 25 ports in the world ranking of container transshipment, although there is strong competition against other ports relatively close like Tangier (Atlas Nacional, 2019).

In the intermediate range, we find the ports of Barcelona, Las Palmas, Bilbao, and Tenerife, which have made great efforts in recent years to receive containers too, while the rest collect more token traffic and where transshipment is less important, gaining weight the function of self-sufficiency and service of the output of products from their hinterland (Atlas Nacional, 2019).

For the nationality of merchant ships, a difference between the Cantabrian coast and the rest of the country exists. In the former, a large part of the movement is made up of foreign vessels, while in the archipelagos and Melilla, national ships predominate as a result of the intense traffic between islands or in the Strait (Atlas Nacional, 2019).

Cruise traffic has also experienced a significant increase. The result of this is that ports like Barcelona have exceeded 2.5 million cruise passengers in one year, while the ports located in the Balearic Islands already exceed 1.5 million and each of the two Canarian port authorities stands out at over a million. Passenger traffic is seasonal since in the Mediterranean and

Biscay Bay movement is concentrated especially from mid-spring to October, while in the Canary Islands it is concentrated from October until spring. Its traffic is closely linked to the conditions offered by the climate in each territory (Atlas Nacional, 2019).

Besides the potential offered by port infrastructures, for this type of traffic, there is also the tourist attraction of each of the hinterlands offered by the ports, and that is why Barcelona (and to a lesser extent Malaga and Valencia) have been highlighted within the Spanish mainland. A different case is that of the archipelagos. The amount of ports and variety of natural and human landscapes of each island system has become an attraction. Cruise ships have increased significantly since distances are ideal and during the night the ship sails between the islands (even in the Atlantic between Madeira and the Canary Islands), calling at a new port every morning (Atlas Nacional, 2019).

The sea route has consolidated in recent years for the movement of travellers over short distances. High-speed boats are used if there are acceptable daily frequencies and there are schedules that allow optimal round-trip accessibility (Atlas Nacional, 2019).

The inter-island routes in the Spanish archipelagos, as well as the connections between the Peninsula and Balearic Islands and some North African cities, have been consolidated in passenger maritime transport. In the Canary archipelago, the route between Los Cristianos and San Sebastián de La Gomera, where the component of tourist excursions is high, exceeds one million round-trip travellers a year. It is followed by the connection between Santa Cruz de Tenerife and the port of Las Nieves (Gran Canaria) since both islands account for more than 80% of the economic activity and population of the archipelago. The movement of passengers between the island capitals is very important, as well as the tourist traffic recorded in Lanzarote, both to the North of the island with La Graciosa and the South between Playa Blanca and Corralejo (Fuerteventura) (Atlas Nacional, 2019).

In the Balearic archipelago, the routes with the Peninsula are almost as important as some inter-island lines. It is the case of the routes between the three large island capitals with Barcelona, Palma de Mallorca with Valencia, and Eivissa with Denia. Only inter-island routes linking Alcudia with Ciutadella and Palma de Mallorca with Eivissa approach half a million passengers a year (Atlas Nacional, 2019).

In the Strait, the shorter distance connections stand out, like those that depart from Tarifa and Algeciras. Besides, those from Malaga, Motril, and Almeria with Melilla and Nador stand out. In all these routes the deregulation of transport has allowed the insertion of new maritime operators. It has stimulated the increase in this traffic (Atlas Nacional, 2019).

3.- Spanish ports

The purpose is to describe the main Spanish ports in maritime trade to find their strengths, weaknesses, opportunities for growth, and threats. Therefore, this section introduces a presentation of *Puertos del Estado*, as it is the competent authority, and a description of the ports of Algeciras, Valencia, Barcelona, and Bilbao based on the factors of cargo volume and connectivity.

3.1 Puertos del Estado

Puertos del Estado is a body that acts under the dependency and supervision of the Ministry of Public Works, with powers of coordination and efficiency control of the state-owned port system that is formed of 46 ports of general interest, managed by 28 Port Authorities (*Puertos del Estado*, n.d.).

According to the Consolidated Text of the Law on State Ports and the Merchant Navy, *Puertos del Estado*, under the dependency and supervision of the Ministry of Public Works, executes the Government's port policy, coordinates an efficient control of the state-owned port system under the terms provided in the law and establishes controls in port spaces and with modes of transport within the sphere of state competence (*Puertos del Estado*, n.d.).

Furthermore, it has the power to train, and promote research, and technological development in matters related to the economy, management, logistics, port engineering, and others. It develops measurement systems and operational techniques in marine oceanography and climatology. They are necessary for the design, exploitation, and management of port areas and infrastructures (*Puertos del Estado*, n.d.).

Puertos del Estado also plans, coordinates, controls, and promotes the Spanish maritime signalling system in terms of training, research, and technological development (*Puertos del Estado*, n.d.).

Puertos del Estado in collaboration with Port Authorities will prepare the Strategic Framework for the port system of general interest. It will be ratified by the Governing Council and sent to the Minister of Public Works for approval (Art. 52, Consolidated Text of the Law of State Ports and the Merchant Navy). The Ministry of Public Works will approve the strategic development model and the action criteria. Besides, the general, technical, economic, financial, and human resource management objectives follow the Government's economic and transport policy (*Puertos del Estado*, n.d.).

Ports 4.0 capital fund is the corporate open innovation model adopted by *Puertos del Estado* and the Spanish Port Authorities. It attracts, supports, and facilitates the application of talent and entrepreneurship to the Spanish public and private port-logistics sector in the context of the fourth industrial revolution. The principal objective of the Fund is to actively promote and incorporate disruptive or incremental innovation as an element of competitiveness, efficiency, sustainability, security, and protection in the Spanish port-logistics sector (public and private) to facilitate its transition towards the 4.0 economy. It is not only associated with disruptive new technologies but also with the development of new, more efficient processes and business models based on the verticals of the 4.0 economy (Big Data, IoT, Blockchain, Artificial Intelligence, Virtual and Augmented Reality, Machine Learning, Additive printing, Robotics, Automation, Analytics) (Puertos del Estado, n.d.).

3.2 Port of Algeciras Bay

Algeciras Bay is located in Cadiz, Andalusia, and is the largest port in Spain in terms of gross tonnage passing through annually. Is managed by the Port Authority of Algeciras Bay. Due to its proximity to the Bay of Gibraltar, the port assumes a large portion of Spanish traffic. Besides, it is the largest port along the Mediterranean coast (Marine Insight, 2021).

The facilities within the port include container handling terminals, tankers and bunker fuel services, passenger and cruise ship wharves, Ro-Ro docks, and wharves dedicated exclusively to the local fishing sector. The port has established itself as a major shipping hub that connects to nearly 200 ports weekly and handles imports, exports, and transshipment. It is visited by 30,000 ships annually (Marine Insight, 2021). The port is also working with the Zaragoza Maritime Terminal (Terminal Marítima de Zaragoza, n.d.), Abroñigal Terminal (Madrid), and Azuqueca de Henares Terminal (Madrid) as supporting hubs (APBA, n.d.).

The main terminals that operate within the port include the APM Algeciras Terminal and the Total Terminal International Algeciras, with several ship-to-shore cranes and state-of-the-art facilities (Marine Insight, 2021).

Technical Features (Puertos del Estado, n.d.; Wikipedia, 2021)

- Quays: 22,534 linear metres and 32.50 metres in depth.
- Area: 990.85 hectares of water and 482.78 hectares of land.
- Freeport Zone.
- 19 shore cranes, eight of which are Super Panamax.
- 59 rubber gantry cranes.

- 102 tractors.

Terminals

- APM Terminal Algeciras.

It is located in the port of Juan Carlos I in the municipality of Algeciras. It belongs to the AP Mollers group. It covers an area of 67 hectares on the Juan Carlos I quay and has a trench 17 metres deep. APM Terminal Algeciras can service new super ships with a capacity of more than 18,000 TEUs (Wikipedia, 2021).

- Total Terminal International.

It is located on the pier outside Isla Verde. It's public, although it has granted a 60-hectare concession to a hybrid shipping company. It has two berths, one with a length of 650 metres and 18.50 draft, and another 550 metres with a draft of 17.50. This is the first semi-automatic terminal in the Mediterranean. It currently has a capacity of 1.6 million containers (Wikipedia, 2021).

