



Maritime Connectivity in the Western Mediterranean

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Executive Summary

Maritime flows of general cargo in the Western Mediterranean

The Western Mediterranean maritime region handles a wide range of general cargo flows. This diversity responds to the kind of handling (i.e. containerized or Ro-Ro cargo), the origin-destination of the goods (transoceanic or intra-Mediterranean route) and the type of operation carried out on the goods at ports (e.g. transit or import-export operations).

In recent years, there has been a trend in the container shipping industry towards vertical and horizontal business integration. In other words, shipping companies have moved into business concentration and the creation of a very limited number of major alliances. At the same time, they are increasing their shareholdings in infrastructure and services on land, such as port terminals, and logistics and rail services. In conjunction with this process, the size and capacity of vessels, terminals and equipment have steadily increased with the aim of maximizing economies of scale. It specially takes place in the European GTMO 5+5 countries.

Starting in the second half of 2020, container shipping rates have increased significantly. If this increasing of rates was sudden and surprising, so was the drop of container rates in the second half on 2022. In any case, both the sudden rise and fall of rates are indicative of the volatility and uncertainty maritime transport is subjected to. These post-pandemic changes, the drop in supply and increase in freight rates, seem to be linked to the dominance of the major alliances in global container shipping.

Transit flows play a key part of the organization of container distribution between routes and ports in container shipping. Transoceanic connections of almost all Maghreb ports, with the exception of Tanger-Med, require a transit movement, which generally takes place at the northern GTMO 5+5 ports. Algeciras Valencia, Barcelona, Marseille, Genoa and Gioia Tauro accounted for 53.2% of total container flows of the European GTMO 5+5 countries by 2019.

Ro-Ro cargo services are the other service that contributes to the movement of general cargo flows in the Western Mediterranean. Ro-Ro cargo services focus on short routes and are basically provided in connections between countries on the northern shore, as well as between the northern and southern shores of the Western Mediterranean. Ro-Ro cargo flows can be considered almost exclusively import/export flows.

Services between European countries benefit from the abolition of customs and sanitary controls and different policies to promote short-sea shipping as the maritime component of the Trans-European Transport Network (TEN-T). In connections with the Maghreb, it is worth highlighting those established around the Strait of Gibraltar. Other connections are established between Morocco and the ports of Sete, Marseilles or Genoa; Tunisia, specially the port of Rades, and the ports of Genoa, Marseilles and Barcelona; and Algeria with the ports of Almeria, Alicante, Valencia or Marseilles.

The transformation of Ro-Ro cargo services in recent decades has mainly involved the increased presence of the private sector, company mergers and integrations and vessel changes, driven by the challenge of sustainability (Ro-Ro ships with larger cargo capacities, while incorporating new fuels or technologies to reduce emissions).

The different kinds of maritime flows of general cargo in the Western Mediterranean should be considered together, especially at a time of profound transformations that is affecting the patterns of goods distribution and the structuring of transport services, infrastructure and means.

Maritime connectivity

Maritime connectivity refers to the structure, scope and efficiency of global service networks that include a maritime transport link in one of their sections and provide access to markets and opportunities.

Maritime connectivity is a comprehensive concept that takes into account different dimensions (network of maritime connections between ports, port passage, and connection with the hinterland) as well as actors and processes that make up the maritime transport of goods. Trade in the Western Mediterranean countries depends heavily on maritime connectivity. However, this comprehensive approach of connectivity is not consolidated in the region and improvements to the Mediterranean transport system are often dealt with independently, whether by improving road transport, infrastructure or maritime services, of the customs system, etc.

The concept of maritime connectivity is the ideal starting point for improving regional integration. In addition, this comprehensive approach to improving maritime connectivity is shared since it helps to overcome the idea of independent interventions in different dimensions, being as they are so intertwined and interconnected. Moreover, the concept and approach shown here regarding maritime connectivity allows strengthening collaboration among the myriad of actors involved in it.

Quantitative assessment of maritime connectivity in the Western Mediterranean

The United Nations Conference on Trade and Development (UNCTAD) currently publishes a series of indices for assessment of maritime connections of container services: the Liner Shipping Connectivity Index (LSCI), the Port Liner Shipping Connectivity Index (PLSCI) and the Liner Shipping Bilateral Connectivity Index (LSBCI). But they do not provide information that makes it possible to regularly assess connectivity linked to other kinds of services, especially Ro-Ro cargo services (very important in the Western Mediterranean). There have been attempts to provide a theoretical definition of a synthetic index to assess maritime connectivity arising from Ro-Ro cargo services but they have not been followed up successfully.

The results of the indices published by UNCTAD show that the northern shore of the Western Mediterranean is better connected by regular container shipping services. These improved connections can be explained by ports that are capable of attracting transoceanic flows and economies with higher foreign trade volumes than those of the Maghreb countries, which favours the establishment of regular maritime services. The scores of the Maghreb countries can be explained by lower trade flows and ports with limitations in accommodating vessels carrying out transoceanic services. The case of Morocco and the port of Tanger-Med is important because it shows container and ship handling capacity as a key requirement to obtain a high score on the indices proposed by UNCTAD.

UNCTAD has also regularly published a set of performance indicators on the efficiency of goods movement through ports. With a focus on container ships, three indicators are of particular relevance for the assessment of port efficiency: the median time in port of container ships, the average size of ships based on capacity measured in TEU, and the size of the vessel with the greatest capacity handled at the country's ports measured in TEU. In all three cases, the European countries of the Western Mediterranean, as well as Morocco, present the most efficient port passage in the region.

Furthermore, since April 2021, the World Bank and IHS Markit have published a synthetic index on the efficiency of container handling in ports. Tanger-Med stands out as the top port in the ranking of Western Mediterranean ports. The next Maghreb port, Radès, is ranked in 31st position of the 41 ports of the region. So, the ports with the greatest container handling efficiency are ports with large port calls, and with the capacity to handle vessels of more than 5,000 TEU, which is when economies of scale come into play.

When considering the rest of the Western Mediterranean ports, all of which are in Europe, it can be inferred that especially in transit operations.

Currently, there is no indicator or system of indicators that would allow a regular assessment in the Western Mediterranean of the three dimensions of maritime connectivity considered. The improvement of existing indicators and their extension to the evaluation of Ro-Ro services, as well as the connection of ports with the hinterland, appears as a challenge for a better understanding and monitoring of maritime connectivity in the Western Mediterranean. Better exploitation of existing statistics, the use of new data sources, such as those offered by the AIS system, and greater coordination between actors in the handling and publication of information should help to create greater knowledge to enable better assessment and monitoring of maritime connectivity in the western Mediterranean.

Dimensions of maritime connectivity in the Western Mediterranean

Network of maritime connections between ports

In Western Mediterranean, multiple typologies of maritime flows intersect. The first distinction of sea flows is made between container flows and Ro-Ro flows. When taken into account the origin or destination of flows, it is possible to separate between intra-Mediterranean and transoceanic flows. Import or export flows from or to hinterlands of Mediterranean ports are also distinguished from transshipment flows. The latter is limited to the transport of containers. All these types of flows make the Western Mediterranean a complex from the point of view of maritime flows and therefore it becomes necessary to understand the relationships that are established between them.

The flow of containers ensures the global connectivity of Western Mediterranean ports, either by direct import-export services or by routes requiring a transit operation. Regional flows are based on Ro-Ro and container services, which have traditionally specialized in specific niche markets with limited competition between these types of services. However, the alteration of the conditions of container services, with a significant increase in costs and a loss of reliability, causes this division between types of services to be altered, thus showing the interrelationships between the different types of flows.

The current needs for the flow of goods between the countries of the Western Mediterranean are covered by services that are considered adequate to cover the existing demand. However, the existence of circumstances limiting its extension and improvement. The companies operating the maritime services appear as the main actor in the process of promoting new relations between the ports of the western Mediterranean. The involvement of the other actors related to maritime transport may contribute to improving and accelerating the process of creation and establishing new routes and therefore to improve maritime connectivity.

Other factors that may contribute to increased connectivity in the western Mediterranean are:

- The upgrading of the port infrastructure in the Maghreb which conditions the calls of large container ships;

- Policies prioritising the use of maritime transport services over road transport and reducing transport chain externalities, targeting the different types of actors involved regardless of their nationality;
- Progress towards more homogeneous regional port regulations facilitating the homogeneous operation of maritime services;
- The capture of flows of goods that pass through the Mediterranean without stopping at it.

Goods movement through port

As regards the port crossing, it is considered that there is no a general problem in the region. However, the existence of differentiated customs treatment among some of the countries is a major handicap for improving maritime connectivity in the western Mediterranean. It is necessary to develop alternatives or procedures that contribute to reduce differences in time, costs and facilitation of the passage of goods through ports that this situation generates.

There exist barriers to the development of maritime connectivity from the point of view of infrastructure and port operations. They are derived from capacity constraints, conditioned by the physical space of the port, its equipment and facilities as well as lack of human resources,

Improving digitisation levels will also mean progress towards greater regional harmonisation of the port passage procedures. The maritime single windows and the Port Community Systems, digital platforms that integrate the different procedures and actors affected by the passage of goods through the port, have been and are very powerful tools for facilitating port passage. Nevertheless, further work is needed to ensure harmonisation and integration between digital platforms used in ports, as well as on the integration into these platforms of all actors involved in maritime transport.

Other factors that may contribute to increased connectivity in the western Mediterranean are:

- Greater time span to facilitate the implementation of port procedures;
- The promotion of the training of the specialized workforce for the development and use of new technological tools.

Connection with the hinterland

The connection of the ports with its hinterland is a point to be analysed individually for the different ports of the region. However, the commitment to multimodality, as an element of efficiency and sustainability, represents the main challenge of the connection with the hinterland for ports in Western Mediterranean. This commitment has to adapt to the situation and particularities of each country. Vertical integration processes, as they are introduced in the region, can favour the efficiency of this multimodality, but at the same time they may mean market control by a limited number of players.

The expansion of the hinterland of the various Mediterranean ports, both European and Maghreb, will also help to improve maritime connectivity in the region.

Other factors that may contribute to increased connectivity in the western Mediterranean are:

- The situation of the land infrastructures and the inter-modality of them;
- The change in the unimodal vision of certain actors to take advantage of the various modes of transport.

Global trends affecting maritime connectivity

Sustainability and energy transition

On the trend towards sustainability and the energy transition of shipping, ports and land transport, there is widespread concern. It deals with the definition and implementation of new regulations on ship emission limits, on the commitment to more environmentally efficient propulsion systems and on the availability of their respective recharge infrastructures.

The IMO adopted the “*Initial IMO Strategy on Reduction of GHG Emissions from Ships*” in 2018 and designated the Mediterranean Sea as an Emission Control Area for Sulphur Oxides and particulate matter (Med SOx ECA) in December 2022-. In the EU framework, the Fit for 55 package aims at reducing net emissions through the use of more sustainable alternative fuels and, for ships at berth in port, connections to the onshore power grid for ships at berth in port.

Stakeholders are mainly concerned about two issues: the high volume of investment associated with meeting these environmental requirements, and the lack of a clearly defined and agreed technological commitment, taking into account that this should be a coordinated investment between port authorities, shipping companies and the countries of the region.

Digital transformation

The trend towards digitization is perceived as beneficial and necessary for improving regional competitiveness, being digital platforms one of the most widespread technologies. In this regard, the IMO Facilitation Committee (FAL 46) reached the commitment to make the implementation and use of the maritime single window mandatory for port authorities worldwide, starting on 1 January 2024 and work is being done in the European maritime single

However, there are some obvious challenges and risks. The lack of interoperability between technologies in different countries appears as the main challenge to overcome. In this sense cooperation in exchange of knowledge and experience appears as a tool to help all actors in the transport system be able to take on this technological revolution, without leaving anyone abandoned. Digital transformation must therefore include urgent training.

Relocation and regionalization processes

Another trend with a significant potential impact on the region is the global process of relocation and regionalization triggered by the need to increase the resilience of supply chains. Taking advantage of this opportunity will demand greater maritime connectivity in the Western Mediterranean. The impact of regionalization will be greater or lesser in each geographical area, depending on whether they are able to provide supply chains with an efficient and connected transport system, among other factors.

Resilience to disruption

Also in order to ensure better adaptability of supply chains, it is needed to improve resilience against disruptions. In this sense, the effects of climate change are currently perceived as the main disruptive phenomena to be taken into account, due to the increasingly frequent exposure of transport infrastructures to more severe and extraordinary phenomena. These require a study and joint regional work to adapt as well as a task of awareness of and updating of knowledge at the Western Mediterranean level.

Recommendations to improve maritime connectivity in the Western Mediterranean

Finally, a series of recommendations resulting from the above conclusions are drawn for each of the topics addressed throughout the diagnosis.

Overview:

- An integrated approach should be taken to improving maritime connectivity (networks of maritime connections between ports, goods movement through ports and connections with the hinterland).
- Communication and cooperation should be encouraged between different maritime connectivity stakeholders in consideration of the relationships and dependencies between them.

Knowledge:

- Information should be monitored and processed to display an integrated approach to maritime connectivity and a better understanding of the specific conditions in the Western Mediterranean.
- Trends should be monitored to anticipate and improve adaptability to future situations in the sector.
- Stakeholders should be coordinated for management and publication of information and knowledge.

Network of maritime connections between ports:

- Work should be done to strengthen identification of future needs and the ability to attract new flows through dialogue and the participation of all stakeholders involved in maritime connectivity.
- Policies should be promoted that facilitate maritime services.
- Progress should be made on regulatory harmonization.

Goods movement through ports:

- The complexities of maritime-port procedures should be reduced, especially customs clearance.

Connections with the hinterland:

- A commitment to multimodality should be displayed through infrastructure and services that help facilitate flows with the hinterland and contribute to the sustainability of maritime connectivity.

Trends:

- A shared regional position in the Western Mediterranean should be defined regarding maritime transport sustainability.
- Successful digital transformation processes should be facilitated and promoted to bridge the digital maturity gap of maritime connectivity within the region.
- Awareness should be raised of the effects of climate change on the transport system and the measures that must be taken in order to adapt.

1 Introduction

1.1 Purpose of diagnostic

During the 31st meeting of the expert group of the Group of Transport Ministers of the Western Mediterranean (GTMO 5+5)¹, held on 23 March 2022, the work programme under the Maltese presidency of the group was validated and will run until the last quarter of 2023.

Maritime connectivity was identified as a priority for the members of the group and for this reason a specific action dedicated to this topic was defined within the work programme.

A diagnosis on maritime connectivity in the Western Mediterranean is proposed as first activity within this action in order to know the situation and trends of maritime connectivity in the Western Mediterranean and to identify lines of action that will enable its improvement and adaptation to the new emerging conditions in maritime transport.

1.2 Objectives

The main objective of this diagnosis is to understand the situation of maritime connectivity in the Western Mediterranean, especially with regard to container and Ro-Ro cargo flows of general cargo, in order to propose lines of action that contribute to its improvement.

The following secondary objectives are defined as part of this main objective:

- Description and evolution of maritime connectivity in the Western Mediterranean, as well as the information necessary to obtain a more detailed knowledge at country and main port levels in the region.
- Identification of the main challenges and barriers that hinder the comprehensive development of maritime connectivity in the Western Mediterranean and its full potential, especially between the two shores of the region.
- Definition of possible lines of action that contribute to improving the situation of maritime connectivity in the Western Mediterranean to be developed within the framework of the GTMO 5+5 or other collaboration frameworks.
- Nearness to the maritime and port ecosystem stakeholders in the Western Mediterranean in order to try to establish lines of dialogue in view of the proposed lines of action and the interest that these may have in the different stakeholders.

1.3 Methodology

The elaboration of this diagnosis has involved three distinct phases: the literature review, the analysis of indicators and their application in the Western Mediterranean, and the collection of qualitative information.

- Literature review. It represents the starting point of the analysis, especially to understand how maritime connectivity is studied at a global level and the possibilities of extrapolating it to a region as specific as the Western Mediterranean. It has also helped to understand the current situation and its origin, and to identify the factors that condition it and trends to be taken into account in the short, medium and long term.

¹ GTMO 5+5: Transport cooperation group composed of the following countries: Algeria, France, Italy, Libya, Malta, Mauritania, Morocco, Portugal, Spain and Tunisia.

- Analysis of indicators and their application in the Western Mediterranean. The components of the maritime connectivity indicators and their calculation system have been analysed and their application to the Western Mediterranean has been considered. This quantitative approach has allowed a first description of maritime connectivity.
- Collection of qualitative information. More detailed information on the situation of maritime connectivity in the Western Mediterranean was obtained through surveys and personal interviews. To this end, 30 experts from 8 countries in the region and with complementary professional profiles collaborated.

1.4 Structure of diagnostic

This diagnostic on maritime connectivity in the Western Mediterranean is structured in five main chapters:

- Maritime flows of general cargo in the Western Mediterranean;
- Maritime connectivity;
- Quantitative assessment of maritime connectivity in the Western Mediterranean;
- Qualitative assessment of maritime connectivity in the Western Mediterranean; and,
- Conclusions, recommendations and action lines.

They are described very briefly hereafter.

Maritime flows of general cargo in the Western Mediterranean.

This chapter provides an overview of the processes that have marked the structuring of global maritime transport in recent years and its concrete expression in the Mediterranean area, especially with regard to container and ro-ro cargo services.

To this end, firstly, the main characteristics and transformations of recent years in relation to container transport are summarised. Secondly, the adaptation of these trends in the Western Mediterranean is explained. Next, the structure of ro-ro cargo services in the region is presented. Finally, some global trends in the transport sector that may affect the development of maritime flows are described.

Maritime connectivity.

This chapter aims to address the concept of maritime connectivity and its dimensions, as well as the actors involved and the complexity of some of its associated processes.

It describes the meaning of maritime connectivity and the dimensions to be taken into account for its study. Subsequently, the main actors involved in the procedures and activities of maritime connectivity are presented and finally, three of the main procedures that goods must follow are described in a generic way, in order to reflect the importance of coordination between actors to ensure the proper functioning of maritime connectivity.

Quantitative assessment of maritime connectivity in the Western Mediterranean.

This chapter aims to present and analyse a series of indicators and information that help to understand the situation of maritime connectivity, as well as to show a real picture of the existing information and data needs to measure maritime connectivity in the Western Mediterranean through its integrated approach and dimensions.

On the one hand, the main global indicators that can help to provide insight into connectivity in the Western Mediterranean are described, together with their latest results and historical evolution. On the other hand, more specific indicators and information are presented at national

and port level, knowledge of which should help to obtain a more detailed picture of connectivity levels in the region. Along with this presentation, the availability or absence of such data and its potential sources are also specified.

Qualitative assessment of maritime connectivity in the Western Mediterranean.

This chapter aims to complement the quantitative information on maritime connectivity in the Western Mediterranean with a descriptive assessment of connectivity, based on the pluralistic views of actors and professionals linked to the region's maritime and port ecosystems. It also aims to highlight some global trends that should be taken into account for the future of maritime connectivity in the region.

Based on the dimensions of maritime connectivity and its integrated approach, it presents some of the findings that characterise it and identifies the barriers that hinder its development. The implications for maritime connectivity of some global transport trends that may affect it are then described, and some considerations to be taken into account for its development are pointed out.

Conclusions, recommendations and lines of action.

This last chapter brings together the most salient ideas presented in the previous chapters on the different issues addressed throughout the diagnostic:

- the overview of maritime connectivity;
- the existing quantitative information;
- the dimensions of maritime connectivity; and,
- the major global trends that may affect it

Based on this compilation of ideas, a series of recommendations are briefly presented to improve maritime connectivity in the Western Mediterranean in the different topics addressed. From these recommendations, some more concrete action lines emerge, which may be of interest to the actors involved.

2 Maritime flows of general cargo in the Western Mediterranean

The Western Mediterranean is a complex space in terms of maritime connections and flows of general cargo transport. Far from being a closed maritime transport system, the Mediterranean as a whole is a place where different kinds of connections and traffic converge to provide for internal connections between Mediterranean ports and with ports on other continents. Moreover, because of its position at the junction of different intercontinental routes, the Mediterranean Sea has become a maritime transit area for goods whose origin and destination are outside the Mediterranean.

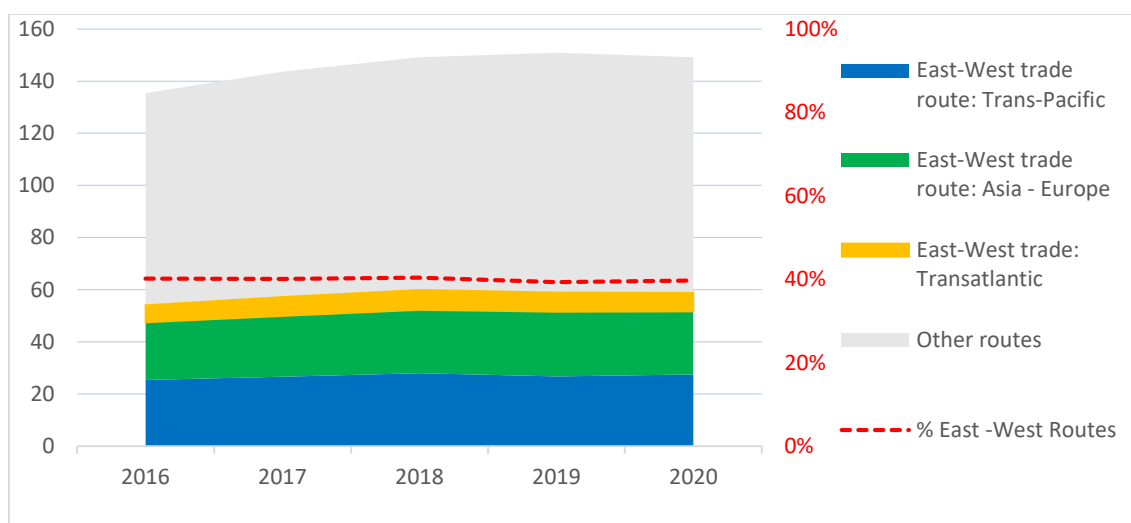
The following points aim to provide a synthetic overview of the structure of maritime transport in the Western Mediterranean for general cargo, taking into account container and Ro-Ro cargo, as a first step towards understanding the status and trends in maritime connectivity in the Western Mediterranean.

To achieve this goal, the first section of this chapter presents the main characteristics of global container shipping and the transformations that have affected these kinds of flows in recent years. This is followed by an explanation of how these characteristics and transformations have materialized in the Western Mediterranean. The third section describes the characteristics of general Ro-Ro cargo services in the GTMO 5+5 countries (Group of Transport Ministers for the Western Mediterranean). These three sections show how the Western Mediterranean has been set up as a place where different kinds of maritime flows of general cargo converge. Instead of treating each kind separately, these flows should be treated as interrelated parts. Finally, the last section presents some global trends in the transport sector that may affect the development of maritime flows.

2.1 The global general cargo container transport system

The configuration of the myriad maritime connections in the Western Mediterranean cannot be separated from the structure of the shipping industry at global level or, in particular, the structure of container transport. There can be no doubt about the importance this type of transport has acquired in international trade in recent decades, especially in connections between major production and consumption centres at world level. Their importance is reflected in the existence of major container shipping routes between production and consumption centres. These routes are classified as transoceanic. They include the set of east-west routes linking Asia, North America and Europe, which have accounted for nearly 40% of total world TEU flows in recent years (Figure 1). They are transpacific routes that link Asia and the West Coast of North America, the route between Asia and Europe with almost obligatory passage through the Mediterranean, and the transatlantic route between Europe and the East Coast of North America. Specifically, in 2020, these routes handled 27.5, 24.1 and 8 million TEU, respectively (UNCTAD, 2021). Besides these transoceanic routes, north-south flows and regional flows covering destinations closer to each other are also important.

Figure 1. Container cargo by main route and percentage of east-west routes (both directions) in the 2016-2020 total. Million TEU



Source: Prepared by CETMO based on UNCTAD 2021

These major transoceanic routes link the main ports and are operated by vessels with a large cargo capacity. They make limited calls along their route and, in addition to loading and unloading containers, they also carry out transit operations, i.e. transshipment of part of their container cargo either to relay vessels in the intercontinental flow or to smaller vessels that redistribute or are loaded with containers in import-export movements through a denser network of ports. This is what is known as the hub-and-spoke system.

Accordingly, there are two kinds of ports based on the role they play in the container transport system: hub ports, where transit operations are the most common, and gateway ports, where unloading and loading of import and export containers to and from the hinterland are the most common. Some ports clearly focus on one of the two roles, but it is also common to find ports that perform both roles. Hub ports are characterized by their capacity to handle large vessels and large quantities of containers, and their tendency to have few links with their hinterland. Gateway ports focus on serving their hinterland. In many cases, these gateway ports have the infrastructure and capacity to receive ships and handle containers like those of hub ports. In some cases, this also allows them to partially perform this role. In other cases, these ports have limited infrastructure and container handling capacity and therefore lack the conditions required to perform hub functions. These limitations in handling capacity prevent ports in this category from being able to even partially perform the role of hub port or simply to accommodate the large vessels that cover transoceanic routes.

Classification as a hub or gateway port, and the relative importance of hub or gateway roles in different ports is associated with the geographic position of the ports in relation to the main maritime routes mentioned above. The main routes linking the Asian continent with North America and Europe, as well as the route linking these two regions, are set up in such a way as to minimize the distances travelled by ships. These routes have geographic points they must pass through, such as the Strait of Malacca, the Suez Canal, the Strait of Gibraltar and, to a lesser extent, the Panama Canal. Hub port facilities are therefore located along these routes and geographic points to handle container transit. As the distance of these routes increases, hubs become less important in favour of gateway ports, though this is not a strict correlation. As indicated above, the capacity to handle ships and large volumes of containers is a necessary condition for a hub. Ports located in the vicinity of the major routes that do not have these capacities perform only operations linked to services for their hinterland.

In recent years, there has been a trend in the container shipping industry towards vertical and horizontal business integration. In other words, shipping companies have moved into business concentration and the creation of a very limited number of major alliances. At the same time, they are increasing their shareholdings in infrastructure and services on land, such as port terminals, and logistics and rail services. In conjunction with this process, the size and capacity of vessels, terminals and equipment have steadily increased with the aim of maximizing economies of scale, a phenomenon now known as gigantism. For example, today's mega-ships have a capacity of between 20,000 and 24,000 TEU. The result is a tendency to increase the concentration of port calls, which are now fewer in number, thus creating significant workload peaks in certain ports. This process of concentration and gigantism is evident from the fact that the average TEU capacity of container vessels increased by 36.3% between 2014 and 2019 (UNCTAD, 2019). Between the same dates, scheduled services offered by alliance member operators increased from 29.8% to 62.6% (UNCTAD, 2019). When considering the major east-west trade routes, the percentage of TEU moved by the three existing major alliances² stands at 86.6% on the transpacific route, 91.5% on the transatlantic route and 98.9% on the Asia-Europe route (UNCTAD, 2019). Moreover, four of the top ten container terminal operators are directly related to or a subsidiary of one of the major shipping companies. These four terminal operators handled 32.9% of all containers processed in ports worldwide in 2018 (UNCTAD, 2019).

Starting in the second half of 2020, in the context of the changes brought about by the pandemic, container shipping rates have increased significantly. The causes of these increases appear to be uneven economic and consumer recovery after the lockdown in spring 2020, imbalance between imports and exports in different parts of the world and the consequent lack of replaced containers, the slowdown in goods movement through ports due to health measures, and the virtually oligopolistic situation among shipping companies. Based on the SCFI³, global container shipping rates increased by a factor of five from summer 2020 to January 2022. If this increasing of rates was sudden and surprising, so was the drop of container rates in the second half on 2022. Taking into account the values of the SCFI, the global container shipping rates at the end of 2022 were similar to pre-COVID-19 situation. Improvement of supply chains, lower port congestion and a weakening demand explain the drop of rates. In any case, both the sudden rise and fall of rates are indicative of the volatility and uncertainty maritime transport is subjected to.

This dizzying increase in freight rates between 2020 and 2022, may have had major repercussions on the organization of maritime transport. It is first necessary to point out the immense profits made by shipping companies, which they seem to be using to consolidate their vertical integration through the purchase of port terminal, logistics and land transport operators. The increase in freight rates had made import and export options more difficult, thus altering the configuration of trade flows between countries. The restructuring of logistics chains in pursuit of closer production centres and more reliable transport services may also be a response to this situation (UNCTAD, 2019, Hoffmann, 2022 and ITF, 2022). The sudden drop of rates has as a response the reduction of capacity by shipping companies, whose consequences are still to be seen.

The future of container transport, like that of the entire maritime industry, also involves considering the environmental factors. The effects of the direct impact of climate change on infrastructure must be taken into account, as well as more pressing issues of the new restrictions on emissions adopted by the International Maritime Organisation (IMO) in April 2019 and June 2021, and implementation of the Fit for 55 legislative package in the European Union (EU), which

² The three major alliances are: 2M Alliance, Ocean Alliance and The Alliance

³ Shanghai Containerized Freight Index. Index used as a benchmark for assessment of container freight rates.

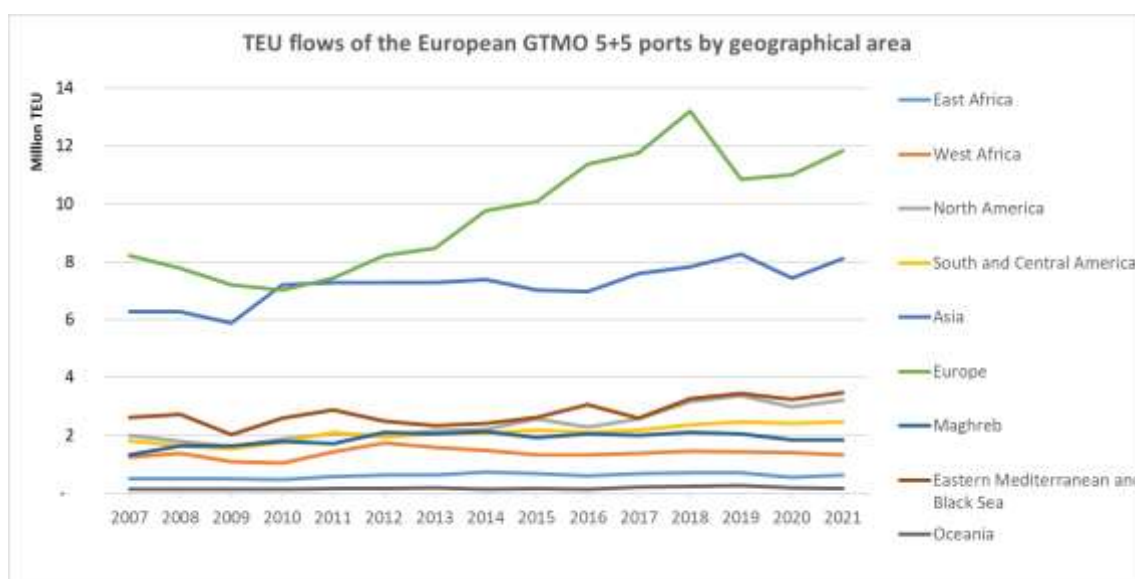
is still under discussion. Their implementation will require transformation of the shipping fleet and ports to adapt to new fuels and energy sources. How this transformation takes place, its speed, the uneven geographical development of this process and the distribution of costs among the different stakeholders will be key parts of the future evolution of global container transport.

2.2 General cargo container transport in the Western Mediterranean

Container flows in the Western Mediterranean are certainly affected by the global characteristics and trends described in the previous section. These flows include different types of traffic in terms of their origin/destination and handling of these flows at ports (transit or import/export)⁴.

Considering the origin and destination of goods, some flows can be classified as regional flows, including flows with Europe, the Maghreb and the Eastern Mediterranean. In 2021, the volumes of these flows in the European ports of the GTMO 5+5 countries stood at 11.9, 1.9 and 3.5 million TEU, respectively, and accounted for 51.8% of total TEU handled in these countries that year. Transoceanic flows, including flows to and from Asia, stood out with nearly 8.1 million TEU. These transoceanic flows jointly accounted for 48.2% of total TEU handled in European ports in the Western Mediterranean.

Figure 2. TEU flows from European GTMO 5+5 ports by geographic area



Source: Prepared by CETMO based on Eurostat.

Besides the range of flows based on geographic origin and destination, there is also the distinction between hub ports and gateway ports. As mentioned in the previous section, some ports operate almost exclusively as hub ports and are located very close to the main route that crosses the Mediterranean from East to West⁵, such as Marsaxlokk, Gioia Tauro, Algeciras and Tanger-Med, the latter being the only port with these characteristics in the Maghreb. Other ports, such as Barcelona, Marseille, Genoa, La Spezia and Livorno, are located farther away from

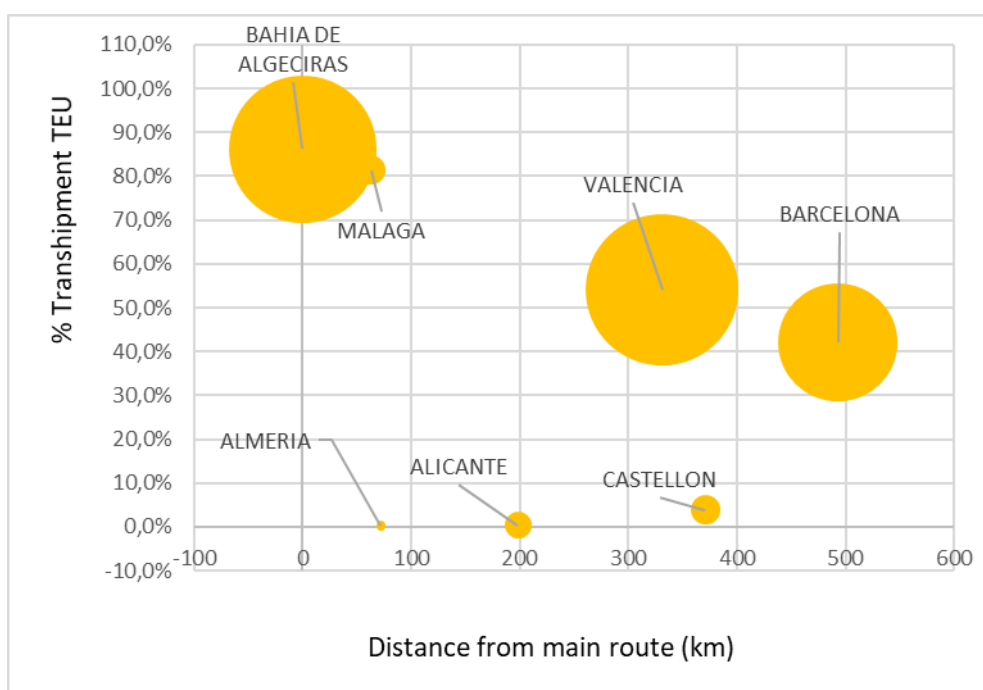
⁴ Flows that pass through the Western Mediterranean without calling at the ports in this region should also be taken into account.

⁵ In the Western Mediterranean, this route comes from the Suez Canal and goes to Malta, the Strait of Sicily and runs parallel to the Maghreb coast to the Strait of Gibraltar. From there, it goes to the ports in Northern Europe.

the main route, operate mainly as gateway ports, though not exclusively, and have the capacity to handle large ships and container volumes. Valencia is considered a clear example of the combination of hub and gateway roles. Finally, there is a group of ports that operate predominantly as gateway ports, because they have less capacity in terms of infrastructure to handle ships and goods, or very limited or specialized hinterlands. Nearly all the ports in the Maghreb, except for Tanger-Med, could be placed in this last category.

For example, this structure can be seen in the distribution of container flows in the Spanish ports on the Mediterranean. Located a short distance from the main container ship route, Bahía de Algeciras records a transit rate of nearly 90%. This percentage decreases as the distance from the main route increases, as in the cases of the ports of Valencia and Barcelona. Besides these large ports, there are smaller ports with much lower operating volumes than the three main ports.