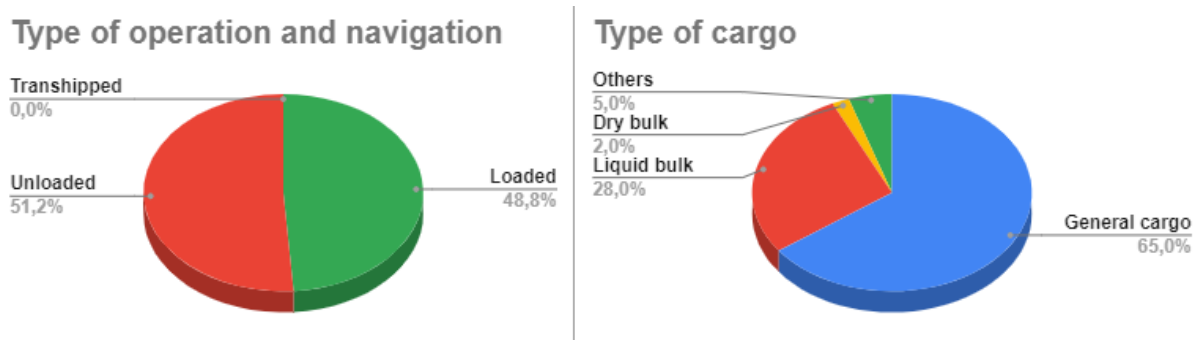
Type of Cargo

The main dry bulk components are coal, scrap metal, and ferrous alloys. In 2021, 692,098 tonnes of cargo were downloaded, whereas 78,948 tonnes were loaded (APBA, 2021).

In liquid bulk, we can find fuel oil, diesel oil, gasoline, and refined oil. 20,730,604 tonnes were downloaded and 12,290,535 tonnes were loaded in 2021 (APBA, 2021).

Eventually, the Port of Algeciras Bay also deals with containers (3,390,708 in 2021), general cargo, passenger vehicles, Ro-Ro (275,000 commercial vehicles), and project cargo (APBA, 2021).

Figure 3.1: Port of Algeciras Bay handled products



Source: self-made graphic

Intermodal split

- Road transport (APBA, n.d.).

The Port of Algeciras Bay is linked to its hinterland by the following roads:

- A-7 highway (Malaga).

- A-381 motorway (Jerez).
- N-340 Road (Cadiz).
- Rail (APBA, n.d.).

The main rail connection is the Port of Algeciras Bay (Isla Verde Exterior Terminal (T1))-Madrid (Abroñigal Terminal). However, it exists the possibility of arranging customer trains to the following peninsular points:

- Port of Algeciras (T1)-Madrid (Azuqueca de Henares Terminal).
- Port of Algeciras (T1)-Zaragoza (Maritime Terminal).

Regarding the LSCI, the Port of Algeciras Bay has experienced a favourable rise in its classification, since it goes from the 27th place to the 21st, consolidating itself as the main port of the Strait, since the African competition through Tangier Mediterranean remains behind. Indeed, this route is one of the principal tracks connecting Asian, African and American ports (El Economista, 2021).

3.3 Port of Valencia

This port is the fifth busiest port in Europe and is an important seaport that deals with container ships and other general cargo vessels. Managed by the Valencia Port Authority (VPA), is the largest container port in Spain and the second largest in the Mediterranean region, and the second port in Spain in terms of gross tonnage (Marine Insight, 2021).

The port is located in a region of Spain where it generates over 50% of the nation's GDP. It employs over 75,000 people and services up to 10,000 ships per year. It operates a 12 kilometres quay with large container yards spanning 300 acres. In addition to cargo shipment, the port also deals with passenger ships and has increased the number of passengers inbound in the last years (Marine Insight, 2021).

Located on the Spanish east coast, the port controls 2 satellite ports located on the Mediterranean Sea: the Port of Sagunto and the Port of Gandia. Sagunto deals with liquefied natural gas, iron, steel, fertilisers, construction materials, and timber shipments, and is also close to a regasification plant. On the other hand, Gandia is concerned with the shipment of forestry goods such as timber, reel, pulp, paper, and furniture (Marine Insight, 2021).

The Port of Valencia is working with Teruel and the Zaragoza Maritime Terminal (Terminal Marítima de Zaragoza, n.d.) as supporting hubs. However, unlike other Spanish ports, it does not have a Freeport Zone.

Technical Features (Puertos del Estado, n.d.; Wikipedia, 2022)

- Quays: 20,644 metres and 18.50 metres in depth.
- Area: 825.82 hectares of water and 764.22 hectares of land.
- 27 stacking cranes.
- 9 container-handling cranes.

Terminals

- Port of Valencia.

It handles traffic of almost all types of goods from every sector of the economy. Additionally, the port has regular passenger traffic to and from the Balearic Islands and Italy. Recently, it has experienced a continued and solid growth in Mediterranean cruise traffic (Valenciaport, 2022).

- Port of Sagunto.

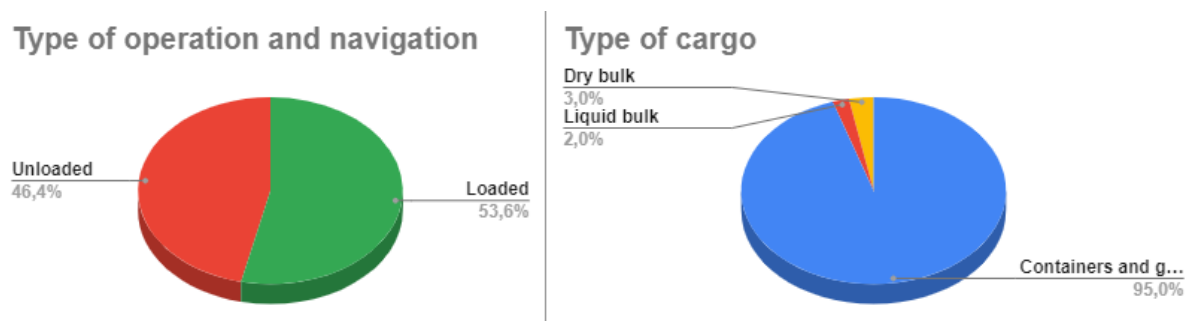
Traditionally, the Port of Sagunto has specialised in the traffic of iron and steel products. However, it has become multi-purpose nowadays, opening up to new traffic such as natural gas, vehicles, containers, and solid bulk (Valenciaport, 2022).

Type of Cargo

The Port of Valencia handles traffic of almost all types of goods. The most representative are: the furniture and timber industries; textiles, footwear; agriculture and foodstuffs (grain and fodder, wine and beverages, tinned food, fruit); fuel products (diesel fuel, petrol, or coal); chemicals and motor vehicles (Ford, Fiat, Land Rover or Jaguar); cement and clinker, ceramic tiles, marble; machinery (Valenciaport, 2022).

The Port of Sagunto handles vehicles, steel products, and liquid bulk like natural gas (Valenciaport, 2022).

Figure 3.2: Port of Valencia handled products



Source: self-made graphic

Intermodal split

- Short sea shipping (Valenciaport, 2022).

The Port of Sagunto is ideal for developing this type of traffic, according to the European transport policy.

- Road transport (Valenciaport, 2022).

The port is connected by the V-30 (Valencia ring road) to the Network of General Interest.

The V-30 connects directly to the A-7 (Mediterranean highway) and allows it to access all the connection nodes in its hinterland:

- The V-21 to the North (Valencia-Sagunto).
- The V-31 to the South (Valencia-Silla).
- The North-South corridor includes the A-38 motorway (Valencia-Cartagena) and the A-7 highway on its Barcelona-Algeciras route.
- The East-West corridor is fundamentally supported by the A-3 motorway (Madrid-Valencia) and near Atalaya (Badajoz), it connects with the A-43 towards Lisbon.
- The A-7 highway near Sagunto connects with the A-23 motorway (Sagunto-Somport). It has access to Aragon, Castilla-Leon, and the rest of the Northern communities. Near Xativa it links with the A-35 highway, being accessed to the Southern part of Castilla La Mancha.

- Rail (Valenciaport, 2022).