Figure 3. Spanish ports on the Mediterranean coast according to their distance from the main container route, their volume in TEU and percentage of transit. 2020



Source: Prepared by CETMO based on Puertos del Estado (Spain)

As indicated above, in some cases, a port is almost exclusively a hub or gateway port, whereas, in other cases, especially in large ports, the port can operate as a combination of hub and gateway. This combination tends to result in an increase in the port's maritime connectivity. Operating as a hub port increases the possibility of attracting transoceanic and intra-Mediterranean connections (through a network of feeder services), as well as the port's status as an import/export facility in its hinterland. The ports in Maghreb countries, except for Tanger-Med, operate exclusively as gateway ports, and do not have the capacity to receive vessels that sail on major transoceanic routes. Intercontinental imports and exports of container cargo require transshipment operations, usually at ports on the northern shore of the Western Mediterranean.

The process of concentration and gigantism in the global maritime industry has also had an impact on the Western Mediterranean, and has played a key role in the transformations that have taken place in container shipping in the wake of the Covid-19 pandemic. The importance of the major shipping alliances in the Western Mediterranean was a fact before the pandemic

began. This was evident from the very high share of these alliances in flows between Europe and Asia, as noted in the previous section.

Major alliances are relevant for horizontal concentration in container maritime flows, but also for the process of vertical integration. By 2017, the major alliances held a share in 32 container terminals, which represented 58% of the total container handling space at ports on both shores of the Western Mediterranean. This percentage increased to 76% for terminals of more than 40 ha (Selfa and Santandreu, 2019). More and more infrastructure and services, especially in the European GTMO 5+5 countries, including container terminals, logistics spaces and land transport companies such as railways and urban distribution companies, have some level of participation in their shareholding from the major shipping lines and their subsidiaries.

This business structure, in line with general descriptions of gigantism in global container shipping, has been accompanied by a concentration of flows at ports with greater vessel and container handling capacities. There is a tendency for container flows to be concentrated in a small number of ports, such as Algeciras Valencia, Barcelona, Marseille, Genoa and Gioia Tauro. In 2007, these six ports accounted for 45.5% of total container flows of the European GTMO 5+5 countries. By 2019, this percentage had increased to 53.2%. This small group of ports has the capacity to manage transoceanic flows and can operate as major redistribution centres on a regional and intercontinental scale, whereas many smaller ports, such as Maghreb ports, rely on feeder services to guarantee their container flows. Tanger-Med is the only port in the Maghreb comparable to the main ports in the European countries of the GTMO 5+5 in terms of the technical characteristics of its terminals and its shareholding structure. Connecting Maghreb ports, except for Tanger-Med, with transoceanic flows involves offering container transit services, which are generally provided in ports located on the northern shore of the Western Mediterranean. The ongoing process of port concentration linked to the organization of transoceanic routes, which implies fewer calls, a reduction in call frequency and more frequent peaks of congestion, is therefore expected to have an impact on the organization of maritime services between European and Maghreb ports.

The impact of the Covid-19 pandemic on container flows in the Western Mediterranean has broadly mirrored the impact on the global container shipping industry. However, some details describe the specific processes arising from the crisis in this sector in the Mediterranean area. During the height of the pandemic and in subsequent months, supply restrictions were caused by the major shipping lines. This has had two consequences. First, there has been a drop in services and they have become more concentrated, as evidenced by increases in relative weights at the main ports. As mentioned above, the top six ports on the European shore of the Western Mediterranean accounted for 53.2% of these services in 2019 and 54.8% in 2021, taking as reference the statistics from Eurostat. As reflected in the SCFI, there has also been a significant increase in freight rates for the Shanghai-Mediterranean link, which increased sevenfold between summer 2020 and January 2022 (Hoffmann, 2022). A more specific view of the Western Mediterranean is provided by the Valencia Containerized Freight Index (VCFI)⁶, which provides information on the evolution of freight rates from the Port of Valencia to different geographic areas. In the Western Mediterranean, freight rates in the Port of Valencia increased by 145.7% from November 2020 to August 2022. Nevertheless, the Mediterranean area has also been affected by the drop in container freight rate, but at minor extend than the global rates. So, taking again the VCFI, the values of this index fall from august to November an equivalent of 15,7%. When considering the VCFI specific for the Western Mediterranean, the reduction is limited to 12,7% between August and November.

⁶ <https://www.valenciaport.com/valencia-containerised-freight-index/>

As a recent publication of ITF states, these post-pandemic changes, the drop in supply and increase in freight rates, seem to be linked to the dominance of the major alliances in global container shipping. Operating as an oligopoly, these alliances have acquired a position that enables them to shift some of the transport capacity from the routes connecting Europe with America and Asia to the transpacific route, which experienced increased demand and congestion at its main ports. They can fix the freight rates in the same way. Therefore, any discontinuations in the global container transport network are felt the Western Mediterranean region (ITF, 2022).

The other factor affecting the organization of container transport in the Mediterranean is the environmental issues. Besides the decarbonization and emission-reduction requirements arising from IMO regulations and the set of regulations issued by the European Union, the Mediterranean will soon be designated an emission control area for sulphur oxides and particulate matter. How this affects maritime transport is explained below (see section 2.5).

2.3 Ro-Ro cargo services in general cargo transport in the Western Mediterranean

Along with container services, Ro-Ro cargo services are the other service that contributes to the movement of general cargo flows in the Western Mediterranean. Without counting services for the transport of vehicles as goods, Ro-Ro cargo services focus on short routes, which implies connections almost exclusively with other Mediterranean countries and immediately adjacent areas. In other words, in addition to services aimed at linking the different islands with their national mainland locations, Ro-Ro cargo services are basically provided in connections between countries on the northern shore, as well as between the northern and southern shores of the Western Mediterranean. These are usually direct connections between two ports, although a smaller number of services make several intermediate calls.

There are two kinds of services in flows of Ro-Ro cargo in the Western Mediterranean. Ro-Ro services, in which only goods are transported, and Ro-Pax services, in which goods, passengers and their vehicles are transported. Ro-Pax services are mixed services for connections in which the volume of goods does not make it economically viable to operate dedicated freight lines.

In terms of geography, Ro-Ro cargo services can be classified in two categories, not counting services for connections between the mainland and islands. On the one hand, there are services linking ports in European countries in the Western Mediterranean and on the other, services linking ports in European countries with ports in the Maghreb, and services between ports in Maghreb countries.

This geographic distinction has a significant impact on operation of these services. Services between European countries benefit from the fact that, as Member States of the European Union, the formalities linked to goods movement through ports are reduced by eliminating customs and sanitary controls, which is not the case for flows between the two shores or between Maghreb countries. Flows between EU countries also benefit from the different policies to promote short-sea shipping and especially the Motorways of the Sea (MoS), as the maritime component of the TEN-T. This has contributed to the creation and maintenance of high-quality, reliable services between European countries, particularly between the east coast of Spain (Valencia and Barcelona) and the centre of Italy (Livorno and Civitavecchia).

In connections with the Maghreb, in first place are flows established around the Strait of Gibraltar between the Port of Algeciras and Tanger-Med. It is, without question, the most commonly used route for flows between the two shores, with around half a million Ro-Ro units per year. All other connections are well below this figure. Other connections with Morocco leave from Sète, Marseille and Genoa. Tunis, more specifically the Port of Radès, is connected to

Genoa, Marseille and Barcelona. Flows with Algeria are established from different Spanish ports, such as Almería, Alicante and Valencia, and from Marseille.

The business structure of Ro-Ro cargo services in the Western Mediterranean has changed considerably in recent decades. This transformation has mainly involved the privatization or abolition of state-owned shipping companies and increased presence of the private sector. At the same time, the sector has not been immune to company mergers and integration between companies, fact that does not exclude the emergence of new stakeholders. In relation to means, i.e. the kinds of vessels used and their characteristics, changes have also been made, driven by the challenge of sustainability. The trend towards larger vessels, as in the case of container ships, is reflected in Ro-Ro ships with larger cargo capacities in pursuit of energy efficiency, while incorporating new fuels for propulsion and technologies to reduce emissions while at sea or in port stays.

2.4 Diversity and interdependence of general cargo flows in the Western Mediterranean

As discussed in the previous sections, the Western Mediterranean maritime region handles a wide range of general cargo flows. This diversity responds to the kind of handling (i.e. containerized or Ro-Ro cargo), the origin-destination of the goods (transoceanic or intra-Mediterranean route) and the type of operation carried out on the goods at ports (e.g. transit or import-export operations). Far from being set up as independent and closed flows, the range of flows resulting from the combination of the characteristics mentioned above are structured as interrelated structures.

Currently, the organization of different services has converted the transit role into a key part of the organization of container distribution between routes and ports. One of the specific features of the Western Mediterranean is the fact that the transoceanic connections of almost all Maghreb ports require a transit movement, which generally takes place at the northern GTMO 5+5 ports. Ro-Ro cargo flows can be considered almost exclusively import/export flows and therefore do not compete with container import/export flows. The lack of competition between these modes could be explained by the different kinds of goods, their characteristics and needs. However, changes in the conditions of container services (higher freight rates, fewer port calls and longer crossing times), as has occurred in recent years, have transformed the conditions of competition between these means and led to redistribution of containerized and Ro-Ro cargo and, consequently, the reorganization of routes and ports.

In conclusion, the different kinds of maritime flows of general cargo in the Western Mediterranean should be considered together while taking into account the different connections between them, as well as with the infrastructure and means used for handling and transport. At the same time, organizing these flows should be considered dynamic over time, especially during a profound transformation that is now affecting the patterns of goods distribution and the structuring of transport services, infrastructure and means.

2.5 Trends affecting the development of maritime flows

In addition to maritime transport specific features, it is also affected by the constant evolution of the transport sector, which determines how it works in the short, medium and long term.

There are major global trends that represent both a challenge and an opportunity for maritime flows in the Western Mediterranean. These trends mainly involve:

- Sustainability and energy transition
- Digital transformation
- Relocation and regionalization processes
- Resilience to disruption

Sustainability and energy transition

In the coming years, the transport sector will face the global challenge of improving its environmental sustainability. In the maritime industry, this challenge involves limiting pollutant emissions and embracing the energy transition towards alternative fuels that are more environmentally friendly.

Harmonised systems for calculating emissions are therefore necessary to enable the homogenous definition and comparison of emission values. In this respect, the Global Logistics Emissions Council (GLEC) Framework⁷ represents a globally recognised methodology for harmonised calculation and reporting of the logistics greenhouse gas (GHG) footprint across the multimodal supply chain. In addition, ISO 14083, concerning the quantification and reporting of GHG emissions arising from transport chain operations, should be published during 2023. Application of these calculation methodologies may have an impact on the use of different transport alternatives in Mediterranean trade.

At global level, the scope for reducing GHG emissions is set by the International Maritime Organization (IMO), which adopted the *“Initial IMO Strategy on Reduction of GHG Emissions from Ships”* in 2018. The most ambitious objectives of this strategy include a 50% reduction of GHG emissions by 2050 compared to 2008 levels and a 40% reduction of CO₂ emissions from maritime transport by 2030 compared to 2008 levels. Since the adoption of the strategy, the IMO’s Marine Environment Protection Committee (MEPC) have held sessions focused on discussing short, medium and long-term measures to meet its goals⁸.

One of the measures with the most impact on the Mediterranean is the agreement reached at the 78th session of the MEPC (10 June 2022) to designate the Mediterranean Sea as an Emission Control Area for Sulphur Oxides and particulate matter (Med SOx ECA). This agreement was adopted at the 79th session of the MEPC (12-16 December 2022) and will be binding for ships as from 2025. This measure will mean that ships sailing in the Mediterranean Sea will have to comply with a maximum fuel sulphur content limit of 0.1% mass per mass (m/m), which is equivalent to one fifth of the limit outside emission control areas (ECA) (0.5% m/m).

Sustainability and energy transition requirements in the maritime sector in the Western Mediterranean are also defined by decisions taken at European Union level. In fact, in 2019, the European Commission (EC) launched the European Green Pact⁹, a set of policy initiatives designed to achieve EU climate neutrality by 2050. Although this legislation is binding on EU countries, it also has implications for neighbouring countries.

⁷ Smart Freight Centre (2019). Global Logistics Emissions Council Framework for Logistics Emissions Accounting and Reporting. (2019). ISBN 978-90-82-68790-3.

⁸ Minutes of the sessions of the IMO MEPC and its working groups:
<https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MEPC-Default.aspx>

⁹ EUROPEAN COMMISSION, COM (2019) 640 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. *The European Green Pact*. Brussels, 11 December 2019.

Among these initiatives is the Fit for 55 package¹⁰, which includes a set of proposals to align EU legislation with EU targets in the areas of climate, energy and transport and reduce net emissions by at least 55% by 2030 compared to 1990 levels. For maritime transport, it aims to promote the use of more sustainable alternative fuels and, for ships at berth in port, connections to the onshore power grid and the generation of electricity using emission-free technology. The Fit for 55 package is pending discussion between the Council and the European Parliament to adopt the final proposals¹¹.

One of the key decisions in the promotion of alternative fuels involves identifying the fuels that should lead the energy transition. There is currently no clear consensus on this issue, and the choice of fuel depends on a number of factors, including cost, global availability, environmental impact, infrastructure and technology availability. Potential alternative fuels include liquefied natural gas (LNG), hydrogen and biofuels.

The trend towards greater sustainability in transport will ultimately have implications for maritime transport. Reducing emissions globally will continue to have implications for ships (engines, technology), fuels (refuelling) and port requirements (electrification).

Differences between Mediterranean countries with respect to these requirements can lead to technological gaps and conditioning factors that affect how maritime transport works as well as the definition of future maritime flows.

Digital transformation

Digital transformation is the process of improving efficiency by integrating technology (Accenture, Digital Transformation). Digital transformation has a long way to go in the maritime ecosystem. With technologies¹² such as big data, artificial intelligence and digital twins, it is possible to automate processes, increase operation transparency and visibility, streamline transactions and bureaucratic procedures and make them more reliable, connect with different players in the logistics chain through platforms and improve decision-making, to name just a few of the benefits.

Central Maghreb countries are no strangers to digital transformation of transport, which is a key part of the different national administrations responsible for transport management. Interest is specifically focused on its application in port activities through implementation of digital port activity management platforms, as well as initiatives on land such as digitization of transport manifests.

Indeed, one of the first stages of digital transformation of transport, and, by extension, maritime transport, is the digitization of documents. At EU level, there is a commitment to make progress on implementation of this process so that e-documents are mandatory for all public administrations in the transport sector in the EU by 2025, as indicated in the regulation on electronic freight transport information (eFTI)¹³ which is under definition. Digitization of transport documents requires significant work to harmonize concepts and information. In

¹⁰ EUROPEAN COMMISSION, *COM (2021) 550 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. "Fit for 55": delivering the EU's 2030 Climate Target on the way to climate neutrality*. Brussels, 14 July 2021.

¹¹ Follow the timeline for adoption of the Fit for 55 package on the following link:

<https://www.consilium.europa.eu/en/policies/green-deal/timeline-european-green-deal-and-fit-for-55/>

¹² <https://www.cetmo.org/emerging-technologies-transport-logistics/>

¹³ Official Journal of the European Union (2020). Regulation (EU) 2020/1056 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 July 2020 on electronic freight transport information. Brussels, 15 July 2020.

addition to the work done by the EU within the framework of the eFTI regulation, the United Nations Economic Commission for Europe (UNECE) has published a package of standards for digitization of multimodal transport data and document exchange¹⁴ as the basis for operational interoperability of freight data across different modes of transport. Finally, in the maritime field, it is worth highlighting the work carried out by the Digital Container Shipping Association (DCSA), which has developed standards in aspects such as the tracking and tracing of containers or the booking process and the electronic bill of lading (eBL), with the aim of setting the technological foundation for interoperable technological solutions.

Moreover, also within maritime transport, the IMO Facilitation Committee (FAL 46), which met from 9 to 13 May 2022, reached the commitment to make the implementation and use of the maritime single window mandatory for port authorities worldwide, starting on 1 January 2024. Previously, in 2016, the FAL Convention already introduced some amendments referring to the mandatory electronic exchange of information from 2019, considering the use of single window. The maritime single window is a digital platform that helps simplify procedures, documents and other formalities for entry, stay and departure of vessels using electronic data exchange, given that information must be submitted only once. Single windows are subject to security criteria on the authentication, integrity and confidentiality of information exchanges. They started to be implemented in some ports in the 1990s, but this tool is not globally available in all ports. There are varying degrees of implementation of this technology in the Western Mediterranean.

At European level, work is being done in the European maritime single window environment (EMSWe)¹⁵ with the aim of harmonizing data entry procedures and the set of data to be provided at all European national maritime single windows. This will facilitate transmission of information between declarants, competent authorities and port service providers in the different Member States. Final implementation is expected in the second half of 2025 (Savo, 2020).

Port Community Systems (PCS) is another digital platform in operation and under development in some Western Mediterranean ports. In this case, the goal is to facilitate port operations logistics through the secure exchange of information. It therefore optimizes, manages and automates efficient port logistics processes after submitting data only once (as in the case of maritime single windows).

Ongoing digital transformation will make it possible to improve the physical and virtual processes that shape maritime connectivity and make them more efficient. The changes caused by this digital transformation are proving to have enormous potential for change in the way many industries operate. The ability to embrace this digital transformation depends in many cases on the skills of the people operating the sector. Digital transformation must therefore include urgent training.

Relocation and regionalization processes

In the 1980s, some companies in developed countries began to relocate production processes to reduce costs. But this trend has been reversed since the 2000s. Some reasons for this shift included trade wars between countries, strong dependence on Asian value chains, the financial crisis that began in 2008, and the emergence of regional and global disruptions that affected the operations of global value chains.

¹⁴ United Nations Economic Commission for Europe Information Unit (2022). *UNECE publishes a package of important standards for the digitalization of multimodal transport data and document exchange*. UNECE. 11 February 2022. Available at: <https://unece.org/media/press/365096>

¹⁵ Official Journal of the European Union (2019). Regulation (EU) 2019/1239 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 establishing a European Maritime Single Window environment and repealing Directive 2010/65/EU. Brussels, 25 July 2019.

Not only did this relocation of companies stop, but new relocation and regionalization processes began in which some companies took production back to their country of origin or to countries closer to these countries. One of the main drivers of this change in approach was the Covid-19 pandemic and a series of subsequent phenomena resulting from the impact of the pandemic itself, especially on ports and maritime transport, which revealed the fragility and unreliability of global transport chains in the event of major disruptions. For example, between 2020 and 2021, there was a reduction in shares of East Asian exports in the clothing and accessories sector. When this is studied along with shares of European imports, they reveal the relocation process back to Europe and the Mediterranean (ITF, 2022).