Valencia railway connection assures access to any productive area of the Iberian Peninsula and Europe.

The different possibilities of railway connection the port offers are the following:

- Valencia-Barcelona-PortBou.
- Valencia-Zaragoza-Basque Country.
- Valencia-Cuenca-Madrid.
- Valencia-Albacete-Madrid. From Madrid, there is the chance of access to regions like Extremadura and Portugal. Besides, it links with the North and Northwestern areas of the peninsula.
- Valencia-La Encina-Alicante. It also allows the possibility to reach further destinations from Alcázar de San Juan (Andalusia), Alicante (Murcia), and Madrid (North and Northwest, Extremadura).

Concerning the LSCI, Valencia has consolidated as the first Spanish port in connectivity. It remains the fourth port in Europe, behind the big three (Rotterdam, Antwerp, and Hamburg), and the first in the Mediterranean, above Barcelona and the Greek port of Piraeus (El Economista, 2021).

3.4 Port of Barcelona

One of the oldest ports in the region, it is an important shipping hub of Spain; it is managed by the Barcelona Port Authority and comprises several minor harbours (Marine Insight, 2021).

The port is divided into five different zones. According to the final purpose in each part, we identify the civic, commercial, cruise, energetic, and logistics. Each terminal has its installations and staff according to its activity to make it more suited and adjusted to the required facilities. Additionally, the port houses a tourist centre, a theatre, a cinema, an aquarium, and a shopping mall (Wikipedia, 2022).

Next to it are the industrial and Freeport zone. The free port zone is an industrial park located within the port, easily accessible by rail and road, and is located close to the International Airport (Marine Insight, 2021).

The Port of Barcelona is linked daily with fifty of the largest container ports in the world. It has significant connections with Asia, India, and South America (Port de Barcelona, 2021). The Port of Barcelona is also working with the Zaragoza Maritime Trade as a supporting hub (Terminal Marítima de Zaragoza, n.d.).

Moreover, the rail structure in Spain structures the whole infrastructure around Barcelona and Madrid as main stations. Therefore, Barcelona is a single city with a significant connection between railways and maritime transport (Wikipedia, 2022).

Eventually, the port has two different entries for vessels. The older and bigger one has 370 metres in width and 16 metres in depth. The new one was built to lighten traffic so smaller vessels and boats don't cross paths with the commercial vessels with a larger length. This new entry is smaller, 145 metres in width and 11.50 metres in the draft (Wikipedia, 2022).

Technical Features (Puertos del Estado, n.d.; Wikipedia, 2022)

- Quays: 20,877 linear metres and 16.50 metres in depth.
- Area: 902.10 hectares of water and 1,112.20 hectares of land.
- More than 30 specialised terminals: 3 ferries, 8 international cruises, 3 containers, 2 automobiles, 1 cocoa and coffee, 9 liquid bulk, and 5 dry bulk.
- Special fridges and metal adaptations.
- 45 total cranes: 27 container cranes and 9 tugboats among them.
- 30 Ro-Ro ramps.
- Train station → Big network of railways, and direct European connection.

Terminals

- Commercial Port.

Several divisions can be parted in this section. The traffic of automobiles through the port is pinpointed since the Port of Barcelona comprehends the highest figure of auto vehicles transport in the Mediterranean Sea. It reached a historical peak in 2016, with a value of 916,179 vehicles, taking the leading position in this aspect. The reason for this achievement can be explained thanks to the existence of several recognized automobile production plants near Barcelona. Some examples are the Nissan and Seat factories in the proximity of the port, which are the main reasons for the high volume of automobile vehicles transported. Regarding container shipment, the port of Barcelona disposes of 4 different terminals. The total surface is 210.48 hectares and 4.50 kilometres of docks (Wikipedia, 2022).

- Energetic Port.

The objective is directed to the reception, storage, and distribution of the energy resources and chemical products that the port requires. The energetic port has 15 berths destined for the liquid bulk that will compose the oil-bearing and chemical resources. It can be found as the biggest oil-bearing terminal in the Western Mediterranean Sea (Wikipedia, 2022).

Several organisations related to the energy sector have at least one plant placed in the port section. It is pinpointed as the "Gas Natural Fenosa" plant, which operates in the port. This plant uses natural gas to produce energy, with a total power of 850 megawatts (Wikipedia, 2022).

- Logistics Port.

The logistics part of the port in Barcelona, also known as “ZAL” (Logistics Activities Zone in Spanish) was the first ZAL as such implemented in Spain. The total surface of this section of the port is 212 hectares, and the logistics platform is also controlled by the same public body that manages the whole port (Wikipedia, 2022).

The goal is to bring closer organisations to maritime transport. Besides, it helps all these companies, even adding value to the management and solving any problem that may arise.

Some of the main entities in the complex are DHL, Seur, Decathlon, Damm and Carrefour. All these companies share a common characteristic: logistics and distribution play a starring role in their activity. Consequently, being located next to the maritime routes, within the port, makes the attainment of their main activities easier (Wikipedia, 2022).

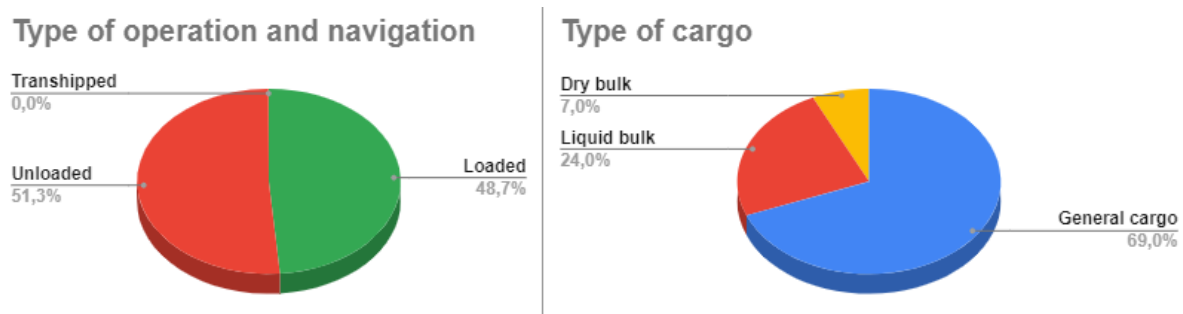
Type of Cargo

The main dry bulk components the Port of Barcelona handles are soya beans, cement, clinker, grains, flour, and potash (Port de Barcelona, 2021).

In liquid bulk, we can find products such as hydrocarbons, chemical products, and biofuels (Port de Barcelona, 2021).

Eventually, when it comes to containers and general cargo, the port handles containerized import-export cargo, fruit, coffee, cocoa, heavy lift, and project cargo (Port de Barcelona, 2021).

Figure 3.3: Port of Barcelona handled products



Source: self-made graphic

Intermodal split

- Short sea shipping (Port de Barcelona, 2021).
 - Is the leading port of the Peninsula for short sea shipping.
 - It contributes to a mode of sustainable transport with a reliable, clean, safe, and economical alternative to road transport.
 - Efficient and frequent short sea shipping services. It offers connections to the major Mediterranean and North African ports.
 - Eventually, the port participates in the European Intermodal Transport School and is part of the board of directors of the ShortSea Promotion Centre Spain.
- Road transport (Port de Barcelona, 2021).

The Port of Barcelona is located next to a junction of land transport infrastructure. A network of railways and highways brings the port closer to the hinterland.

The Ronda, a fast track laid out along the perimeter of Barcelona, passes by the port, and the access to the road network is immediate.

The main ways are:

- AP-2 motorway, connecting with the centre of the country and Aragon. It also joins with the A-68 highway to the North of Spain and the French border via Irun.
- Mediterranean highway AP-7 connects the South with the East, central Spain, and the North with the French border and the European motorway network.
- AP-9 motorway links with the AP-7 highway on the French border via La Jonquera.

- C-32 motorway, connecting with the South and East of the country.
- C-58 highway to Sabadell, Terrassa, and Manresa connects with the Llobregat axis and through the Cadi tunnel with France by Puigcerda and the Pimorent tunnel.
- C-31 motorway, which links with the National II to the French border.
- National II connects with the West, centre, and North.
- National C-17 connects with the French border via Puigcerda.
- National 150, which links with Sabadell, Terrassa and Manresa.
- National 340 connects with the South and East of the country.
- Rail (Puertos del Estado, 2019).

The Railway Network of the Port of Barcelona is an integral part of the Railway Network of General Interest and is made up of the railway infrastructures (track infrastructure, track superstructure, and railway safety and signalling facilities) managed by the Port Authority of Barcelona, as well as the railway terminals of the Port of Barcelona.

The railway tracks that connect the port and its proximity to the rest of the country are:

- Iberian track gauge:
 - PortBou/Cerbere (towards France) by Castellbisbal, Granollers, and Maçanet.
 - Centre and West of the peninsula via Zaragoza-Madrid-Avila.
 - North/Northwest of the peninsula through Zaragoza and Huesca, Zaragoza and Pamplona, Zaragoza-Burgos-Palencia-Valladolid.
 - South of the Peninsula by Tarragona-Valencia.
- UIC track gauge:
 - France and the rest of Europe via Castellbisbal, Mollet junction, Girona Mercaderies, and Le Perthus tunnel.
- Metric track gauge:
 - Suria and Sallent (Spain).
 - Martorell (Spain).

Regarding the LSCI, Barcelona has gained two positions, from 28th to 26th. The improvement of its facilities and its connections have made progress, until it is ranked as the second world port in the Mediterranean, according to the UNCTAD Index (El Economista, 2021).

3.5 Port of Bilbao

Situated on the estuary of Bilbao, it spans nearly 17 kilometres of the Bilbao waterfront and has been used since the early 14th century (Marine Insight, 2021).

It deals with containers, general cargo, and passenger traffic. It has an annual container volume of nearly 1 million TEUs (twenty equivalent units). Size-wise, this port is the largest in Spain and is well connected by road and rail (RENFE rail network links the port at present) (Marine Insight, 2021).

Furthermore, the port deals with cruise ships through the Getxo dock and provides ferry services for Brittany Ferries, Acciona Trasmediterranea, and P&O Ferries. The volume of passengers the Port of Bilbao has is, approximately, 250,000 people (Marine Insight, 2021).

The port is also working with the Zaragoza Maritime Terminal as a supporting hub (Terminal Marítima de Zaragoza, n.d.).

Technical Features (Puertos del Estado, n.d.; Wikipedia, 2022)

- Quays: 20,877 linear metres and 30 metres in depth.
- Area: 1,919.60 hectares of water and 402.84 hectares of land.
- Freeport zone
- 10 container cranes from 32 to 65 tonnes; 16 transtainer cranes from 32 to 40 tonnes; 47 gantry cranes from 6 to 35 tonnes; 7 bridge cranes from 28 to 35 tonnes.
- 2 continuous ships, 8 Ro-Ro ramps.
- Special loading and unloading facilities.
- General cargo, containers, Ro-Ro, solid bulk, and liquid terminals.
- Train station → Direct connection with the national network of motorways and expressways.

Terminals

The terminals are managed by four stevedore companies.

- Bergé Marítima Bilbao, S.L.

Founded in Bilbao in 1870, Bergé y Cía started to expand all over the country. Then, Bergé Marítima appeared as a parent company in the logistics industry, offering transport, trading, storage, administration, promotion, and advice services (Bilbao Port, n.d.).

- Consignaciones Toro y Betolaza S.A.

Founded in Bilbao in 1966, it has developed its activity in the maritime sector as ship operators, ship consignees, stevedores, custom agents, and carriers. In the Port of Bilbao, Consignaciones Toro y Betolaza S.A. receives deposits and distributes cargo. These goods are

forestry and iron and steel products, and sulphates. The terminal also owns a Ro-Ro ramp, a Liebherr crane with 104 tonnes of capacity, and wagons especially adapted for the transportation of forestry goods (Bilbao Port, n.d.).

- CSP Iberian Bilbao Terminal, S.A.

It allows an excellent and competitive way of entrance and exit to the Basque Country, Iberian Peninsula, and the South of France to shipping companies. With no draft and storage area limitations, the terminal is ideal for the exchange of goods. Besides, thanks to the latest technology systems, its annual handling capacity is 600,000 TEUs (Bilbao Port, n.d.).

- Servicios Logísticos Portuarios, S.A. (SLP)

SLP offers a great technological and human specialisation for the receipt and handling of cargo. Furthermore, it operates as a representative and consignee of more than 500 ships.

It allows its clients the use of nine fixed cranes. Two mobile cranes of more than 100 tonnes are used for the loading and downloading of goods. Besides, auxiliary machinery like two hoppers for cereals, one conveyor belt, or a scale for lorry weighing is at the clients' disposal (Bilbao Port, n.d.).

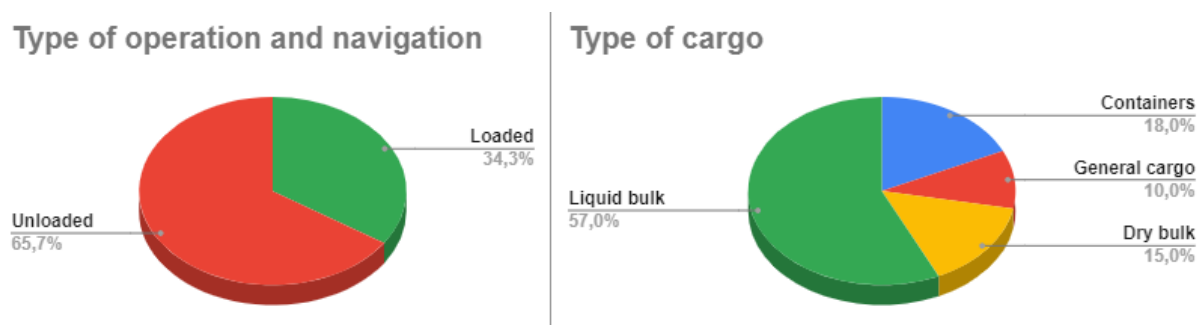
Type of Cargo

The main liquid bulk components the Port of Bilbao handles are crude oil, diesel oil, natural gas, gasoline, fuel oil, other oil products, and chemical products (Bilbao Port, 2021).

In general cargo and containers, we can find products such as steel products, machinery, spare parts, wine, beverages, and alcohol (Bilbao Port, 2021).

Eventually, when we talk about dry bulk, we are referring to soya beans, cement, clinker, other non-metallic minerals, coal, petroleum coke, and scrap iron (Bilbao Port, 2021).

Figure 3.4: Port of Bilbao handled products



Source: self-made graphic

Intermodal split

- Road transport (Puertos del Estado, 2019).

- The approach road in Santurtzi from the A-8 highway. It links with the Port entrances at Landeta and El Calero by a four-lane road. It also allows access to the marshalling yard and TECO.
- The N-639 road from Santurtzi to Abanto y Ciervana. It is a road with two lanes linking both places to the Port entrances at Landeta and El Calero.
- Access via Santurtzi town centre: only for light vehicles.
- The N-639 road and La Arena relief road. A two-lane approach road to the terminals at Punta Lucero from the A-8 motorway.
- Approaches to Zorroza from the N-634 road. It is compulsory to cross Hermogenes Rojo Street in Zorroza.
- The A-8 highway Bilbao-Behobia and Santander: connects at Eibar-Elgoibar with Placencia relief road, Vergara, Mondragon; at San Sebastian with the N-1 road, Tolosa; at Behobia with the French motorway, Bayonne-Bordeaux.
- Txorierrri Ring Road: allows A-8 highway access from the East by-passing Bilbao.
- Bilbao-Zaragoza A-68 motorway: links at Altube with the Alava Council Highway, Foronda Airport, and Vitoria (N-1 and N-240 roads to Pamplona); at Miranda with the A-1 Burgos Motorway and the North Highway (Madrid); at Alfaro with the A-15 Pamplona Motorway; at Zaragoza with the A-2, Lerida, Tarragona, and Barcelona Highway.
- The N-634 Road: French border, San Sebastian, Bilbao, Santander.
- The N-240 Road: Madrid (Barazar). It connects the N-634 road seven kilometres from Bilbao with the N-1 road at Vitoria.
- The N-625 Road: Madrid (Orduña). It links the N-634 road five kilometres from Bilbao with the N-1 road at Pancorbo.
- The N-637 road: access to the Cruise Terminal through N-637 road Bilbao-Getxo. It connects with the Txorierrri Ring Road.
- Rail (Puertos del Estado, 2019).
 - National Network: the Bilbao-Miranda de Ebro Line diverges at Miranda de Ebro in two directions: one to Burgos-Madrid and the other to Zaragoza.
 - Bilbao Centre-Santurtzi Line: 16 kilometres of dual-gauge wide track. A branch at Olabeaga links with the National Network at Abando Station, Bilbao.
 - Barakaldo-San Julian de Muskiz Line: 13 kilometres of dual-gauge wide track. It connects with the Bilbao Centre-Santurtzi Line at Barakaldo Station.