Instead of relocation, in other cases, there has been diversification of suppliers in the search for alternatives closer to company headquarters and shifting production from Eastern Asia to Eastern Europe, Morocco and Turkey (Torrent et Roman, 2022).

This trend may lead to a shift from trans-oceanic flows to intra-Mediterranean flows, which should be exploited to increase Mediterranean maritime connectivity, as well as regional development and integration.

Resilience to disruption

The impact of Covid-19 in 2020 highlighted just how vulnerable society and its activities are to disruptive situations. Transport was no stranger to this situation and its operations were drastically altered. Some effects of this disruption are still present today, such as high freight rates in maritime transport. This has provided a warning to the transport system to get ready for other disruptions in the future.

The effects of climate change are now seen as one of the major disruptors in coming years, as exposed by the Intergovernmental Panel on Climate Change (IPCC). In its Sixth Assessment Report¹⁶, the IPCC highlights the vulnerability of the Mediterranean region to intensifying climate change in the region over the 21st century, with air and sea temperatures rising 20% faster than the global average. It also identifies the region as a hotspot of climate risks due to its high vulnerability and the combination of climate hazards to which it may be exposed (e.g. more intense heat waves, lower but more extreme rainfall, draughts).

At European level, the new EU climate change adaptation strategy¹⁷ points out the lack of preparedness for the intensity and frequency of climate change impacts and calls for the development of collective action on adaptation. This risk and adaptation also includes the impact on transport infrastructure and services.

More specifically for maritime transport infrastructure and services, these impacts can include port flooding and the deterioration and failure of maritime infrastructure due to rising sea levels, heavy rainfall, thunderstorms and even hurricanes, which have been rare in the Mediterranean until now (Rodrigue, 2020).

Mediterranean countries must adapt to the impacts of climate change, including rising sea levels and more frequent extreme weather events affecting ports. There is a need to invest in risk management and emergency preparedness and response that goes beyond pandemic measures. Preparing the maritime supply chain for the future and managing risks requires greater visibility of door-to-door transport operations (Hoffmann, 2021).

¹⁶ IPCC Sixth Assessment Report, Working Group II. *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Cross-Chapter Paper 4. Mediterranean Region

¹⁷ COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. COM(2021) 82 final.

3 Maritime connectivity

This chapter aims to provide a description of maritime connectivity in the Western Mediterranean. This description is based on deciding on a definition of maritime connectivity and its dimensions, which include the network of maritime connections between ports, goods movement through ports and connections with the hinterland.

The following sections aim to show the complexity of the processes linked to maritime connectivity by defining the main stakeholders involved and some of their relationships. Thus, the second section presents these stakeholders and the third section presents some of the most relevant processes of maritime connectivity.

3.1 Definition of maritime connectivity

A synthetic definition of connectivity, as provided by Rodrigue (2020), refers to the ability of a node to use a network in order to access, connect to or reach another node. This definition of connectivity implies a relational conception of connectivity, since the connectivity of a node can only be conceived, and therefore measured, in relation to other nodes. For Rodrigue, the study of connectivity can be based on the three kinds of effects it generates. First, its economic effects are related to interactions between economic stakeholders such as producers, distributors and consumers. A second set of effects on the transport network address the configuration of transport services and infrastructure capacity. Thirdly, there are spatial consequences arising from the effects that a region (such as a metropolitan area or hinterland) and connectivity can have on each other, which is also open to political intervention.

A similar definition is offered by Arvis et al. (2019) in which connectivity refers to the structure, scope and efficiency of global service networks that provide access to markets and opportunities. These authors also point out that this concept was recently identified as a key factor for business competitiveness and economic growth. Global networks thus imply great complexity, since they have to consider different spaces, modes of transport, infrastructure, types of services and regulatory agencies, as well as the different flows that occur of merchandise, information or finance. Three dimensions are considered when analysing maritime connectivity, i.e. global networks that include a maritime transport link in one of their sections:

- The network of maritime connections between ports, which refers to organization of the maritime route and therefore takes into account the type of cargo handling, route, type of vessel, speed, calls and frequency, among other factors.
- Goods movement through ports, understood as the efficiency of ports at moving goods, considering the different processes involved in handling vessels in the port area, cargo loading and unloading, as well as the different administrative procedures and formalities required.
- Connections with the hinterland, i.e. physical connections and modes of transport that provide for connections between the port and its surrounding area, regardless of size, as well as the connections established with stakeholders located in this area.

These three dimensions are considered relevant for this study and provide the structure for the quantitative analysis of maritime connectivity in the Western Mediterranean, the qualitative vision and the conclusions.

3.2 Maritime connectivity stakeholders

Bearing in mind the three dimensions described above, maritime connectivity has traditionally been known for the many stakeholders involved in related procedures and activities. These stakeholders sometimes overlap and share roles and responsibilities. This fact often adds complexity to the understanding of how the transport system operates because it is difficult to get a clear picture of the chain of stakeholders involved.

Such multiplicity and overlapping of stakeholders are also represented in the various reference glossaries on port and shipping terminology identified by the IMO¹⁸, because it is not possible to find a glossary that provides detailed coverage of all the stakeholders involved. Nevertheless, it is necessary to list the main stakeholders involved in maritime connectivity in order to gain a clearer view of the chain of stakeholders. The following is therefore a compilation of the definitions of the main stakeholders involved¹⁹:

- Carrier: Any person or entity who, in a contract of carriage, undertakes to perform or to procure the performance of carriage by rail, road, sea, air, inland waterway or by a combination of such modes.
- Consignee: A person or company to whom commodities are shipped.
- Consignor: A person or company shown on the bill of lading as the shipper.
- Customhouse Broker: A person or firm, licensed by the treasury department of their country when required, engaged in entering and clearing goods through Customs for a client (importer).
- Customs: Government agency charged with enforcing the rules passed to protect the country's import and export revenues.
- Freight Forwarder: A person whose business is to act as an agent on behalf of the shipper. A freight forwarder frequently makes the booking reservation.
- Inland Carrier: A transportation line that hauls export or import traffic between ports and inland points.
- Port Authority: The official organization that controls and manages the activities in a port.
- Shipper: The person or company who is usually the supplier or owner of commodities shipped. Also called Consignor.
- Shipowner: a person or company that owns a ship or ships.
- Ship Operator: The company which has been novated the rights of use to a vessel by the Beneficial Owner. Often these rights are transferred by way of putting it into a pool, long term bareboat or leasing contract.
- Shipping agent: The party who represents the owner and/or charterer of the ship (the principal) in port. If so instructed, the agent is responsible to the principal for arranging with the port for a berth, all relevant port and husbandry services, meeting the needs of the master and crew, clearing the ship from port and other authorities (including the preparation and presentation of appropriate documentation) and releasing or receiving the cargo on behalf of the principal.
- Stevedore: Individual or firm that employs longshoremen and who contracts to load or unload the ship.

¹⁸ <https://imo.libguides.com/c.php?g=659460&p=4764783>

¹⁹ Definitions taken from the Convention on Facilitation of International Maritime Traffic (FAL), 1965, as amended, in the framework of the IMO, the *Glossary of Shipping Terms* of the US Department of Transportation, the *Glossary of Port and Shipping Terms* of the Public-Private Infrastructure Advisory Facility (PPIFA) and the *Glossary of Shipping Terms* released by MAERSK.

- Terminal: An assigned area in which goods are prepared for loading into a vessel, train, truck, or airplane or are stacked immediately after discharge from the vessel, train, truck, or airplane.
- First Party Logistics (1PL): A company that handles logistics internally.
- Second Party Logistics (2PL): A company that provides basic domestic and international transport to other companies, e.g. a shipping line.
- Third Party Logistics (3PL): A company that provides logistics services to other companies for some or all of their logistics needs. It typically includes warehousing and transportation services. Most 3PL's also have freight forwarding licenses.
- Fourth Party Logistics (4PL): An integrator that assembles the resources, capabilities and technology of its own organization and other organizations to design, build and run comprehensive supply chain services (Trademark term, Accenture 1996).

Despite these definitions, it must be taken into account that the vertical integration processes currently taking place in the transport sector, as well as the entry of companies from other sectors with their own transport fleets (see Chapter 2), help blur the lines between the roles of specific stakeholders, such as operators of the different modes of transport, port terminal operators, freight forwarders and other intermediary agents as a result of concentration of the transport chain.

3.3 Procedures and formalities involved in maritime connectivity

In import and export processes at ports, the stakeholders involved in maritime connectivity interact with each other in a number of procedures and formalities to allow goods to move from the point of origin to the point of destination through loading and unloading ports.

The focus is on imports because they are more complex and more important in the protection of national financial interests. These goods are mainly subject to the procedures and formalities of unloading, inspection, customs clearance and exit from the port area. The complexity of these flows is reflected in the controls carried out by the different competent authorities. For example, customs authorities carry out safety controls (e.g. ENS and origin and nature of the goods) and inspections of the goods themselves (e.g. sanitary, veterinary, phytosanitary, commercial quality inspections) (Ticó, 2022).

The impact of these procedures and formalities on smooth maritime connectivity is tightly linked to the level of coordination between all stakeholders involved. For example, to visualize the importance of the different stakeholders and their coordination, three of the most relevant procedures for goods are described below: customs clearance of imports, cargo inspections on the wharf, and exit of the goods from the port area by road. In this case, the focus will be on container transport.

The procedures described are presented as examples to provide an overview, with the understanding that these procedures have their own specific features in the countries and ports of the region, and that some of them are also being updated as a result of current digital transformation.

Customs clearance of imports

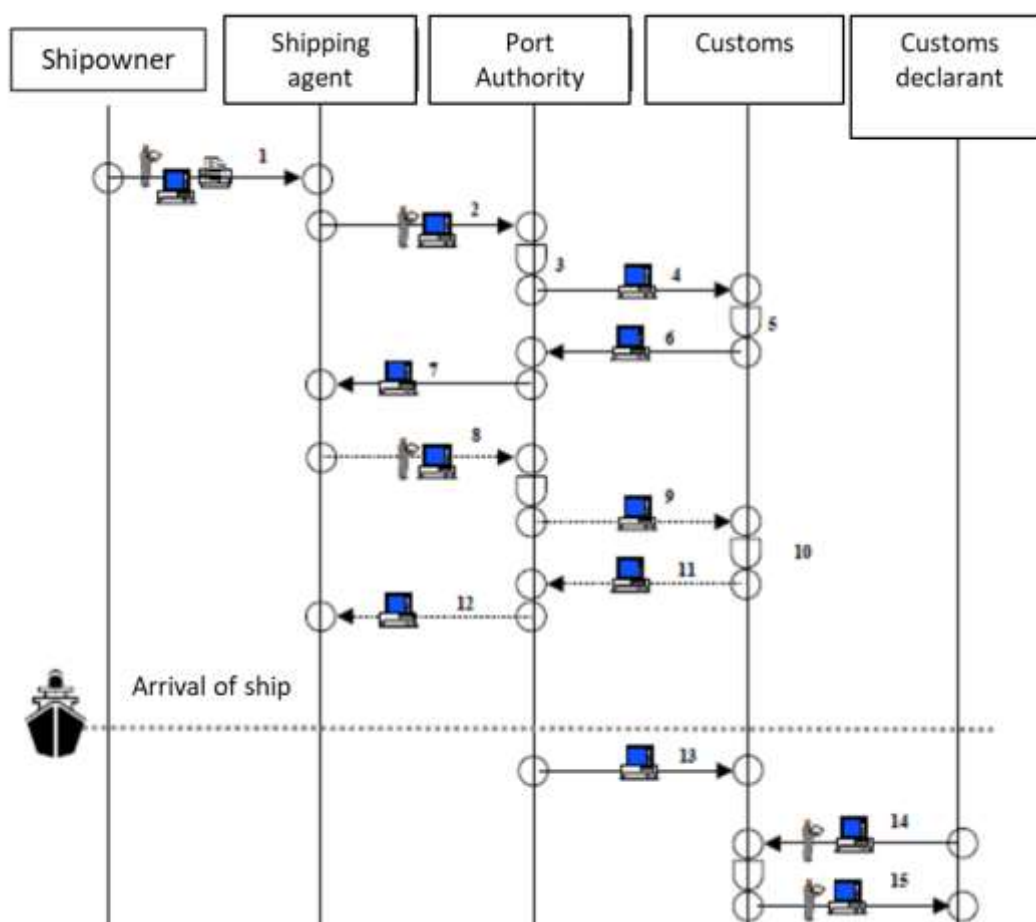
Customs clearance refers to compliance with the customs formalities necessary to allow goods to enter the geographic area of the customs domain. This is one of the formalities necessary to allow goods to leave the port area, provided that they come from a port subject to the jurisdiction of another customs authority or that they are not subject to a special transit procedure.

The customs clearance procedure begins with communication of the goods to be unloaded by the shipowner to the shipping agent, who is responsible for drawing up and sending the simplified customs declaration²⁰ to the port authority.

The simplified customs declaration first passes through the port authority filters and then the customs filters. If there are no changes in the simplified declaration, it is activated and the goods are released to customs.

The customs broker can also independently present the Single Administrative Document (SAD)²¹ with the other documents (e.g. invoice, administrative import authorization, certificates, permits) to customs, so that customs can begin clearance and finally issue the release of the goods²².

Figure 4. Customs clearance procedure



Source: REG-MED, 2004

²⁰ Simplified customs declaration: Declaration of goods that fails to include mandatory information or supporting documents (Spanish Tax Agency).

²¹ The single administrative document (SAD) is a form used for customs declarations in the EU, Switzerland, Norway, Iceland, Turkey, the Republic of North Macedonia and Serbia. The document covers the placement of any goods under any customs procedure such as: export, free circulation, transit, warehouses, temporary admission, inward and outward processing, etc. (DG for Taxation and Customs Union, EC)

²² Release of goods: The action by the Customs to permit goods undergoing clearance to be placed at the disposal of the persons concerned. (World Customs Organization (2018), Glossary of International Customs Terms).

Description of wharf inspection procedures

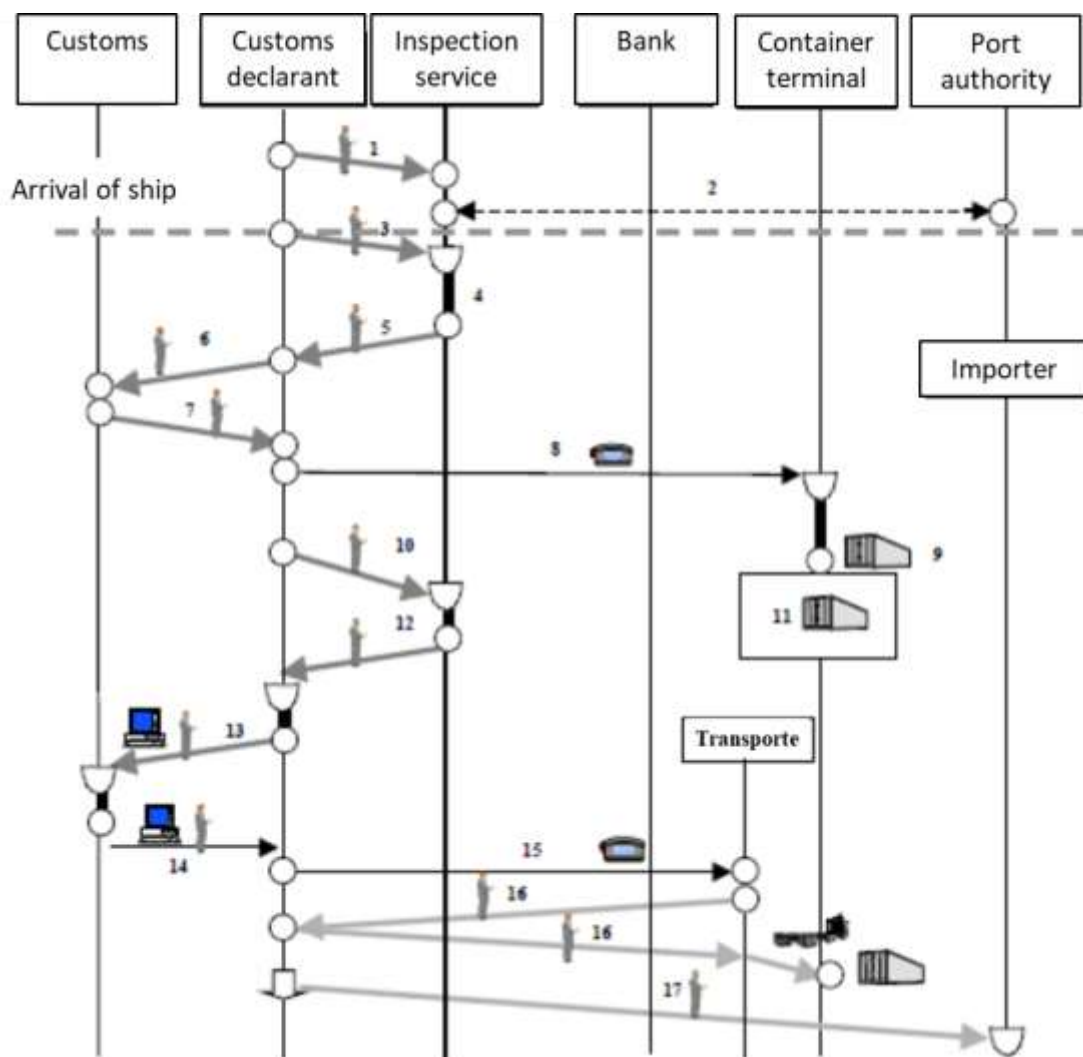
Inspection procedures refer to the physical inspection of goods by customs to ensure that the nature, origin, quantity and value of the goods are consistent with the information provided on the declaration (World Customs Organization, 2018).

Prior to arrival of the goods at the port, the representative of the goods at the customs office must send advance notification to the different inspection services with a detailed description of the goods that may be subject to veterinary and phytosanitary inspection, and also provide a copy of the simplified customs declaration.

Once the goods to be inspected have been identified, the customs broker submits the inspection request and the rest of the documentation to the inspection department. The department carries out the inspection, analyses the samples in the authorized area and issues a certificate to the customs broker. The customs broker can now go to customs with the certificate and clearance documents to clear the goods and obtain their release.

Finally, transport is organized and the documentation is handed over to the stakeholders concerned (hauliers, importers, recipients).

Figure 5. Cargo inspection procedure on wharf



Source: REG-MED, 2004

Departure of goods by road

The departure of goods from the port area represents the interface between goods movement through ports and connections with the hinterland. In this procedure, the goods go from being under the control and supervision of the stakeholders located on the port authority's premises to being the responsibility of the transport operator.

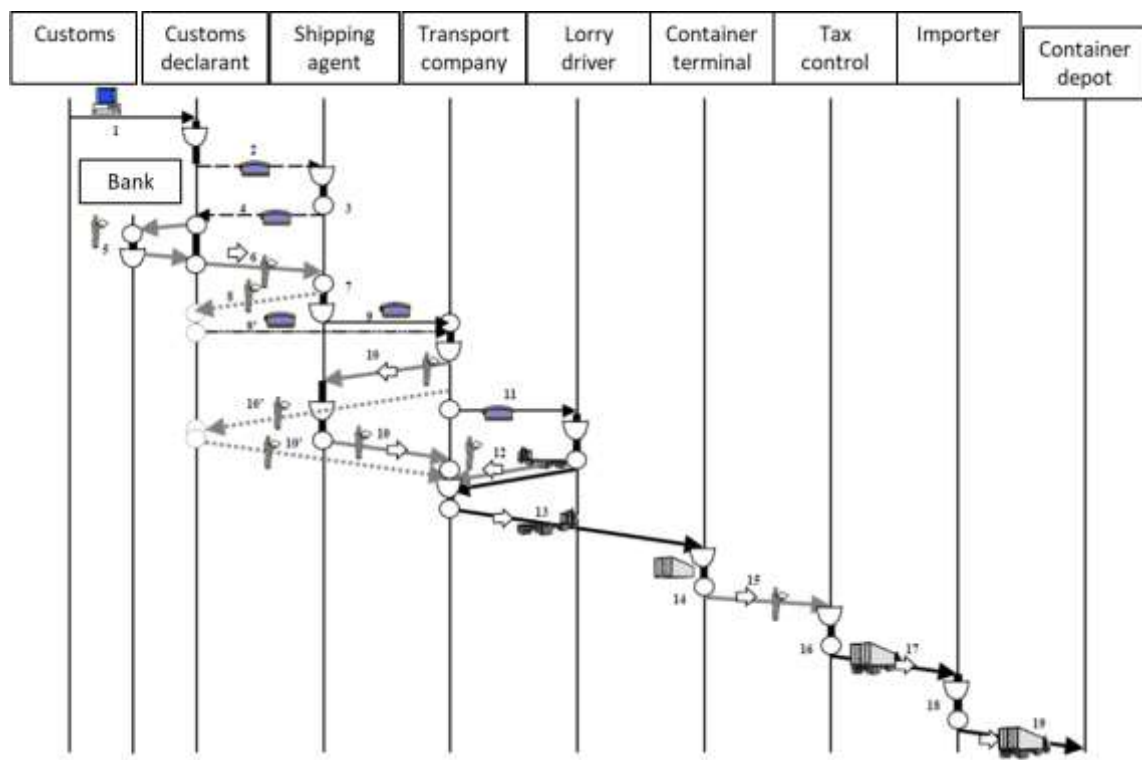
After release of the goods, the customs broker requests the shipping invoice from the shipping agent, who prepares the invoice and communicates the amount due for payment. When the original loading and release document is available, the customs broker must receive the delivery note of the goods from the shipping agent.

If inland transport is carried out by a freight forwarder, the delivery note and instructions for delivery of the goods are handed over to the freight forwarder.

Land transport is organized and all documentation is handed over to the driver from the company responsible for transport. The driver picks up the container and goes to the tax office, where the documents authorizing the goods to leave the customs facility are checked. After verification, the driver receives the departure form, which must be shown at the second checkpoint to leave the port.

Finally, the driver transports the goods to their final destination and, once the container has been emptied, it is stored in the container depot.

Figure 6. Procedure for exit of goods by road



Source: REG-MED, 2004

4 Quantitative assessment of maritime connectivity in the Western Mediterranean

The quantitative assessment of maritime connectivity in the Western Mediterranean presented below is based on the consideration of different indicators accessible to the public. A description of these indicators is given first, followed by a presentation of the specific perspectives they offer in the Western Mediterranean. This should provide an initial view of the status and characteristics of connectivity between the GTMO 5+5 countries, as well as an assessment of the quantitative information available and accessible for analysis. The approach of using indicators and applying them to the Western Mediterranean is organized based on the three factors mentioned in the previous section: networks of maritime connections, goods movement through ports and connections with the hinterland.

4.1 Indicators of maritime connections

The analysis of maritime connections was carried out using two types of indicators: synthetic indicators, which provide a score or assign a rank based on a set of scores, and topological indicators, whose mathematical formulation, calculation and interpretation are based on the analysis of the network topology.

Synthetic connectivity indicators

The United Nations Conference on Trade and Development (UNCTAD) currently publishes a series of indicators in the form of indices that are considered to be the most widespread and widely used for assessment of maritime connections of container services. The first and possibly most widespread is the Liner Shipping Connectivity Index (LSCI). Linked to it is the Port Liner Shipping Connectivity Index (PLSCI). A third index is the Liner Shipping Bilateral Connectivity Index (LSBCI), which assesses connectivity between pairs of countries. The synthesis capacity and long series of years covered by these indices, not to mention how easy they are to access online²³, explain their recurrent use when analysing maritime connectivity linked to regular container lines.

The LSCI provides a relative score for the connectivity of container shipping services in each country, with data from 2004. The index is the result of six weighted components:

- The number of container ships on regular services that arrive at and depart from the country's ports
- Total container capacity (measured in TEU) of container ships on scheduled services that arrive at and depart from the country
- The maximum size container ship (in TEU) that can berth at any of the country's ports
- The total number of container services
- Total number of companies offering regular container services in the country
- The number of countries with which connections are established, an indicator introduced in 2019

As indicated above, based on these six components, UNCTAD also determines the Port Liner Shipping Connectivity Index (PLSCI), which provides a score for connectivity at port level. It has provided data since 2006.

²³ <https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx>

The Liner Shipping Bilateral Connectivity Index (LSBCI) provides an assessment of connectivity between pairs of countries, which involves weighting five components:

- The number of transshipment needed to connect the two countries
- The number of common connections between the two countries
- The number of port-to-port connections between the two countries
- The number of shipping companies operating between the two countries
- The maximum size of vessel (in TEU) used in services between the two countries

It is interesting to note that, based on UNCTAD's LSCI, the Port Authority of Valencia developed its own Port Connectivity Index (ICP). Since 2016, it has measured the connectivity of short sea shipping traffic of containerized goods from Spanish ports²⁴:

Some of the criticisms of these indices, such as those presented by Nierat et al. (2019), include the lack of a geographic breakdown of connectivity by country or port, a failure to consider the importance of connections for trade in each country, and proper interpretation of the annual index variations. In order to correct these deficiencies, these authors propose publishing the value of the index components, and including components that show connectivity in large geographic areas and the monthly frequency of port calls, among other suggestions.

The data for the indices calculated by UNCTAD are provided by a private consultancy firm, which in turn obtains them from registers that are accessible to the public for a fee.

The different maritime connectivity indices developed by UNCTAD focus on container services and therefore do not provide information that makes it possible to regularly assess connectivity linked to other kinds of services, especially Ro-Ro cargo services. This fact becomes important for the present study because of the role that this type of service plays in connections between the two shores of the Western Mediterranean.

However, there have been attempts to provide a theoretical definition of a synthetic index to assess maritime connectivity arising from Ro-Ro cargo services at EU ports, which include the ports of the European GTMO 5+5 countries. De Langue et al. (2016) propose an index in which the Ro-Ro connectivity of ports is assessed based on four components:

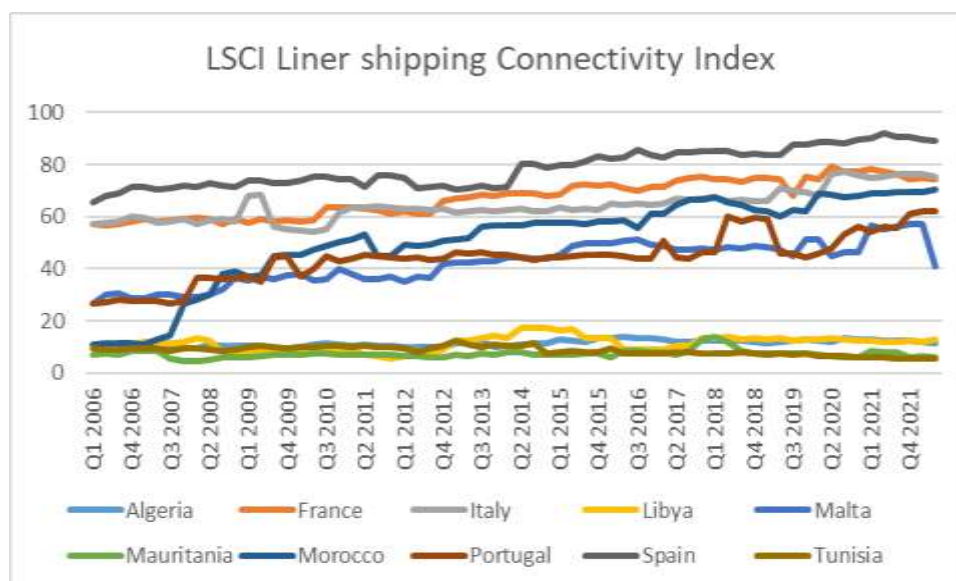
- The number of destinations served with a direct connection
- The number of service providers (shipping companies offering services at a port)
- Frequency of services
- The number of intermediate calls

The results of this index were published for 2014 and no updates have been released in subsequent years. The information for calculating this index is available to the public. It comes from commercial information on existing regular services published by shipping companies and ports.

Assessment of network of maritime connections between ports in the Western Mediterranean based on synthetic indicators

As indicated above, UNCTAD has calculated and published the scores of the LSCI since 2004, which includes Western Mediterranean countries and provides a score of the connectivity of the network of container service connections in this region and their evolution.

²⁴ <https://www.valenciaport.com/en/business/indice-de-conectividad-portuaria/>

Figure 7. Evolution of the LSCI for Western Mediterranean countries (2006-2021)

Source: Prepared by CETMO based on UNCTAD.

The index clearly shows two groups of countries according to the results obtained in the last quarter of 2021 (Figure 7). The first group is made up of the European GTMO 5+5 countries plus Morocco, with scores ranging from 89.3 for Spain to 41.1 for Malta (in immediately preceding quarters, Malta's score was almost 60). A second group consists of Algeria, Libya, Mauritania and Tunisia, with scores ranging from 5.4 for Tunisia to 12.6 for Libya.

A clear distinction is therefore drawn between the northern shore, with its high level of connectivity of regular container lines, and the southern shore, with very low scores, except for Morocco, which boasts connectivity comparable to that of European countries and, in fact, better connectivity than Portugal or Malta.

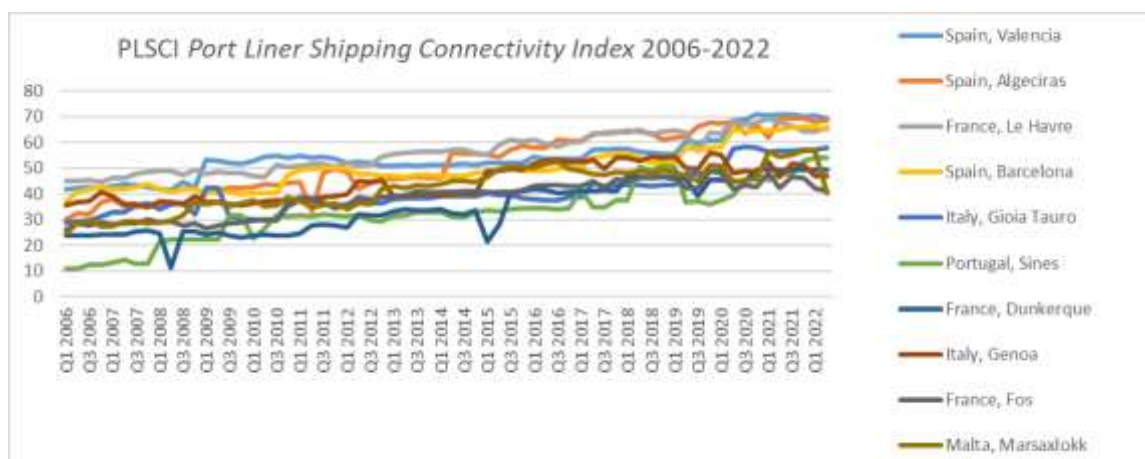
When considering the evolution of LSCI values over time, three features stand out. First, the continuing trend of higher connectivity scores in European countries and smaller gaps between countries, not counting the evolution of Malta in the most recent quarter. Second, the relative stagnation of scores in the Maghreb countries, which are below the scores of European countries. The scores indicate low connectivity in four Maghreb countries throughout the period under consideration: Algeria, Libya, Mauritania and Tunisia. Third, the sharp rise in Morocco's score in 2007 and 2008, which allowed it to move away from scores like those of other Maghreb countries towards scores similar to those on the northern shore of the Mediterranean. This higher score can be explained by the opening of the port of Tanger-Med and its successive extensions, which has enabled Morocco's score to rise even further. Considered together, these three features imply uneven evolution of maritime connectivity of container lines in European countries and Maghreb countries, except for Morocco. European countries have experienced continuous improvement compared to the stagnation of Maghreb countries.

A look at the PLSCI²⁵, which measures the connectivity of container services by port, reveals the division between European countries and Morocco on the one hand and the other four Maghreb countries on the other. The ten ports with the best position on the European side of the GTMO 5+5 (Figure 8) had scores between 40 and 69 in the second quarter of 2022. These scores were achieved after improvements began in 2006, when their scores were between 10 and 44. The top ten Maghreb ports (Figure 9) had scores between 5 and 68 in the second quarter of

²⁵ The Atlantic ports of Mauritania, Morocco, Spain, Portugal and France are included.

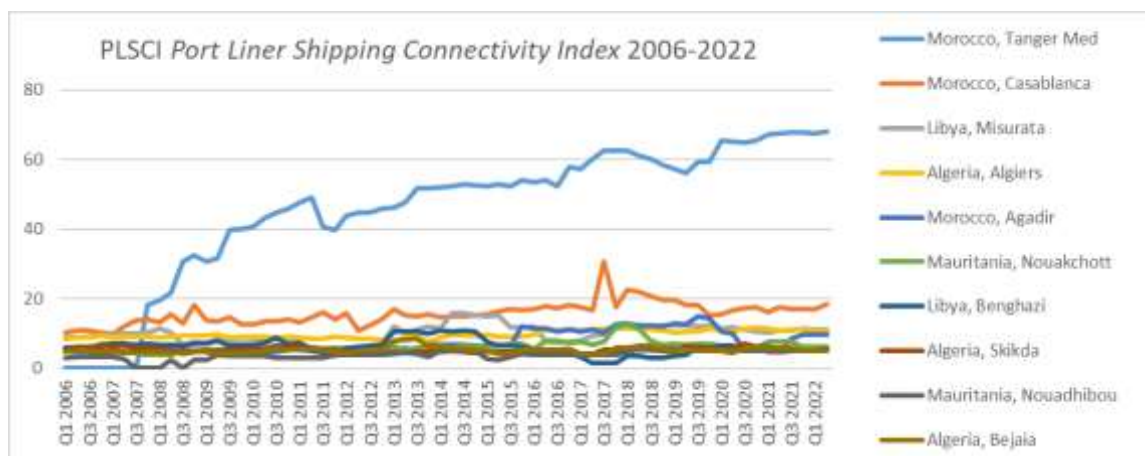
2022. However, there is a big difference between Tanger-Med, the top port in the Maghreb, with a score comparable to European ports, and Casablanca, the second port, whose score was 18. In other words, 9 of the 10 most important ports had scores between 5 and 18. Since Tanger-Med began operating, it has achieved high scores, always with an upward trend. Meanwhile, other Maghreb ports have not shown clear signs of improvement in their connectivity scores. In other words, the connectivity scores of Maghreb ports are clearly lower than those of European ports, except for Tanger-Med. When analysing the evolution of the ports on either shore the differences between the ports on the southern and northern shores have increased in favour of the northern shore, except for Tanger-Med, as it was the case of the LSCI.

Figure 8. Evolution of the PLSCI for the ports of the European countries of the Western Mediterranean (2006-2022)



Source: Prepared by CETMO based on UNCTAD.

Figure 9. Evolution of the PLSCI for the ports of the Maghreb countries (2006-2022)



Source: Prepared by CETMO based on UNCTAD.

The Liner Shipping Bilateral Connectivity Index (LSBCI), calculated by UNCTAD for bilateral connections of Western Mediterranean countries, has the same features as the LSCI and PLSCI. Higher scores are observed for bilateral connections between European countries (Table 1) than between Maghreb countries (Table 2). While the former include scores of 0.530 for connections between Spain and Italy and 0.281 for connections between Portugal and Malta, in the Maghreb, the scores are 0.237 for Mauritania-Morocco connections and 0.163 for the bilateral connections between Tunisia and Mauritania.

Table 1. LSBCI results for the relations between the European countries of the Western Mediterranean (2021)

	France	Italy	Malta	Portugal	Spain
France					
Italy	0,455				
Malta	0,426	0,445			
Portugal	0,407	0,369	0,281		
Spain	0,480	0,530	0,438	0,447	

Source: Prepared by CETMO based on UNCTAD.

Table 2. LSBCI results for the relations between the Maghreb countries (2021)

	Algeria	Libya	Mauritania	Morocco	Tunisia
Algeria					
Libya	0,226				
Mauritania	0,169	0,170			
Morocco	0,231	0,194	0,237		
Tunisia	0,218	0,217	0,163	0,219	

Source: Prepared by CETMO based on UNCTAD.