- Bilbao-Santander Lines. With 119 kilometres of narrow-gauge track, it provides access to the port zone at Luchana-Barakaldo.
- Pipelines (Puertos del Estado, 2019).
 - Oil Pipeline Bilbao-Miranda de Ebro-Burgos-Valladolid: 14-inch refined petroleum product line with a capacity of 5.2 million tonnes per year runs from the CLH plant at Somorrostro close to the Petronor Refinery, over a distance of 305 kilometres to its final destination, Valladolid, through Burgos.
 - Gas Euskadi Transportes pipeline: it starts at the Regasification and Combined Cycle Plant and links with the Iberdrola Power Station at Santurtzi and with the general gas overseas distribution network.

4.- Belgian ports

The aim is to describe the main Belgian ports in maritime trade to compare the strengths, weaknesses, opportunities, and threats observed in Spain. Therefore, this section presents a description of the North Sea Port and the Port of Antwerp-Bruges. The description is based on the factors of cargo volume and connectivity.

4.1 North Sea Port

North Sea Port is a Western Europe port extended across two countries: Belgium and the Netherlands. Because of its location in the North Sea, it is accessible by sea-going vessels, which benefits global trade (North Sea Port, n.d.).

Its location in Europe makes the port a logistics hub through which goods flow smoothly to all corners of Europe and even China. Furthermore, North Sea Port is part of the Rhine-Alps, NorthSea-Mediterranean, and North Sea-Baltic transport corridors, which ensures that goods can be delivered quickly and efficiently whether by rail, road, or inland shipping to their final destination (North Sea Port, n.d.).

Location, multimodality, and diversification in goods make North Sea Port an important European port: the third most important in terms of added value and the ninth in freight traffic (North Sea Port, n.d.).

Raw materials, parts, and semi-finished products arrive in the port on ships and are processed into final goods. This represents added value for the activities carried out in the port area in the form of new valuable opportunities for growth and employment (North Sea Port, n.d.).

A global leader in steel manufacturing operates in the port. It manufactures high-quality sheet steel used to make things like cars and household appliances. All phases of steel production take place in North Sea Port at a commercial site where 6,000 people work (North Sea Port, n.d.).

The plant also generates its heating warmth and electricity in a CO₂-free method, thanks to clever modifications to boilers, the use of wind turbines, and solar panels, purchasing "green" power, and applying measures to conserve energy (North Sea Port, n.d.).

Eventually, North Sea Port has 1,000 hectares of commercial property available for warehousing, logistics, and/or distribution (North Sea Port, n.d.).

Upcoming new projects and investments will ensure growth in storage and distribution. Besides, connections enable extensive multimodal transport into the hinterland and are an important asset (North Sea Port, n.d.).

Technical Features (Marine Traffic, 2022)

- Area: more than 60 kilometres, 9,100 hectares.
- The maximum length of a vessel entering the port is 270 metres.
- Maximum draught: 14.20 metres.
- Maximum deadweight: 87,605 tonnes.

Terminals

- ArcelorMittal Gent (Marine Traffic, 2022).

It consists of three berths. The barges calling at the terminal are motor freight (42%), general cargo (20%), bulk carriers (13%), liquid cargo (4%), and others (21%).

Additionally, the turnaround time (the average duration of the vessels staying docked) is 0.50 days.

- Ghent Container Terminal - Kluizendok (Marine Traffic, 2022).

The terminal consists of three berths, like ArcelorMittal Gent. The types of vessels regularly arriving are liquid cargo (20%), general cargo (17%), motor freight (14%), motor tankers (12%), oil/chemical tankers (8%), and others (29%).

Besides, the turnaround time of vessels in the terminal is 0.70 days.

- Port service Shipyard (Marine Traffic, 2022).

It consists of three berths, like the previous terminals. The barges regularly called are motor freight (40%), pleasure crafts (20%), motor tankers (8%), general cargo (4%), and others (28%).

Furthermore, the average duration of barges staying docked in Port service Shipyard is 4.60 days.

- Euroports Sifferdok (Marine Traffic, 2022).

Unlike the previous terminals, it has only one berth. Vessels calling at Euroports Sifferdok are motor freight (50%), liquid cargo (11%), general cargo (5%), bulk carrier (5%), and others (29%).

Currently, the turnaround time in the terminal is 1 day.

- Euroports Grootdok (Marine Traffic, 2022).

Like Euroports Sifferdok, this terminal consists of one berth. The barges regularly called are motor freight (50%), liquid cargo (14%), general cargo (9%), bulk carrier (5%), and others (22%).

Eventually, the turnaround time for barges staying in the terminal is 1.10 days.

Type of Cargo

A wide variety of goods passes through the port area (which is extended from the North Sea up to 32 kilometres inland) before moving on to their destination in a variety of ways (North Sea Port, n.d.).

- Dry bulk (North Sea Port, n.d.).

It accounts for 51% of the transshipment of goods by sea-going vessels. The port receives and provides accommodations for a large number of businesses that store, tranship, process, or manufacture dry bulk goods.

North Sea Port is referred to as the "granary of Europe". Nearly a half grain in Europe passes through the port area. Besides, the port has the largest in-port salt terminal in Europe and is one of the top players in fertilisers in the "ARA range" (Antwerp-Rotterdam-Amsterdam).

The most common dry bulk goods the port handles are agricultural products, salt, sugar, iron ore, fertilisers, solid fuels, ferrous alloys, and building materials.

- Liquid bulk (North Sea Port, n.d.).

It accounts for 26% of the transshipment of goods by sea-going vessels in the port area. The port also offers added value through production, tolling, blending, transport, and different storage options.

The current storage capacity is 3.9 million m³, which enables the port to retain reserves of liquid bulk for the short (and long) term storage. It is expected to further expand the storage capacity to 4.7 million m³ in the future.

Furthermore, North Sea Port is investing in the production of 1 million tonnes of bio-fuel (bio-ethanol and bio-diesel) per annum. This gives the port a place among sustainability leaders in Europe.

The most common liquid bulk goods the port handles are fuels and biofuels, oils, lubricants, sulphuric acid, adhesives, polythene chemicals, fruit juice, and liquid fertilisers.

- Breakbulk (North Sea Port, n.d.).

It accounts for 15% of the transshipment of goods by sea-going vessels. Thanks to it, North Sea Port is the top port in Europe for breakbulk.

One of the world's largest steel manufacturers has integrated the entire steel production chain at one commercial site on the Gent-Terneuzen Canal. The largest newspaper machine in the world, located in the port, produces paper for a significant portion of Europe as well. North Sea Port is also the top port in Europe for the handling, storage, and distribution of cellulose. Eventually, in Vlissingen, the wind industry is developing rapidly: from the transport of offshore turbine parts to the site, to the installation, maintenance, and recycling of the previously mentioned parts.

The most common breakbulk goods the port handles are steel rolls, sheet steel, paper, lumber, bridges, lock gates, and commercial cargo for the offshore industry.

- Ro-Ro (North Sea Port, n.d.).

It accounts for 4% of the transshipment of goods via maritime shipping.

Port's centric location offers Ro-Ro transport overseas connections and access via short sea shipping. Transshipment can take place whether on the North Sea coast or further inland.

The most common Ro-Ro goods the port handles are trucks, trailers, and passenger cars.