The level of connectivity of bilateral connections between the two shores of the Western Mediterranean (Table 3) seems to be determined more by the low levels of connectivity already detected in the Maghreb countries when considering the index at national level, than by the high levels of connectivity in European countries. In other words, the scores are below those found in bilateral connections between the northern countries of the GTMO 5+5 and closer to those observed in bilateral connections in the Maghreb. Except for Morocco, the scores waver from 0.171 for Portugal-Tunisia connections to 0.260 for Spain-Algeria connections. As indicated above, Morocco is the exception, with scores of 0.440 and 0.292 in its bilateral connections with the five European countries.

Table 3. LSBCI results for the relations between the two shores of the Western Mediterranean by country (2021)

	Algeria	Libya	Mauritania	Morocco	Tunisia
France	0,245	0,249	0,221	0,440	0,172
Italy	0,252	0,259	0,177	0,389	0,222
Malta	0,241	0,242	0,173	0,292	0,218
Portugal	0,225	0,229	0,223	0,336	0,171
Spain	0,260	0,259	0,234	0,435	0,217

Source: Prepared by CETMO based on UNCTAD.

The results of the indices published by UNCTAD show that the northern shore of the Western Mediterranean is better connected by regular container shipping services. These improved connections can be explained by ports that are capable of attracting transoceanic flows and economies with higher foreign trade volumes than those of the Maghreb countries, which favours the establishment of regular maritime services. The scores of the Maghreb countries can be explained by lower trade flows and ports with limitations in accommodating vessels carrying out transoceanic services. The case of Morocco and the port of Tanger-Med is important because it shows container and ship handling capacity as a key requirement to obtain a high score on the indices proposed by UNCTAD.

Topological indicators and their application to the network of maritime connections between ports in the Mediterranean.

Topological connectivity indices are based on graph theory for calculating a set of values to quantify the form, hierarchy and functioning of the network of maritime connections, among other parameters. Many studies by academics and institutions apply different models for calculating these indicators in different regions and areas. These include the 2019 World Bank publication “Maritime Networks, Port Efficiency and Hinterland Connectivity in the Mediterranean” (Arvis et al, 2019), whose study area is confined to the Mediterranean, as mentioned. The main measures used as indicators in this study are presented, as well as their interpretation in relation to the network of maritime connections in the Mediterranean:

- Density: refers to the ratio of existing connections (arcs or bridges) between network nodes to the number of possible connections. High scores indicate a more interconnected network.
- Clustering coefficient: It quantifies the centrality of a network by considering the concentration of arcs at the nodes. In the case of a maritime services network, low scores indicate a hub-and-spoke configuration, whereas higher scores reflect more uniform distribution of connections between ports.
- Average eccentricity: relative to the topological proximity of the nodes. Low scores indicate a network with few connections between its ports.
- Average shortest-path length: measures ease of movement in the network. Low scores indicate higher efficiency in the configuration of routes between ports.
- Centrality: measures the level of hierarchical organization of a network. Negative scores indicate uneven distribution of the number of connections of each port, resulting in many ports depending on a small group of ports. High scores suggest a more even distribution of the number of connections of each port.

The abstract nature of these scores and the difficulty of intuitively understanding them often limit the use of these indicators to academic circles. Nevertheless, collection of some of these measures between 2009 and 2016 in the study by Arvis et al. allows them to be used as indicators of the evolution of the network of maritime connections in the Western Mediterranean. They indicate an increase in centrality scores and a drop in scores for density and the clustering coefficient.

In other words, from 2009 to 2016, increased hierarchisation took place in connections between ports, which involved the concentration of connections in a small group of ports and, therefore, the dependence of many more ports on this small group. Lower density indicates a reduction in the number of possible connections between ports, which means that flows of goods are channelled through fewer ports and routes. Finally, the clustering coefficient also drops, which indicates that maritime connections have an increasingly hub-and-spoke structure.

This reflects the process of streamlining routes that has been taking place in parallel with the consolidation of the major alliances and the shift towards gigantism. The reduction in calls and routes, as well as the concentration of calls and flows, has led to a smaller group of ports acting as hubs for redistribution of containers to other ports, which are increasingly dependent on the smaller group of ports.

This type of analysis requires detailed information on existing services. In the case of the study cited above, the information was obtained from the ship movement register of Lloyd’s List Intelligence, access to which requires a commercial agreement.

4.2 Indicators on the efficiency of goods movement through ports

Indicators on goods movement through ports are intended to provide a synthetic vision for jointly or separately assessing the efficiency of the different steps in the process of moving goods through the port. To this end, existing indicators are based on the compilation and presentation of certain measurable and intuitively understandable parameters, such as the time of calls and vessel size, and on synthetic indices of performance in goods handling. The indicators published for the types mentioned are set out below and an assessment is presented of goods movement through the ports in the Western Mediterranean based on these indicators.

Indicators of time and port calls

These indicators provide information in absolute values on the number of calls and time in port of different kinds of vessels in ports as basic measures of port performance and efficiency.

Since 2018, UNCTAD has published scores by country on the total number of port calls and average time of calls of different kinds of ships. Although Ro-Ro and passenger ships are not included, the average and maximum size (GT) and capacity (DWT or TEU) of the ships is provided.

Data for the creation of this indicator come from the consultancy Marine Traffic, which processes the AIS data²⁶, which it accesses through a commercial agreement.

Performance indicators

Since 2019, the Container Port Performance Index (CPPI) has been published annually by the World Bank (WB) and IHS Markit as an indicator showing port performance in container handling. This index offers a great deal of data on container ships obtained from different sources: port calls, loading and unloading volumes, as well as vessel time in port and geolocation data on vessels obtained by AIS. IHS Markit is the manager of Lloyds List, as well as the IMO List of Numbers and IMO classification by tonnage, which allows access to a significant amount of information and data. Moreover, data on calls and cargo are supplemented by detailed information from the main shipping lines.

This complex index considers different parameters, some of which are obtained in two different ways, resulting in two indices. One is an “administrative” approach based on the information provided by shipping companies and ports, and the other is a “statistical” approach in which the index is calculated using mathematical models. The two indices are published with a breakdown by port, which provides for coherent comparison of scores, thus making the results more robust.

Similar indices for bulk cargo are provided by the consultancy Vesselsvalue and combine AIS data and information on cargo loading and unloading. This provides indicators on port performance measured in tonne loaded/unloaded per minute and the average time of loading and unloading operations per country. However, access to these indicators is not public, as in the previous case, but requires a commercial contract with the consultancy that produces them.

Other attempts have been made to define indicators to assess the quality of goods movement through ports, though they are based more on port organization than on times and cargo. However, they have not become quantifiable and comparable indicators. This is the case of the port efficiency indicators proposed by the EU-funded PORTOPIA Project. This project presented indicators relating to congestion at sea, the charges and taxes paid for moving goods through

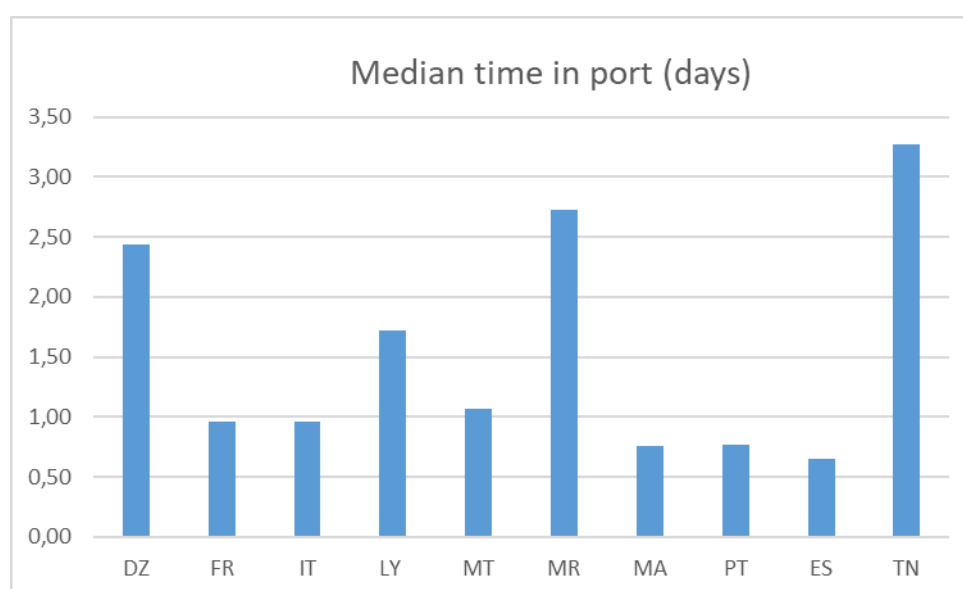
²⁶ The Automatic Identification System (AIS) is an automated, autonomous tracking vessel system exchange of navigational information between AIS-equipped terminals. It allows for static and dynamic vessel information to be electronically exchanged.

ports and an assessment of services rendered. However, in many cases, it did not propose calculation methods.

The assessment of goods movement through ports in Western Mediterranean countries based on indicators

As indicated above, since 2018, UNCTAD has regularly published a set of performance indicators on the efficiency of goods movement through ports. These indicators include different parameters according to vessel type, but do not include Ro-Ro or passenger vessels, which are particularly important in flows in the Western Mediterranean. With a focus on container ships, three indicators are of particular relevance for the assessment of port efficiency: the median time in port of container ships, the average size of ships based on capacity measured in TEU, and the size of the vessel with the greatest capacity handled at the country's ports measured in TEU.

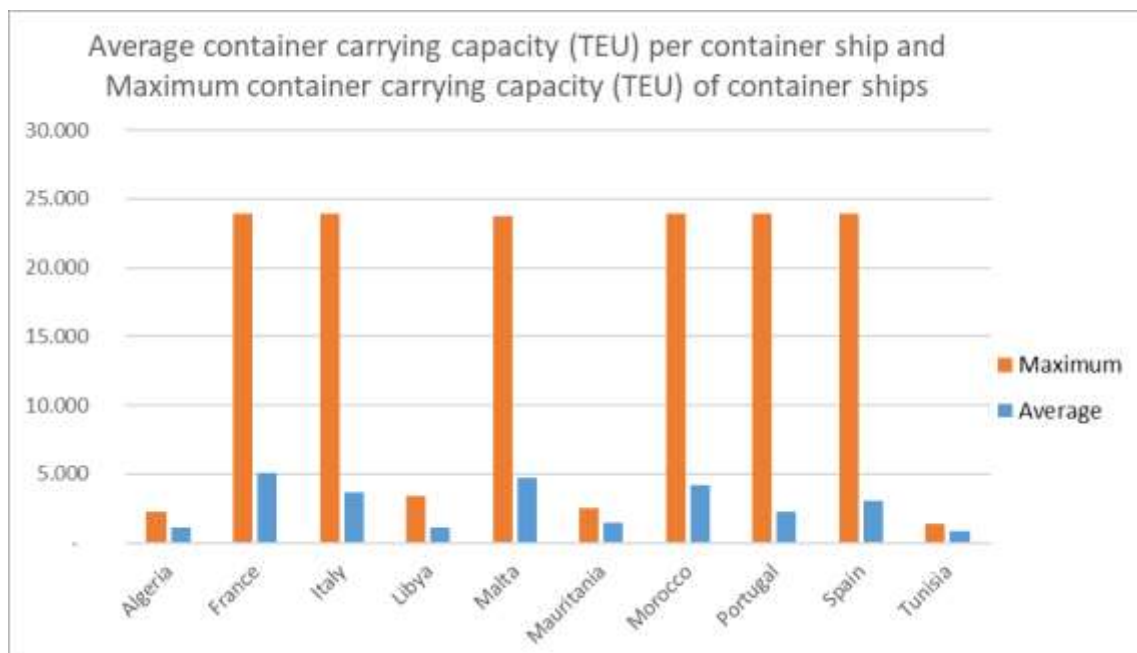
Figure 10. Median time of container ships in port by Western Mediterranean country. In days (2021)



Source: Prepared by CETMO based on UNCTAD.

The median time in port of container ships by country (Figure 10) can be linked to ports' capacity to manage and handle ship loading and unloading, the documentary processes for activities linked to vessel arrival and departure, and the level of port congestion. A look at 2021 results shows clear differences between the two shores of the Western Mediterranean, with Morocco once again the exception. Ports on the northern shore have times of less than one day, which is exceeded only by Malta, whose median time in port is 1.07 days, whereas Spain has the lowest time of 0.65 days. As indicated above, Morocco is at the same level as European countries with an average time in port of 0.76 days. In contrast, the times of the other Maghreb countries range from 1.72 days in Libya to 3.28 days in Tunisia.

Figure 11. Maximum and average container carrying capacity (in TEU) of vessels handled at ports in the Western Mediterranean countries (2021)



Source: Prepared by CETMO based on UNCTAD.

The other two indicators related to port efficiency published by UNCTAD refer to the size of container ships handled at the ports of each country (Figure 11). These indicators focus on the average size and maximum size of vessels, measured in TEU. The same differences as shown in the indicators above can be seen between countries on either shore. The European countries of the Western Mediterranean, together with Morocco, have significantly higher values for both the average and maximum size of vessels handled than Algeria, Libya, Mauritania and Tunisia. While the countries in the first group handle ships of more than 23,000 TEU, the Maghreb countries, except for Morocco, show more discreet results, such as 3,400 TEU in Libya and 1,350 TEU in Tunisia. The fact that European countries, together with Morocco, have the capacity to handle maximum vessels sizes of over 23,000 TEU is indicative of the capacity of these countries' ports to accommodate the largest container ships currently in operation.

The same pattern is detected when considering the average size of container vessels handled at ports in the different countries. The average size of vessels handled in European countries includes 5,105 TEU in France and 3,029 TEU in Spain, whereas figures for the Maghreb include 1,095 TEU in Algeria, 1,071 TEU in Libya, 1,480 TEU in Mauritania and 845 TEU in Tunisia. As indicated above, Morocco is at the same level as European countries with an average vessel size of 4,210 TEU. All these results reflect the handling limitations for container ships at Maghreb ports, except for Morocco, with longer times and a limited capacity to welcome large-capacity ships.

Furthermore, since April 2021, the World Bank and IHS Markit have published a synthetic index on the efficiency of container handling in ports. The result is a score and a ranking of ports that provide an assessment of port efficiency compared to the set of ports considered (almost 350 ports worldwide). In addition, this ranking of each port, which considers the total number of vessels, is also calculated based on the size (in TEU) of the vessels handled. Finally, it provides information on the average size of calls in each port, expressed as the number of TEU handled. The first issue of the index considers 41 ports in the Western Mediterranean countries and Table 4 shows the values obtained for the top 20 ports.

Despite the complexity of calculating the index and the many factors to be considered, some insights into the performance and efficiency of ports in the Western Mediterranean for container handling can be inferred from its results. First of all, the position of Tanger-Med stands out, not only as the top port in the ranking of Western Mediterranean ports, but also as the only representative of ports in the Maghreb in the top thirty positions. The next Maghreb port, Radès, is ranked in 31st position of the 41 Western Mediterranean ports. Moreover, Tanger-Med is the only port in the Maghreb capable of handling vessels of more than 5,000 TEU. With an average of 2,923 containers per call, it is ahead of all other ports on the southern shore of the Western Mediterranean. In fact, Casablanca, the second largest port in the Maghreb in terms of port calls, moves an average of 301 containers per port call. This is indicative of the exceptional nature of Tanger-Med in the Maghreb port system and of the major differences between this system and that of the European countries of the GTMO 5+5.

When considering the rest of the Western Mediterranean ports, all of which are in Europe, it can be inferred that the ones with the greatest container handling efficiency are ports with large port calls (measured in TEU), and especially ports with the capacity to handle vessels of more than 5,000 TEU, which is when economies of scale come into play, especially in transit operations.

Table 4. Ranking, score, average call size and ranking by vessel size of the top 20 Western Mediterranean ports according to the CPPI in 2019)

Port	Overall rank	Rank in the Western Mediterranean	Points	Containers moved by call	Rank by vessel size (TEU)							
					< 1,500	1,501-5,000	5,001-8,500	8,501-13,500	>13,500			
Tanger Med	6	1	178.9	2,923	67	56	9	16	4	15	9	
Algeciras	11	2	155.9	2,248	149	63	26	24	8	32	21	
Barcelona	22	3	119.3	1,660	201	41	43	23	37	46	24	
Sines	30	4	105.4	46	115	64	90	41	36	28	-2	
Gioia Tauro	65	5	62.4	71	234		119	50	48	212	147	
Santa Cruz de Tenerife	71	6	58.8	121	26	11	140	46		95	24	
Marsaxlokk	74	7	55	1,486	255	255	83	69	57	101	27	
Savona Vado	94	8	45.9	157	99	79	86	96		314	220	
Nantes Saint Nazaire	105	9	41.6	171	174	195	7			246	141	
Valencia	135	10	23.8	908	227	191	130	102	66	308	173	
Málaga	137	11	22.3	182	51	81	97	106	77	129	-8	
Vigo	149	12	18.2	272	102	74				159	10	
Tarragona	160	13	15.9	81	70	105				134	-26	
Civitavecchia	162	14	15.6	45	45	122				181	19	
Ancona	179	15	11.8	142	142	143				183	4	
Ravenna	187	16	10	253	152	167				176	-11	
Catania	191	17	9.4	73	135	177				190	-1	
Salerno	192	18	9.3	181	133	179				168	-24	
Bari	193	19	9.2	54	175	164				203	10	
Bilbao	202	20	7.2	115	123	238		112		243	41	

Source: Prepared by CETMO based on BM, IHS Markit.

4.3 Connections with the hinterland

There is currently no set of uniform, standardized indicators that provides a global vision of the connections between Western Mediterranean ports and their respective hinterlands. Despite this, there have been attempts to define these kinds of indicators. In these cases, it has generally been a question of creating indicators on land transport, such as the volume of flows according to the transport mode and calculation of port accessibility based on the land infrastructure network. These indicators have been used in case studies and specific locations, but are rarely applicable as a uniform series over time.

The difficulty in creating these indicators is discussed in the study by Arvis et al. (2019). It attempts to identify five indicators, but provides very little information to calculate three of them. The proposed indicators are:

- Hinterland volume: Volume loaded/unloaded at the port, excluding transit traffic.
- Modal split: Volumes of goods to and from the port to the hinterland by mode of transport
- Intermodal connectivity: Descriptive information on rail and inland waterway services (number of services, frequency, distances)
- Road congestion: Assessment of congestion on port access roads, such as waiting time for incoming goods
- Corridor governance: The existence and definition of governance structures for transport corridors involved in flows to and from the port

The authors were able to obtain information only on volumes from the hinterland, modal split, intermodal connection and congestion. In all cases, the information obtained refers to a very limited number of ports with no clear time frame, which makes it impossible to obtain a global vision of the state of connections with the hinterland of Mediterranean ports.

4.4 Possibilities and limits of studying maritime connectivity in the Western Mediterranean using indicators

The complexity of the factors involved in maritime connectivity explains why it is impossible to develop a single synthetic index that provides overall assessment and monitoring of connectivity. However, partial indices on their components have been developed or at least proposed.

There is a set of indicators that can be applied to understand maritime connectivity in the Western Mediterranean, although these indicators are limited to container transport and cover only maritime connections and goods movement through ports. These indicators are currently published by different organizations (UNCTAD and WB, IHS Markit). The commitment and solvency of the organizations responsible for publishing them and the fact that these indicators form part of a relatively long time series indicate that they will be maintained over the coming years. Calculating these indicators on an international scale ensures that the results obtained in the Western Mediterranean can be compared to those of other geographic regions.

In fact, based on existing indicators, it was possible to make an initial quantitative assessment of connectivity in the Western Mediterranean. The outcomes of this approach show the coherence of the results of different indicators. Interpretation of the approach is also consistent with the descriptions of the structure and evolution of the general cargo transport system in the Western Mediterranean in recent years. However, these descriptions are still based on a limited number of the factors that shape and affect maritime connectivity. These limitations include:

- The focus is exclusively on container transport and therefore does not address Ro-Ro cargo transport, which is of great importance in the GTMO 5+5 region.
- These indicators reflect the connectivity of maritime service networks and goods movement through ports from container vessels. Indicators on connections with the hinterland have been proposed, but not developed.
- Breakdown of indicators is limited. More geographic breakdown, i.e. by port or by index component, would provide more relevant information to understand the levels obtained.
- Despite regularly published indicators, there is a whole set of indicators, calculated on a one-off basis or simply proposed, that appear to be useful for providing new assessments of maritime connectivity.

Some of the shortcomings identified could be addressed through access to databases and information currently created and maintained by private consultancies, access to which requires a commercial agreement. However, it is worth highlighting the possibilities offered by geolocation data from AIS, which are publicly available, although they require significant processing. In fact, some of the indicators implemented and discussed above use this type of data, which is an indication of the extent of their usefulness. However, other types of indicators, especially those related to goods movement through ports and hinterland connections, would require a joint effort by stakeholders of the Western Mediterranean on harmonized collection of data for calculating indicators.

5 Qualitative Assessment of Maritime Connectivity in the Western Mediterranean

This chapter presents a qualitative assessment of the situation of maritime connectivity for freight transport in the Western Mediterranean in order to complement the information on data and indicators presented in the previous chapter. As in previous chapters, this assessment focuses on general cargo and specifically on container and Ro-Ro cargo.

The main ideas that emerged from a bibliographic review were validated, updated and developed through interviews and surveys with stakeholders and professionals connected to the region's maritime and port ecosystems. Different experts with a range of professional profiles were interviewed in order to acquire a diverse perspective. A total of 30 different viewpoints were collected from experts of eight nationalities who worked in the public administration, port authorities, maritime clusters, consultancy, logistics and transport companies, the shipping industry and universities and research centres. Other topics considered in the development of this chapter include the ideas and knowledge shared in forums and seminars on the situation of maritime transport and ports.

This qualitative assessment focuses on the three dimensions of maritime connectivity by presenting some of the findings that characterize them and identifying the barriers that hinder their development. The assessment then analyses some of the trends expected to affect the future situation that are already being addressed by decision-making of stakeholders in the sector. Finally, the implications of these trends are described, along with considerations that should be taken into account to develop connectivity.

5.1 Assessment of the main dimensions of maritime connectivity in the Western Mediterranean

As defined in Chapter 3, maritime connectivity is understood to be the structure, scope and efficiency of global service networks with some maritime transport link that provide access to markets and opportunities. It is determined by three dimensions: network of maritime connections between ports, goods movement through ports and connections with the hinterland.

Maritime connectivity

In the following, a detailed analysis of maritime connectivity will be made on the basis of its three dimensions, however, it is necessary to present an overview. The concept of maritime connectivity goes beyond the sum of its three features as independent elements. In fact, the development of each of them has a direct impact on the others. Thus, a delay in the arrival of maritime transport services would affect the scheduling of port activities and outgoing flows to the hinterland, reducing their efficiency. The closure of the port infrastructure (as was already experienced during the most critical moments of Covid-19) would also affect the planned maritime services and connections with the hinterland, which would no longer be supplied from this port. And the worsening of connections with the hinterland could mean a reduced capacity for goods to leave the port area and greater congestion, and consequently restrictions on the reception of maritime services. This dependence also occurs at the level of actors and procedures, since the passage from one feature to another depends on formalities, such as the notification of the goods to be unloaded or the organisation of transport for the departure of the goods, in which actors involved in the different features intervene. The analysis of the different features must therefore be subject to the broader framework of maritime connectivity as an integral concept.

This integral concept also applies to the integration of the Western Mediterranean. One of the bases for advancing regional integration is to achieve interaction between the national value chains of the countries in the region, moving from national value chains to regional value chains, but also for member countries to be able to integrate into global chains thanks to relations with other members of the region. In this sense, the adoption of this integral concept of maritime connectivity allows a vision that resembles that of national transport chains and therefore facilitates the identification of relationships between them.

Furthermore, the concept of maritime connectivity allows us to move from port-port analysis and relations to an analysis between transport networks, which is what ultimately conditions trade exchanges between the countries of the Western Mediterranean and, at the same time, also influences their regional integration. Consequently, the greater the maritime connectivity in the region, understood as a greater network of services between ports, a more efficient movement of goods through ports and a better connection of ports with their hinterland, the more likely it is to increase trade exchanges between their countries, which would lead to a strengthening of relations between them in the interests of favouring a common good.

But there is a major barrier in this overview of maritime connectivity:

- The lack of consolidation of the integral approach to the concept of maritime connectivity, which leads to addressing transport system issues from an individual or modal perspective. Although the integral approach generates consensus within the region, the simpler treatment of the problems from a modal perspective prevents the application of an integral approach.

Network of maritime connections between ports

Chapter 2 presented the operational structure of maritime transport in the Western Mediterranean for general cargo, made up of transoceanic traffic based on container services and intra-Mediterranean traffic using the import/export container services of the countries in the region and Ro-Ro cargo services.

Current services (container and Ro-Ro cargo services) are sufficient and provide good coverage of existing needs for connections between the two shores of the region. Despite the correspondence between supply and demand, there is still room for improving services by increasing flexibility and density in the port network, and through price stability and the reliability of maritime services. This correspondence is expected to be maintained in the future, given a possible increase in connection needs.

Although shipping companies are the main drivers of new maritime services, dialogue and collaboration among port authorities, shipping companies, shippers and other stakeholders are important when it comes to defining maritime services tailored to these needs. The construction of new ports able to accommodate deep-draught vessels in the Maghreb, as envisaged in some national plans, together with efficient operations, could also offer alternatives to these future connection needs. Furthermore, the creation and consolidation of Ro-Ro service routes are in some cases preceded by Ro-Pax services that aim to make up for the absence of cargo flows balanced with passenger flows, especially in periods of peak passenger flows. This situation is not permanent, because Ro-Ro vessels have greater capacities than Ro-Pax vessels and therefore provide enhanced full-ship efficiency.

Service conditions may affect container and Ro-Ro cargo services, initially set up as two separate models responding to different needs and therefore also with different markets in intra-Mediterranean traffic, with hardly any competition between them. But this approach based on watertight markets is evolving and Ro-Ro cargo services are beginning to attract flows from container services due to their greater flexibility, speed and stability. For example, the situation

of unreliable timing and high freight rates for container services, especially until early 2022, led some users to choose Ro-Ro cargo services.

In summary, although maritime services are suited to the existing market, measures can be implemented to improve service conditions. Changes in these conditions have now contributed to the emergence of relationships between traditionally distinct markets for container and Ro-Ro cargo services.

In addition to these findings, the following barriers and constraints to the development of network of maritime connections were also identified:

- The difficulty of detecting new market opportunities, mainly led by shipping companies, without having all the necessary information in some cases. The main requirement is the existence of balanced flows of goods in services between two ports and the use of triangulations with other ports to balance them.
- The competitiveness of road transport, which makes it difficult to replace part of a road journey with a maritime section, as in the case of the area near the Strait of Gibraltar, and which consequently favours port concentration and hinders the emergence of connections with new ports of origin and destination.
- The lack of policies to promote maritime services that provide equal benefits to stakeholders on both shores, regardless of whether the targets of policies are the operators of maritime services, their users or others.
- The lack of common regulations on port stays of vessels and the kinds of tariffs to be paid in the region's ports, especially in the Maghreb. Common regulations would allow maritime services to be developed based on a uniform operating pattern.
- The fact that Western Mediterranean ports are not attracting some cargo flows between Asia and Europe in vessels that cross the Mediterranean without calling. Attracting these flows would help improve maritime connectivity in the region.

Goods movement through ports

Goods movement through ports refers to the time spent on treatment of ships and goods and the associated documentation and information at the port of origin or destination from the time the goods arrive at the port and are loaded onto the ship or from the time they are unloaded from the ship and leave the port premises. Customs clearance of cargo is one of the most delicate parts of this process.

Goods movement through ports is affected by the physical movement of goods associated with port infrastructure and operations, and by the processing of documentation and information associated with port procedures.

As far as port infrastructure and operations are concerned, the main constraint is port capacity, which means that a distinction should be made between ports of different sizes. Some ports are limited in size by their geographic setting, which is surrounded by urban development that prevents their growth. But port capacity is not determined by the features of port infrastructure alone. Other factors should also be considered, such as the performance of the cargo-handling equipment and the size and skills of the workforce.

Trying to handle volumes of goods in excess of the port's capacity leads to congestion and limited operations. To cope with increasing volumes of cargo, port authorities are considering taking action through development plans to expand their capacity and even build dry ports and new ports. It is becoming increasingly common for ports to use technology to boost port capacity by increasing the level of terminal automation.

In terms of port procedures, customs clearance is the main difference between European Mediterranean countries and Maghreb countries. European countries form part of the European Union and the customs territory of the Union, which means that trade between these countries is not considered exporting or importing, but intra-Community trade. It is therefore not subject to customs clearance or procedures. However, trade between Maghreb countries and between countries on different shores of the Mediterranean is subject to the bureaucratic procedures and formalities of imports and exports, given that these countries do not belong to the same customs system.²⁷ The more bureaucratic controls and procedures that must be performed, the greater the economic cost of the goods and more time spent at the port. Due to the smooth flow typical of Ro-Ro cargo, its services are more sensitive to problems of delays in the departure of goods than container services.

The introduction of technological tools such as single windows for maritime transport and Port Community Systems (PCS), whose efficiency helps speed up processing and performance of customs clearance, as well as other port procedures related to goods movement through ports. For example, working with digitized documents reduces costs and the risk of lost documentation, which results in blocked goods at border crossings.

There are no general problems in the Western Mediterranean in terms of goods movement through ports, but there are some specific areas for improvement in port capacity in terms of infrastructure and labour.

Moreover, through the automation of terminals and incorporation of harmonized digital tools that include the parties involved in different procedures, the technological transformation of ports also helps increase the efficiency of goods movement through ports, which partly explains the lack of general problems. However, more work needs to be done on the definition of common procedures, legislative harmonization and communication between single windows for maritime transport points of contact and PCS in the different ports.

Barriers and restrictions affecting goods movement through ports do not apply to the region as a whole, but only to specific ports and situations. This was also true in the previous findings. Specifically, these barriers are:

- The physical limitations of some ports in the region that affect their ability to offer new services. Some countries in the region are considering building new ports to address this constraint.
- The inflexible timetables at some ports for performing certain port and customs procedures impede the steady movement of cargo.
- Lack of labour or training in technological aspects to handle the volumes of cargo entering and leaving the port for both container and Ro-Ro cargo services.
- Lack of implementation and harmonization between existing single windows for maritime transport and PCS platforms in the region. The lack of common standards for digital platforms. Having such standards would facilitate port interaction with different users at regional level, as well as interaction between users.
- Low integration of different stakeholders in the maritime port ecosystem in digital information exchange tools (maritime single windows, PCS). It is necessary to evolve towards digital platforms that can handle all the processes affecting goods movement through ports by facilitating the interaction of the parties involved in each process.

²⁷ Some Maghreb countries have signed trade agreements for trade relations with the European Union and are party to the Pan-Euro-Mediterranean Convention on preferential rules of origin.

Connections with the hinterland

Hinterland connections refer to organization of the movement of cargo from the point of origin on the transport chain to the port or the reverse journey from the port to the destination on the transport chain.

The capacity and efficiency of connections represent a very specific situation in each country and port in the region, thus making it difficult to extrapolate a regional vision. These specific features refer to infrastructure limitations on accessing the port that turn into bottlenecks in connections with the hinterland.

As far as the arrival or departure of goods from the port area is concerned, the reality in the region is that road transport dominates connections with the hinterland. Road transport can offer last-mile connections and excellent competitiveness for long hauls, which strengthens the single-modal nature of this type of transport.

However, it is also true that ports in the region are committed to multimodality as a development strategy to improve operations and connection speeds. They are also focusing on creating dry ports and logistics zones, improving rail connections and introducing new modes of transport. The strategies of European countries are designed to improve and consolidate multimodal options, especially rail because of its contribution to the decarbonization of transport. In the rail sector, rail motorways are also being promoted²⁸. Meanwhile, Maghreb strategies are generally focused on the early stages of multimodality and rail used mainly for bulk transport. Some experience has been gained with the use of rail for container transport.

In today's multimodality, the roles of existing stakeholders are being redefined as a consequence of the vertical integration processes implemented by major shipowners. They are expanding the scope of their activities to other components of the supply chain such as port terminals, inland transport and logistics with the aim of offering door-to-door service. With these processes, shipowners achieve greater economies of scale in cargo transport by controlling their routing. But because the chain is concentrated in the hands of a few companies, these processes also lead to reduced competition. Vertical integration processes are present on the European shore of the Mediterranean throughout the supply chain. In the Maghreb, this process is just getting started and is being implemented in port terminals, but will eventually affect the whole chain.

The size of the hinterland, along with its economic activity, are also important in the development of maritime connectivity from hinterland connections. Expanding the hinterland leads to more market opportunities and gives ports the chance to attract more cargo. In turn, attracting more cargo helps consolidate existing maritime services and affects demand for new services. And the ability to offer more maritime services increases port connectivity. A two-way relationship is thus established between port and hinterland in the development of maritime connectivity. The port offers the hinterland a series of maritime services to connect with other regions and foster its development. Meanwhile, the hinterland offers the port a market to consolidate its existing maritime services and define new ones, thereby improving its connectivity.

In summary, despite the specific features of each port's hinterland connections and the fact that road transport is the dominant mode in the Western Mediterranean, an overview of ports in the region reveals that the main challenge for ports in their connections with the hinterland

²⁸ Rail motorways: combined transport systems in which lorries are transported on rail shuttle services thanks to the adaptation of rolling stock.

is ensuring that these connections are multimodal. Vertical integration processes can help make this multimodality process more efficient, but can also lead to dominant market positions.

Finally, in the development of maritime connectivity from hinterland connections, it is necessary to consider how expansion of the hinterland can improve connectivity.

With regard to barriers and limitations on connections with the hinterland, the following points should also be taken into account:

- The limited vision of port-port relations, which hinders integration in value chains, instead of focusing on connections between transport networks, which is much more conducive to regional development.
- The single-mode approach of some transport companies in the region that limits multimodal growth of the region's transport system.
- The lack of coordination between those responsible for the different modes of transport when defining joint strategies.
- The existence of problems specific to each mode of transport, such as the lack of drivers in road transport and rail interoperability, which may hinder overall development of connectivity.

5.2 Analysis of trends in the development of maritime connectivity in the Western Mediterranean

Having completed the qualitative analysis of the features of maritime connectivity, it's time to examine how connectivity can be affected by the more or less rapid progress of certain trends (presented in Chapter 2) currently at the heart of much discussion in the sector.

For this reason, the main implications of these trends in maritime connectivity and the concerns they raise among maritime stakeholders are listed below. This analysis provides a cross-cutting, complementary perspective on the analysis of the features of maritime connectivity carried out above.

Sustainability and energy transition

Meeting new obligations in terms of reducing pollutant emissions and the energy transition will require a major effort from the maritime sector as a whole. This effort is associated with significant spending on adapting to IMO requirements and the Fit for 55 plan (once it is adopted) by the deadlines set by the institutions responsible, shipping fleets and port facilities.

The reduction of pollutant emissions calls for the use of cleaner fuels in ships, which specifically involves adapting propulsion systems to the alternative fuel used or acquiring new ships, and the availability of charging facilities for alternative fuels in ports.

This reduction also involves the electrification of terminals to enable ships at berth to connect to the port's power grid and reduce emissions, which also means that connection infrastructure must be available on ships and in ports. To ensure compliance with new sustainability policies, the energy consumed in port facilities must come from renewables. Some ports are therefore starting to design their own energy capture plans. All these port-related actions will involve redeveloping the port area and implementing new infrastructure.

The adaptations described above call for clear regulations, technological availability, and coordination between stakeholders to ensure that, when adapted vessels are in service, the ports involved have the infrastructure they need to offer the services required.

The new obligations may also have implications for maritime service operations, including container and Ro-Ro cargo services. Shipowners could opt for larger, more environmentally sustainable vessels, take advantage of economies of scale, and provide services at lower sailing speeds. Such measures may affect current scheduling of maritime services.

As a result of the implications outlined above, port and shipping stakeholders have certain concerns, which are listed below:

- The lack of a clear message and support from public institutions on the type of alternative fuel, which would give confidence and security to the stakeholders involved in making the necessary investments. It is now becoming clear that the focus is on green hydrogen as a long-term alternative fuel and liquefied natural gas (LNG) as a transition fuel.
- Failure to adapt to new emission limits may put certain ports and shipowners out of business in terms of regional maritime connectivity if they do not have sufficient resources to make the investments required within the scheduled time frame.
- Differences between countries, ports and shipping companies in terms of resources available to invest in the energy transition to ensure that ship propulsion and charging systems are adapted.
- Poor coordination between the different ports in the region and between ports and shipping companies results in different rates of adaptation to new energy sources and affects maritime service operations.