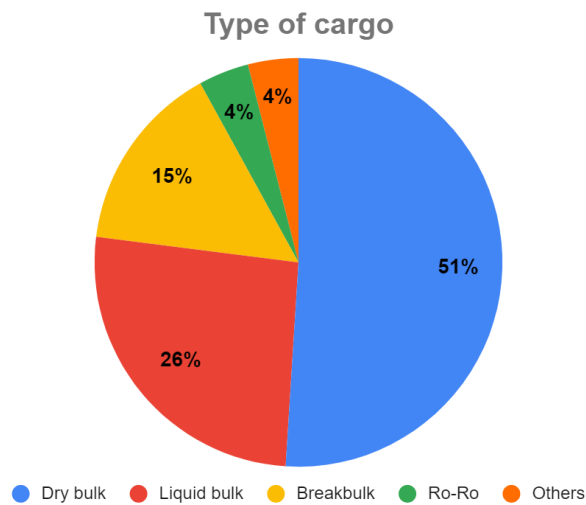
- Containers (North Sea Port, n.d.).

They are a growing trend in the maritime world, and North Sea Port is more often attracting shipping companies and businesses that trade in containers. Due to its connections by seagoing ship, inland, and short sea shipping, rail, and road, containers quickly find their way from the port to the hinterland.

North Sea Port is currently investing in the transport of containers between Rotterdam, Amsterdam, Antwerp, and Rijsel via inland shipping. Containers also play a key role in connection with the modal shift: by gathering containers on a ship, the port subtracts trucks from the road.

The most common containerized goods the port handles are food, cars, fruit, and refrigerated and frozen products.

Figure 4.1: North Sea Port handled products



Source: self-made graphic

Intermodal split

The port distributes the goods that enter the port via inland shipping, rail, pipelines, and motorways. The current modal split is 57% by inland shipping, 29% by road transport, 9% by rail, and 5% transshipment, although North Sea Port is committed to a modal shift by increasing rail, inland waterway, and pipeline transportation to reduce the congestion and CO₂ emissions associated with road transport (North Sea Port, n.d.).

- Inland shipping (North Sea Port, n.d.).

The port is located at a junction of European inland waterways, which goes from the Netherlands and Belgium towards Germany in the East and France in the South. By having 57% of goods being transported by inland shipping, North Sea Port is in a unique position that makes it an important hub for transporting goods over inland waterways by barge.

- Road transport (North Sea Port, n.d.).

North Sea Port is also located at the junction of the most important European motorways: E17 (runs North-South) and E40 (East-West). These links around the port area provide access to quays and industrial sites. Eventually, only 1/3 of hinterland traffic is moved by truck, and it is desired to reduce this share in the short term.

- Rail (North Sea Port, n.d.).

Many wharves and industrial sites have their tracks and sidings. The North Sea Port is also connected to the European rail network. By rail, 7 million tonnes of goods are transported every year. Besides, the port is trying to increase this amount, as rail transport appears to be an attractive alternative to road transport.

- Pipelines (North Sea Port, n.d.).

Between 15 and 16 million tonnes of products are transported by pipeline. It is being studied how it can increase these amounts and provide an alternative to road transport.

4.2 Port of Antwerp-Bruges

Port of Antwerp-Bruges is the second largest port in Europe, with more than 300 liner services and 800 destinations, ensuring worldwide connectivity. The port handles, approximately, 290 million tonnes of international maritime cargo and is home to Europe's largest integrated chemical cluster (Port of Antwerp-Bruges, n.d.).

It employs, directly and indirectly, a total of around 164,000 people and generates an added value of more than 21 billion euros. Therefore, it is an important support for the Belgian economy (Port of Antwerp-Bruges, n.d.).

The Antwerp-Bruges Port Authority plays an important role in the day-to-day operations of the port. 1,800 employees work providing customer-oriented services, optimal infrastructure, innovative projects, and the promotion of the port at home and abroad. They are committed to strengthening the role of the Port of Antwerp-Bruges as a sustainable port (Port of Antwerp-Bruges, n.d.).

With a dynamic network of representatives around the world, the Port of Antwerp-Bruges is at the heart of international world trade. The representatives not only convey the message of sustainable business, but they also help to build international collaboration (Port of Antwerp-Bruges, n.d.).

With the "Extra Container capacity Antwerp" (ECA) project, the Port of Antwerp-Bruges, Scheldt Left Bank Corporation, and the Flemish government give substance to sustainable development and efficient use of the port area. Furthermore, the port is accelerating the greening of the entire container sector, guaranteeing the provisioning of Belgium and the prosperity of current and future generations (Port of Antwerp-Bruges, n.d.).

Technical Features (Ship-technology, 2010)

- Quayside: 160 kilometres.
- Maximum draft: 16.50 metres.
- Warehouse facilities: 5.3 million square metres.
- Divided into two areas: right bank and left bank.
- Three floating cranes.
- 30 dock-mounted cranes.

Terminals

- Antwerp (Port of Antwerp-Bruges, n.d.).

Antwerp has five deepsea terminals. Each of them has multimodal access by road, rail and inland navigation to and from the hinterland. All container terminals are open 24/7 for seagoing vessels but have 24/5 opening times for trucks.

Deepsea terminals are open to trucks 24/5 at night. The night-time opening helps spread road transport more effectively and reduces congestion in the Antwerp port area.

Container terminals:

- DP World Antwerp Gateway Terminal (DP World, n.d.).

It is renowned by its customers for its unrivalled productivity in Europe, advanced technology, and outstanding intermodal connectivity. It is a joint venture between DP World Antwerp Holding, Cosco, Terminal Link, and Duisport Group.

- Antwerp Container Terminal (SEA-invest, n.d.).

It handles Belgium breakbulk, container logistics, customs services warehousing, and storage.

- MSC PSA European Terminal (MPET) (PSA-Antwerp, n.d.).

Since its opening in 2005, PSA has continued to expand the terminal, in terms of surface area and handling equipment.

In 2015-16, a joint venture between TIL and PSA moved its operations from Delwaidedock to Deurganckdock. The terminal has expanded to a throughput capacity of 9 million TEUs annually.

The terminal is currently featuring 41 quay cranes across 9 berths, 200 straddle carriers, and a quay length of 3,700 metres, making it the largest container handling facility in Europe.

- PSA Antwerp Europa Terminal (PSA-Antwerp, n.d.).

In the 1980s, a key step was taken towards securing the continued development of the port of Antwerp. The port had developed behind a series of locks. However, it was decided to expand the port further to the North. So they constructed a terminal in front of the locks.

The terminal was officially opened in 1990 and was the first tidal container terminal in the port. It is located on the right bank, in front of the locks.

- PSA Antwerp Noordzee Terminal (PSA-Antwerp, n.d.).

In 1997, a second tidal terminal followed: Noordzee Terminal. It is located on the right bank, in front of the locks, and is similar to PSA Antwerp Europa Terminal in terms of organisation and infrastructure.

Additionally, the terminal is well equipped to handle the largest container vessels in the world.

- Bruges.
 - CSP Zeebrugge Terminal CFS (CSP Terminals, n.d.).

The deepsea container terminal in the port of Bruges is located on the open sea close to the busiest shipping lanes in Northwest Europe and can serve the largest container vessels in the world. It allows intermodal connections, including rail, and access to the national and European highway systems.

The terminal benefits from no marine and land-based congestion. It improves the service quality. It is a coastal port with hub capabilities to the United Kingdom, Ireland, Scandinavia, and the Baltic region. Eventually, CSP Zeebrugge Terminal is a state-of-the-art common-user terminal with seven super post-Panamax ZPMC gantry cranes.

Type of Cargo

As an essential link in global logistics chains, the Port of Antwerp-Bruges has grown into a leading European port with a strong and comprehensive offering for cargo. Almost every product passes through the port. Every good requires its method of transportation or its form of shipping (Port of Antwerp-Bruges, n.d.).

- Dry bulk (Port of Antwerp-Bruges, n.d.).

It includes grain, coal, iron ore, cement, sugar, salt, and sand. These products are not packaged. They are transported in large quantities, in the hold of a ship, in a railway wagon, or a truck. A large part of dry bulk arriving at the port is intended as raw material for other products.

- Liquid bulk (Port of Antwerp-Bruges, n.d.).

The chemical cluster at Port of Antwerp-Bruges is the largest in Europe and the most versatile in the world. The broad offer of chemical companies has created an extensive network of logistical experts that guarantee a safe and high-quality storage, handling, and distribution of all chemicals, oils, and gas.

- Breakbulk (Port of Antwerp-Bruges, n.d.).

The port is ideal when it comes to shipping steel, project cargo, forest products, and cars. Zeebrugge is a true hub for cars, while Antwerp's strength lies in steel and project cargo. Following years of experience and the presence of specialised companies, the most diverse breakbulk cargoes can be shipped via the Port of Antwerp-Bruges.

- Ro-Ro (Port of Antwerp-Bruges, n.d.).

The port has extensive terminals for rolling stock. Every day, they connect the port to various ports in Africa, Ireland, the United Kingdom, Scandinavia, and Southern Europe.

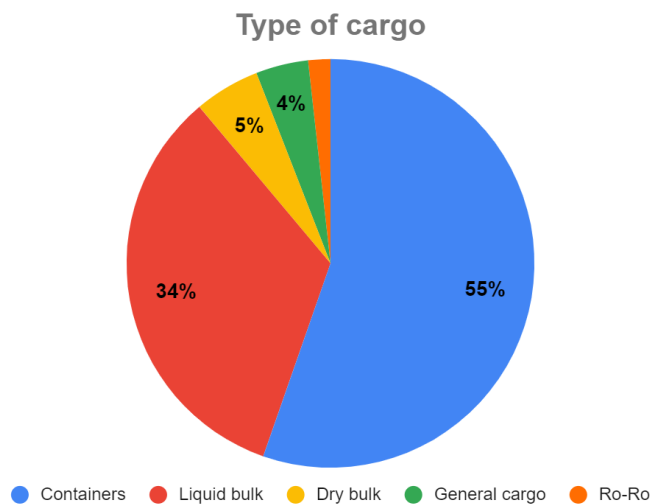
With a throughput of almost 7 million tonnes by 2020, Port of Antwerp-Bruges is the world leader in the import and export of Ro-Ro cargo.

- Containers (Port of Antwerp-Bruges, n.d.).

The Port of Antwerp-Bruges receives the largest container vessels. Good draught and smart use of tides make the port accessible for ships up to 23,00 TEUs.

Besides, each container terminal has multimodal access, which ensures fast and efficient transport of containers by road, rail and inland navigation to and from the hinterland. An extensive network of hinterland connections brings goods to the European interior.

Figure 4.2: Port of Antwerp-Bruges handled products



Source: self-made graphic

Intermodal split

There is a fast and efficient solution for transport between the Port of Antwerp-Bruges and the European hinterland. The port distributes the goods that enter the port via inland shipping, rail, motorways, short sea shipping, and pipelines. Additionally, the port is aiming to achieve a more sustainable modal split by raising the share of railways and inland navigation (Port of Antwerp-Bruges, n.d.).

- Inland navigation (Port of Antwerp-Bruges, n.d.).

It is the largest alternative transport mode in the port. To increase its share, the port is constantly working on new projects.

Antwerp and Bruges have excellent connections to the European barge network. This ensures short transit times to strategic areas in the European hinterland.

Different barge operators are active in the region, in every different segment including tankers, containers, dry cargo, breakbulk, and Ro-Ro. The fleet is diverse in terms of type and size. It also ensures that there is an inland navigation option available for all cargo transport.

- Short sea shipping (Port of Antwerp-Bruges, n.d.).

Port of Antwerp-Bruges offers weekly fixed short sea and feeder services from and to 200 destinations in Europe, North Africa, and the United Kingdom. Furthermore, the port has 300 liner services that connect the port with 1,300 deepsea destinations worldwide, meaning that products will reach their final destination on time.

The extensive network of frequent short sea and feeder connections from Antwerp and Zeebrugge ensures rapid transit times. Short sea shipping offers a larger transport capacity than road haulage, which reduces the costs per unit loaded. Via the Port of Antwerp-Bruges, ships load or unload their short sea cargo closer to the major European centres of consumption and production.

Short sea shipping is an environmentally-friendly alternative that coincides with the port's sustainable development policy.

- Road transport (Port of Antwerp-Bruges, n.d.).

The Port of Antwerp-Bruges is surrounded by international motorways that lead to the European hinterland. 60% of European consumption centres are within a 500-kilometres radius. Its central location in the heart of Europe makes the port a cost-effective choice for getting goods to end customers.

Besides, the Port of Antwerp-Bruges strives for optimal use of the existing road capacity. By installing new policies and launching commercial initiatives, the port offers optimal connectivity to and from the port and smooth mobility in and around the port.

- Rail transport (Port of Antwerp-Bruges, n.d.).

It is fast, reliable, and suitable for any kind of cargo, like containers, dry and liquid bulk, and heavy and dangerous goods. Rail transport also makes the logistical chain at the port more sustainable and efficient. Eventually, rail is an important mode of transport for the port of Bruges, accounting for more than 15% of the modal split. That percentage should have been achieved in Antwerp in ten years.

The Port of Antwerp-Bruges has rapid rail connections with major European rail corridors. Rail connections offer short transit times and congestion-free transport to Europe's major economic hubs.

The number of rail services has increased in the last few years. The port matches supply and demand by working with rail operators. Indeed, new high-frequency rail shuttles with European focus regions in the hinterland are being set up.

- Pipelines (Port of Antwerp-Bruges, n.d.).

The Port of Antwerp-Bruges is one of the most important pipeline hubs in Western Europe. Pipelines offer a safe, reliable, and environmentally friendly means of transport for the supply and distribution of liquid products.

Within the chemical cluster in Antwerp, the industrial and independent tank storage operations are connected by 57 different product pipelines or 1,000 kilometres of pipelines that account for almost 90% of all transport of liquid goods within the port.

5.- Conclusions

The purpose of this paper is to look for factors that might help to improve the efficiency of large Spanish ports. To this end, we have collected data from the four largest Spanish ports (Algeciras, Valencia, Barcelona and Bilbao) and compared them with the data of two of the main Belgian ports (North Sea Port and Antwerp-Bruges).

The difficulty in finding data for Spanish ports has been much greater than for Belgian ports. Regarding ports in Belgium, the information needed was available on their respective websites. In the Spanish ports, collecting data on the intermodal split has not been so easy. In the ports of Algeciras Bay and Valencia, such information was available on their corresponding website. However, in the ports of Barcelona and Bilbao, the data provided on their web pages was not complete. It had to be supplemented with information available on the *Puertos del Estado* website.

To establish a homogeneous comparison, it was necessary to have data that could be comparable. For this reason, we have limited the variables used to the type of cargo and intermodal split. Despite this limitation, the comparison highlights interesting differences in some of the variables studied.

For the variable type of cargo, the volume handled is higher in Belgian ports than in Spanish ports. In turn, breakbulk and Ro-Ro are more relevant in Belgian ports than in Spanish ports. In the latter, general cargo and containers are the most commonly handled cargo. Concerning the variable intermodal split, it can be seen that Belgium has a better transport network than Spain. In Belgium, goods can be transported either by inland shipping, short sea shipping, road, rail or pipelines. In Spain, on the other hand, ports transport their goods mainly by road

or rail. It is worth mentioning that the ports of Valencia, Barcelona and Bilbao offer other alternatives (short sea shipping for the first two and pipelines for the latter), but to a lesser extent than Belgian ports.

These differences are the starting point for finding more concrete actions to improve the efficiency of the large Spanish ports. In this sense, we will now focus on organising the differences around a SWOT analysis.

The principal strength observed is that both the Port of Valencia and Algeciras Bay Port are already important players in the European scene. Valencia is one of the most important ports handling containers and general cargo vessels and Algeciras is influential in terms of the gross tonnage of goods handled. Besides, three ports (Valencia, Algeciras Bay, and Barcelona) are among the fifty best-connected ports in the world, positioning Spain as the eighth-best country in terms of connectivity, according to the LSCI (El Economista, 2021; Consejo Nacional de Competitividad Observatorio, 2021).