Digital transformation

Technology implemented in the field of maritime transport has a many applications, as shown in different studies carried out. However, the level of digital transformation of maritime ecosystems is not uniform and there are different levels of digital maturity (Miró, 2022). This difference in level can be associated with factors such as different port sizes, the relationship between available resources and the needs to be met, and the lack of specific knowledge. Given the continuous evolution of technological applications, the gap will only increase between maritime ecosystems that have not begun digital transformation and those that are at a more advanced stage. The Western Mediterranean is not free from these differences in digital maturity.

At port level, digital platforms are among the most widespread technologies. More documentation and examples are available on them than any other. In practice, digital platforms are known as maritime single windows and PCS, depending on the port procedures they handle and the stakeholders involved (see Chapter 2). Because the mandatory implementation and use of maritime single windows will start in 2024, focusing efforts on this tool is important.

Increased efficiency of port activity is the result of streamlining formalities for vessel entry, stay and departure, and simplifying the port operating logistics enabled by these tools. Other advantages offered by this type of platform include the ability to always work with original transport documents, albeit in digital form, which leads to fewer errors and confusion, as well as better control of cargo statistics. There are varying degrees of implementation of this technology in the Western Mediterranean.

The fact that ships establish services with different ports means that they are obliged to exchange information with all of them, so a harmonized system of data provision would contribute to regional simplification of ship entry and exit processes. This harmonization does not currently exist, even in the Western Mediterranean, but work is being done in this direction. In addition, it is important for the different maritime single windows and PCS in each country to be able to establish relationships and exchange information with each other. Their operating systems must therefore be interoperable.

The situation of digital transformation raises the following concerns among stakeholders in the region:

- Gaps are growing between ports and maritime ecosystems arising from different levels of digital maturity and spending on new technologies for the development of activity.
- The low level of cooperation between maritime ecosystems in different regions, which restricts the creation of a common level of knowledge and affects the incorporation of digital technologies and tools in less digitally mature territories.
- Due to the lack of maritime single windows and PCS in ports in the region, they are less effective in general.
- The lack of regional harmonization in data provision processes for maritime single window systems and interoperability, which hampers relations between different single windows and PCS.

Relocation and regionalization processes

In recent years, global transport has been affected by the impact of certain disruptive events or the consequences of these events (e.g. COVID-19, the traffic jam caused by the *Ever Given* in the Suez Canal, the record increase in freight rates), which has caused many companies to rethink the relationship between the location of production centres and consumption centres. As a result, emphasis has been placed on the idea of diversification of production and supply centres, thus reducing dependence on a single stakeholder or geographic location.

The diversification of production centres in the company's home country and nearby locations through relocation and regionalization processes confirms a change in the criteria governing global supply chains. There is a shift from the transport chains governed by cost criteria so characteristic of the relocation processes at the end of the 20th century to transport chains governed by criteria of reliability and flexibility. These new criteria are based on increasing stocks to respond to unreliable logistics chains, going from just-in-time to just-in-case supply, and gaining flexibility by moving production closer to consumption centres.

Shorter transport chains give companies greater control over what happens along the chain and an increased capacity for response. Meanwhile, shipping, especially Ro-Ro cargo services, can benefit from this proximity by offering services to meet this new demand.

The hinterland of connecting ports also benefits because new industry contributes to the development of the region and its people. It is therefore important to ensure that efficient connections are available to guarantee the smooth flow of goods and help attract new traffic.

The interest in regionalization processes in the Western Mediterranean is therefore linked to strengthening trade relations between different parts of the region and increasing connectivity between the two shores, thus favouring regional integration.

Although the speed of this process has increased in recent years, it is still too early to tell whether this is a temporary or long-lasting trend and how much the Western Mediterranean will benefit from it. Competition comes not only from the technologically advanced countries of Asia, which at least are farther away, but also from countries bordering the European Union and even technologically advanced countries in the European Union itself that are closer.

At regional level, the main concerns arising from relocation and regionalization processes include:

- The existence of sufficient infrastructure and maritime services to help attract relocation processes.

- Identifying the factors that stand out in favour of the Western Mediterranean and that attract companies to the region.
- Consolidation, especially of regionalization, as a long-term trend that contributes to the development of the region and its value chains.

Resilience to disruptions

Extreme weather events are becoming more frequent as a result of advancing climate change. These phenomena can cause disruptions that alter traditional operations of transport chains, caused by hitherto uncommon effects on a specific infrastructure. A disruption at a main port in the network could hinder the development of certain maritime routes or even stop them, which would have implications on the rest of the transport chain (e.g. redistribution of flows through other ports or means of transport, possible saturation of neighbouring ports and loss of efficiency, increased waiting times for ships, alteration of times established for other maritime routes).

In view of the major setbacks that these disruptions can entail, it is necessary to develop adaptation strategies and plans at all levels that take into account the different public administrations involved, as well as potentially affected private stakeholders, to work together to identify and agree on the best alternatives based on the levels of impact. This requires investment in risk management and emergency response preparedness. Preparing the maritime transport chain for the future and managing risks requires greater visibility of door-to-door transport operations.

These strategies and plans are based on an understanding of the possible climate scenarios that infrastructure could face in the future. Depending on the different climate scenarios, infrastructure and equipment actions are designed to be performed on the infrastructure itself to make it resilient and resistant to climate change. However, these strategies and plans should not be based exclusively on infrastructure, but should also include actions aimed at sharing knowledge and raising awareness. Because of increased knowledge and awareness of potential impacts and adaptation options, it is clearly vital to spread and share information and knowledge among different stakeholders. This is all the more essential in a region like the Mediterranean, where there are shared challenges and threats.

The following concerns arise from these implications:

- Lack of vision on how the effects of climate change may affect maritime infrastructure and services.
- The low level of cooperation on climate change adaptation, which hinders greater understanding of the challenges in this area, as well as the spread of concrete measures and good practices.
- Lack of available resources to devote to increasing infrastructure's resilience and resistance to climate change.

6 Conclusions, recommendations and lines of action

This last chapter brings together the most salient ideas presented on the different topics addressed throughout the diagnostic: the overview of maritime connectivity, the existing quantitative information, the dimensions of maritime connectivity and the major transport global trends that may affect it

Based on this compilation of ideas, a series of recommendations to improve maritime connectivity in the Western Mediterranean in the different topics addressed are briefly presented. Some more concrete action lines emerge from these recommendations.

6.1 Conclusions of the diagnosis of maritime connectivity in the Western Mediterranean

A summary of the main ideas emerged during the diagnostic is detailed hereafter in terms of the topic addressed.

An overview of maritime connectivity

Maritime connectivity is a comprehensive concept that allows encompassing its different dimensions (network of maritime connections between ports, port passage, and connection with the hinterland) as well as actors and processes that make up the maritime transport of goods. Trade in the Western Mediterranean countries depends heavily on maritime connectivity. However, this comprehensive approach of connectivity is not consolidated in the region and improvements to the Mediterranean transport system are often dealt with independently, whether by improving road transport, infrastructure or maritime services, of the customs system, etc.

One of the first conclusions drawn from this study is that the concept of maritime connectivity is the ideal starting point for improving regional integration. In addition, this comprehensive approach to improving maritime connectivity is shared since it helps to overcome the idea of independent interventions in different dimensions, being as they are so intertwined and interconnected. Moreover, the concept and approach shown here regarding maritime connectivity allows strengthening collaboration among the myriad of actors involved in it.

On existing quantitative information

Currently, there is no indicator or system of indicators that would allow a regular assessment in the Western Mediterranean of the three dimensions of maritime connectivity considered. The existing indicators are limited to an assessment of the maritime connectivity of regular services and the port passage of container transport. The improvement of existing indicators and their extension to the evaluation of Ro-Ro services, as well as the connection of ports with the hinterland, appears as a challenge for a better understanding and monitoring of maritime connectivity in the Western Mediterranean. Better exploitation of existing statistics, the use of new data sources, such as those offered by the AIS system, and greater coordination between actors in the handling and publication of information should help to create greater knowledge to enable better assessment and monitoring of maritime connectivity in the western Mediterranean.

On network of maritime connections between ports

In Western Mediterranean, multiple typologies of maritime flows intersect. The first distinction of sea flows is made between container flows and Ro-Ro flows. When taken into account the origin or destination of flows, it is possible to separate between intra-Mediterranean and

transoceanic flows. The latter are established with the North of Europe, North America and Asia through regular services of containers exclusively. Import or export flows from or to hinterlands of Mediterranean ports are also distinguished from transshipment flows. The latter consist of flows that tranship the goods in a port to their final destination, and again is limited exclusively to the transport of containers. All these types of flows make the Western Mediterranean a complex from the point of view of maritime flows and therefore it becomes necessary to understand the relationships that are established between them.

The flow of containers ensures the global connectivity of Western Mediterranean ports, either by direct import-export services or by routes requiring a transit operation. It is this last type of flows that guarantees the transoceanic connectivity of those ports that, due to their characteristics, cannot establish direct services with ports from other continents. Regional flows are based on Ro-Ro and container services, which have traditionally specialized in specific niche markets with limited competition between these types of services. However, the alteration of the conditions of container services, with a significant increase in costs and a loss of reliability, causes this division between types of services to be altered, thus showing the interrelationships between the different types of flows. It therefore highlights the need to address the network of maritime connections in the western Mediterranean by looking together at the different types of flows and the relations between them.

The current needs for the flow of goods between the countries of the Western Mediterranean are covered by services that are considered adequate to cover the existing demand. However, the existence of circumstances limiting its extension and improvement, such as the existence of an imbalance between flows back and forth, cannot be overlooked. The companies operating the maritime services, whether container or Ro-Ro, appear as the main actor in the process of promoting new relations between the ports of the western Mediterranean. The involvement of the other actors related to maritime transport may contribute to improving and accelerating the process of creation and establishing new routes and therefore to improve maritime connectivity.

Other factors that may contribute to increased connectivity in the western Mediterranean are:

- The upgrading of the port infrastructure in the Maghreb which conditions the calls of large container ships;
- Policies prioritising the use of maritime transport services over road transport and reducing transport chain externalities, targeting the different types of actors involved regardless of their nationality;
- Progress towards more homogeneous regional port regulations facilitating the homogeneous operation of maritime services;
- The capture of flows of goods that pass through the Mediterranean without stopping at it.

On goods movement through port

As regards the port crossing, it is considered that there is no a general problem in the region. However, the existence of differentiated customs treatment among some of the countries is a major handicap for improving maritime connectivity in the western Mediterranean. It is necessary to develop alternatives or procedures that contribute to reduce differences in time, costs and facilitation of the passage of goods through ports that this situation generates.

There exist barriers to the development of maritime connectivity from the point of view of infrastructure and port operations. They are derived from capacity constraints, conditioned by the physical space of the port, its equipment and facilities as well as lack of human resources,

Improving digitisation levels will also mean progress towards greater regional harmonisation of the port passage procedures. The maritime single windows and the Port Community Systems,

digital platforms that integrate the different procedures and actors affected by the passage of goods through the port, have been and are very powerful tools for facilitating port passage. Nevertheless, further work is needed to ensure harmonisation and integration between digital platforms used in ports, as well as on the integration into these platforms of all actors involved in maritime transport.

Other factors that may contribute to increased connectivity in the western Mediterranean are:

- Greater time span to facilitate the implementation of port procedures;
- The promotion of the training of the specialized workforce for the development and use of new technological tools.

On connection with the hinterland

The connection of the ports with its hinterland is a point to be analysed individually for the different ports of the region. However, the commitment to multimodality, as an element of efficiency and sustainability, represents the main challenge of the connection with the hinterland for ports in Western Mediterranean. This commitment has to adapt to the situation and particularities of each country. Vertical integration processes, as they are introduced in the region, can favour the efficiency of this multimodality, but at the same time they may mean market control by a limited number of players.

The expansion of the hinterland of the various Mediterranean ports, both European and Maghreb, will also help to improve maritime connectivity in the region.

Other factors that may contribute to increased connectivity in the western Mediterranean are:

- the situation of the land infrastructures and the inter-modality of them;
- the change in the unimodal vision of certain actors to take advantage of the various modes of transport.

On major global trends affecting maritime connectivity

On the trend towards sustainability and the energy transition of shipping, ports and land transport, there is widespread concern. It deals with the definition and implementation of new regulations on ship emission limits, on the commitment to more environmentally efficient propulsion systems and on the availability of their respective recharge infrastructures. More specifically, two issues are of concern: the high volume of investment associated with meeting these environmental requirements, and the lack of a clearly defined and agreed technological commitment, taking into account that this should be a coordinated investment between port authorities, shipping companies and the countries of the region.

The trend towards digitization is perceived as beneficial and necessary for improving regional competitiveness, being digital platforms one of the most widespread technologies in the maritime sector. However, there are some obvious challenges and risks. The lack of interoperability between technologies in different countries appears as the main challenge to overcome. In this sense cooperation in exchange of knowledge and experience appears as a tool to help all actors in the transport system be able to take on this technological revolution, without leaving anyone abandoned.

Another trend with a significant potential impact on the region is the global process of relocation and regionalization triggered by the need to increase the resilience of supply chains. Taking advantage of this opportunity will demand greater maritime connectivity in the Western Mediterranean. The impact of regionalization will be greater or lesser in each geographical area, depending on whether they are able to provide supply chains with an efficient and connected transport system, among other factors.

Also in order to ensure better adaptability of supply chains, it is needed to improve resilience against disruptions. In this sense, the effects of climate change are currently perceived as the main disruptive phenomena to be taken into account, due to the increasingly frequent exposure of transport infrastructures to more severe and extraordinary phenomena. These require a study and joint regional work to adapt as well as a task of awareness of and updating of knowledge at the regional level.

6.2 Recommendations and lines of action to improve maritime connectivity in the Western Mediterranean

The following table presents a set of recommendations and lines of action resulting from the above conclusions.

Topic	Recommendations	Lines of action
Overview	An integrated approach should be taken to improving maritime connectivity (networks of maritime connections between ports, goods movement through ports and connections with the hinterland).	Raising awareness of the advantages of the integrated approach in discussions and analysis of maritime connectivity in its different modes, given existing relationships and dependencies between its dimensions (networks of maritime connections between ports, goods movement through ports and connections with the hinterland).
	Communication and cooperation should be encouraged between different maritime connectivity stakeholders in consideration of the relationships and dependencies between them.	Ensuring that directly and indirectly affected transport stakeholders are involved in identifying trends, issues and specific solutions for maritime connectivity.
Knowledge	Information should be monitored and processed to display an integrated approach to maritime connectivity and a better understanding of the specific conditions in the Western Mediterranean.	Regular dissemination of existing maritime connectivity indicators applied to the Western Mediterranean.
		Studying and expanding information sources to contribute to the knowledge and assessment of uncovered dimensions of maritime connectivity.
	Trends should be monitored to anticipate and improve adaptability to future situations in the sector.	Updating knowledge on factors that may affect maritime connectivity in the Western Mediterranean.
	Stakeholders should be coordinated for management and publication of information and knowledge.	Generating and using harmonized information to assist in the analysis of maritime connectivity based on an integral approach and the same concepts and criteria.

Network of maritime connections between ports	Work should be done to strengthen identification of future needs and the ability to attract new flows through dialogue and the participation of all stakeholders involved in maritime connectivity.	Promoting the involvement of port authorities as dynamic agents of economic activity in the region, and fostering the provision and improvement of maritime services that respond to the needs of this economic activity.
		Creating meeting points between the maritime sector and the economic stakeholders connected to its hinterland.
	Policies should be promoted that facilitate maritime services.	Analysing policies to promote maritime transport and help reduce the negative externalities generated by the transport chain, and the chances of applying them on both shores of the Western Mediterranean, thus benefiting all stakeholders, regardless of their origin.
	Progress should be made on regulatory harmonization.	Working for the ratification and implementation of international agreements and conventions that favour trade and maritime traffic, including the Trade Facilitation Agreement (TFA), the Convention on Facilitation of International Maritime Traffic (FAL), the International Convention for the Prevention of Pollution from Ships (MARPOL), .
Goods movement through ports	The complexities of maritime-port procedures should be reduced, especially customs clearance.	Analysing different alternatives to achieve a faster, cheaper, more flexible and less bureaucratic customs procedure.
		Understanding the status of maritime single windows and port community systems (PCS) in the region to help overcome implementation and operational difficulties in different ports and cooperate on regional harmonization and integration of maritime single windows and PCS.
Connections with the hinterland	A commitment to multimodality should be displayed through infrastructure and services that help facilitate flows with the hinterland and contribute to the sustainability of maritime connectivity.	Taking a global perspective, which includes carriers and economic stakeholders in the port hinterland, towards improving the connections and services linking the port with its hinterland.
		Exchanging good practices adopted in the region to show that barriers have been overcome and multimodality opportunities are embraced.
		Raising awareness among carriers and users of transport chains of the benefits of multimodality.
Trends:	A shared regional position in the Western Mediterranean should be defined regarding	Monitoring progress made to define policies and regulations, as Fit for 55, and develop and implement technology

Sustainability and energy transition	maritime transport sustainability.	affecting the sustainability of maritime transport in the Western Mediterranean.
		Exchanging knowledge on the vision, policies and measures adopted in addressing the challenges of maritime transport sustainability.
Trends: Digital transformation	Successful digital transformation processes should be facilitated and promoted to bridge the digital maturity gap of maritime connectivity within the region.	Monitoring implementation of technologies in the region in the area of maritime connectivity to understand levels of digital maturity and its evolution.
		Exchanging knowledge on adopting technologies for regional maritime connectivity through case studies to help increase efficiency and reduce digital gaps.
		Promoting training in technological professional profiles that favour the development and implementation of technological tools.
Trends: Climate adaptation	Awareness should be raised of the effects of climate change on the transport system and the measures that must be taken in order to adapt.	Monitoring the progress of studies on climate change in the Mediterranean and its effects on transport infrastructure in the short, medium and long term.
		Exchanging knowledge on defining adaptability and contingency plans for the effects of climate change on transport infrastructure and services.

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