However, the main weakness of Spanish ports in comparison to the Belgian ports is the intermodal infrastructure. In Europe, the rail track gauge is different than in Spain, so it is difficult for Spain to transport goods to other countries by train. Means of transport like short sea shipping or pipelines are barely used in Spain, being road transport and peninsular rail transport the most frequent ones. Additionally, the levels of cargo the ports handle in Belgium are much higher than in Spain

Thanks to its geographical location, Spain has an opportunity to become an important player in maritime trade. Vessels coming from Asian countries to Europe have to come through the Suez Canal and later the Gibraltar Strait to reach the main European ports. If ships were docked in Spanish ports, companies would be saving transport costs and, consequently, increasing port efficiency (Herrera Dappe, Jooste, and Suárez-Alemán, 2017). Besides, the Port of Bilbao has already developed a pipeline system to handle and transport specific products like oil or natural gas (according to Pérez et al. (2020), specialisation of goods handled increases port efficiency). Therefore, it has an opportunity to specialise in handling this type of product and take advantage of its competitors by becoming a leader in transporting this type of goods.

Nevertheless, these opportunities are threatened by other Mediterranean ports that are also trying to improve their connectivity and become more sustainable. To this end, ports are shifting their intermodal split: road transport is being used less and is being replaced by rail transport or short sea shipping. As previously stated, Spain has a clear disadvantage with the rail track gauge. Spain could be facing a major threat if this issue is not fixed in the future.

Ports in France, Italy and Greece may take advantage of the situation and vessels could dock at their ports.

So, we would like to conclude by highlighting that Spain is the second European country with the best level of maritime connectivity, and thanks to its location it has an opportunity to become a leading country in the maritime sector.

However, the disadvantage that Spanish ports have with the infrastructures on distribution networks, specially by train, is remarkable. If this problem is not solved, competitiveness could be lost in favour of ports located in France, Italy or Greece.

Bibliography

.- Alonso, F. (12 octubre 2021). *Tres puertos españoles de los 30 mejor conectados del mundo*. El Economista.

<https://revistas.economista.es/transporte/2021/octubre/tres-puertos-espanoles-de-los-30-mejor-conectados-del-mundo-JC9260913>

.- AP de Barcelona. (2019). *Memoria estadística 2019*. Puertos del Estado.

https://www.puertos.es/Memorias_Anuales/2019/doc/Memoria%202019%20AP%20Barcelona.pdf

.- Autoridad Portuaria de Bilbao. (2021). Bilbao Port.

<https://www.bilbaoport.eus/>

.- Autoridad Portuaria de la Bahía de Algeciras. (2021). APBA.

<https://www.apba.es/>

.- Autoridad Portuaria de Valencia. (2022). Valenciaport.

<https://www.valenciaport.com/>

.- Autotrans. (14 enero 2021). *La logística, un sector sostén de la economía española*. Grupo Autotrans.

<https://www.grupoautotrans.com/la-logistica-un-sector-sosten-de-la-economia-espanola/>

.- Bilbao Port. (2019). *Informe anual*. Puertos del Estado.

https://www.puertos.es/Memorias_Anuales/2019/doc/Memoria%202019%20AP%20Bilbao.pdf

.- BitNautic. (4 May 2020). *Why is Maritime Shipping Important?* Medium.

<https://medium.com/@bitnautic/why-is-maritime-shipping-important-6a1cd7cc99ef>

- Colaboradores de Wikipedia. (2022a). *Puerto de Barcelona*. Wikipedia, la enciclopedia libre.

https://es.wikipedia.org/wiki/Puerto_de_Barcelona

- Colaboradores de Wikipedia. (2022b). *Puerto de Bilbao*. Wikipedia, la enciclopedia libre.

https://es.wikipedia.org/wiki/Puerto_de_Bilbao

- Colaboradores de Wikipedia. (2021). *Puerto de la Bahía de Algeciras*. Wikipedia, la enciclopedia libre.

https://es.wikipedia.org/wiki/Puerto_de_la_bah%C3%ADa_de_Algeciras

- Colaboradores de Wikipedia. (2022c). *Puerto de Valencia*. Wikipedia, la enciclopedia libre.

https://es.wikipedia.org/wiki/Puerto_de_Valencia#Instalaciones

- Consejo Nacional de Competitividad Observatorio. (20 octubre 2021). *Índice de Conectividad Marítima y Portuaria*. Consejo Nacional de Competitividad Observatorio.

<https://www.competitividad.org.do/indice-de-conectividad-maritima-y-portuaria/>

- Cosco Shipping. *The bridge to Europe*. CSP terminals.

<https://cspterminals.be/>

- DP World. *Antwerp Gateway*. DP World.

<https://www.dpworld.com/en/antwerp/services/antwerpgateway>

- Herrera Dappe, M.; Jooste, Ch.; Suárez-Alemán, A. (September 2017). *How Does Port Efficiency Affect Maritime Transport Costs and Trade? Evidence from Indian and Western Pacific Ocean Countries*.

<https://openknowledge.worldbank.org/handle/10986/28449>

- Herrera Dappe, M.; Serebrisky, T.; Suárez-Alemán, A. (June 2021). *On the Historical Relationship between Port (In) Efficiency and Transport Costs in the Developing World*.

<https://publications.iadb.org/publications/english/document/On-the-Historical-Relationship-between-Port-InEfficiency-and-Transport-Costs-in-the-Developing-World.pdf>

- IGN. (2019). *Transporte marítimo*. Atlas nacional.

https://atlasnacional.ign.es/wane/Transporte_mar%C3%ADtimo

- Marine Traffic. (2022). Marine Traffic.

<https://www.marinetraffic.com/en/ais/home/centerx:-12.0/centery:25.0/zoom:4>

- Menon, A. (4 May 2021). *15 Major Ports in Spain*. Marine insight.

<https://www.marineinsight.com/know-more/major-ports-in-spain/>

- .- Ministerio de Transportes, Movilidad y Agenda Urbana. (2020). *Annual statistical report of the state-owned port system*. Puertos del Estado.
https://www.puertos.es/anuario_estadistico/anuario_estadistico2020/anuario/contenidos_eng/03/030104.html
- .- Ministerio de Transportes, Movilidad y Agenda Urbana. *Dossier of Puertos del Estado*. Puertos del Estado.
<https://www.puertos.es/es-es/Paginas/BibliotecaV2.aspx>
- .- Ministerio de Transportes, Movilidad y Agenda Urbana. *Institucional*. Puertos del Estado.
https://www.puertos.es/es-es/portaldetransparencia/Paginas/P_Transparencia_Institucional.aspx
- .- Ministerio de Transportes, Movilidad y Agenda Urbana. *Nosotros*. Puertos del Estado.
<https://www.puertos.es/es-es/nosotrospuertos/Paginas/Nosotros.aspx>
- .- North Sea Port. North Sea Port.
<https://en.northseaport.com/>
- .- Orgaz, C.J. (22 abril 2022). *El enorme atasco en el puerto de Shanghai por el confinamiento y sus consecuencias para América Latina y el mundo*. BBC.
<https://www.bbc.com/mundo/noticias-internacional-61182986>
- .- Pérez, I.; González, M.M.; Trujillo, L. (August 2020). *Do specialization and port size affect port efficiency? Evidence from cargo handling service in Spanish ports*. ScienceDirect.
<https://www-sciencedirect-com.cuarzo.unizar.es:9443/science/article/pii/S0965856420306042>
- .- Port de Barcelona. (2021). Port de Barcelona.
<https://www.portdebarcelona.cat/>
- .- Port of Antwerp-Bruges. Port of Antwerp-Bruges.
<https://www.portofantwerpbruges.com/en>
- .- PSA Antwerp. PSA-Antwerp.
<https://www.psa-antwerp.be/en>
- .- Russon, M-A. (29 March 2021). *The cost of the Suez Canal blockage*. BBC.
<https://www.bbc.com/news/business-56559073>
- .- SEA-invest. *Antwerp Container Terminal*. SEA-invest.
<https://sea-invest.com/companies/antwerp-container-terminal/>
- .- Ship technology. (27 April 2010). *Port of Antwerp*. Ship-technology.
<https://www.ship-technology.com/projects/portofantwerp/>

.- Terminal Marítima de Zaragoza. *Rutas de transporte*. Terminal marítima de Zaragoza.

<https://tmzaragoza.eu/>

.- UNCTAD. (2021). *Review of Maritime Transport 2021*. UNCTAD.

<https://unctad.org/es/node/35541>