

Italian Maritime Economy

The new challenges for ports in the Euro-Mediterranean region

The Red Sea crisis and
the transformations
driven by green models



SRM

Study Centre based in Naples, connected to the Intesa Sanpaolo Group, originally an intellectual and scientific safeguard, aims to improve knowledge about Italy's territory in terms of infrastructural, productive and social assets with a European and Mediterranean vision in mind.

Specialized in the analysis of economic dynamics, national and international, it runs two research observatories monitoring maritime transport, logistics and energy.

This 2024 Italian Maritime Economy Report is part of the SRM project named 'Permanent Observatory on the Economy of Maritime Transport and Logistics'. A dedicated section of our website collects specific studies, reports, news and events representing the core of the Observatory's activities.

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In this issue of the Italian Maritime Economy Report:

Part One

- A look at the international contexts of port activities and shipping: our analyses on the impacts of tensions in the Red Sea
- The commodity market, logistics chains, and inflationary risks
- The necessary but complex strategic relationships between ports and intermodality
- ETS (Emissions Trading System), a complex impact, analysis, and food for thought

Part Two

- Analysis of the major Northern European ports: the strength of port innovation in Belgium
- Traffic dynamics, investments, and sustainable strategies in the West Med and East Med, with case studies of ports in Turkey, Egypt, and Spain
- Approaches to sustainability in ports and shipping: analyses from the Far East

Part Three

- Ports, shipping, and energy transition in Italian ports: the case of hydrogen in Leghorn and analyses by Opinion Leaders
- Analyses by the young of #Meets4Future: Special Economic Zones

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In the biennium 2023/2024 SRM carried out **3 significant international scientific missions** that added considerable value to the analyses and studies, both practically and in terms of networking. Details of these are summarized as follows:

- **9-10 November FRANKFURT**, organised by Intesa Sanpaolo-SRM and focusing on the development of ports, SEZ and SLZ.
- **19-21 November ISTANBUL**, organised by Propeller Club-SRM focusing on the development of maritime transport and logistics in Turkey and on the analyses of this country's port models.
- **29 April-1 May NEW YORK**, organised by Intesa Sanpaolo-Propeller Clubs-SRM with the aim of promoting the port system, SEZ and SLZ internationally as well as analysing port and logistics models in the US.

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Preface | 2024, a complex year with numerous challenges for the Mediterranean Region

The SRM Report on Maritime Transport and Logistics has now reached its eleventh edition. Unfortunately, the sector has been impacted by a new conflict, leading to a crisis in the Red Sea. This adds to the ongoing challenges already present due to Russia's invasion of Ukraine.

The attacks on ships in the Suez Canal have heightened awareness of the critical importance of maritime transport. This sector is essential for maintaining the fluidity of supply chains and the strategic planning of the global industrial system.

Delays have been observed in the shipments of finished products and raw materials, and there have been complex freight dynamics, as well as rescheduling of departures and arrivals for ships traveling to and from the Middle and Far East.

It has been understood more than ever that ports and logistics cannot be regarded as just another economic sector but as drivers capable of influencing the geopolitical balance of the world.

The extraordinary ability of the maritime and port logistics sector to adapt to crises has been witnessed, providing operational and immediate responses even when navigating more complex routes, such as those around the Cape of Good Hope.

Once again, the sector has remained resilient, thanks to an excellent maritime cluster where all stakeholders – including shipowners, freight forwarders, carriers, terminal operators, shipping agents, Port Network Authorities – acted promptly through their knowledge and resources to address the situation. This resilience is also due to the Navy and the Coast Guard, who continuously work to ensure the safety of the Italian and international fleet in critical areas.

The Report is more than just this. With the support of national and international research centers as well as fruitful collaboration with other departments of Intesa Sanpaolo, this volume presents trends in innovation, sustainability, intermodality, and digitalization through original analyses, data, and unique interpretative keys.

The research continues to be a reference point for operators, institutions, the research community, and the association landscape. This year, it also provided space for young researchers, featuring interesting essays and uncommon perspectives.

In conclusion, I would like to thank everyone who has contributed to the growth of this project and encourage SRM and its researchers to persist and continue on this path, for the development of the country with the South at the forefront.

Paolo Scudieri
President SRM

Introduction | Mediterranean ports increasingly more strategic in the international context

Geo-economic and geopolitical rivalries and conflicts are the order of the day. Major shifts in the international power axis have often been accompanied by great wars, starting with the one in the Peloponnese almost 2500 years ago. During periods when an old order is eroding while a new one struggles to emerge, and both the ability and the will to govern are lacking, Antonio Gramsci noted that ‘morbid symptoms’ can appear. This idea is relevant to ports, maritime trade, and transport in the Euro-Mediterranean area and beyond, as detailed in this new edition of the Italian Maritime Economy 2024.

The morbid symptoms are clearly visible, spanning Ukraine and the Middle East, as well as Haiti and the Sahel. Nevertheless, the Thucydides Trap need not be seen as a prophecy, and a global conflict between competing powers is not inevitable. On that note, the tight economic interdependence between the West and China, once considered ‘chimerical,’ will continue to make direct confrontations undesirable for great powers. At the same time, it is also true that this very interdependence has been a decisive factor in enabling the military capabilities of countries like Russia and China. Just as Russian hydrocarbon exports to Europe allowed Putin to fuel his war machine, which he then launched against Ukraine, China’s economic growth resulting from increased integration into the global market has enabled it to invest more significantly in defence and become more assertive globally, including in Europe and the Mediterranean. If there is a mistake or miscalculation in this context, it is not the idea that interdependence produces prosperity, peace, and progress, but rather the illusion that widespread wealth and interdependence will naturally prevent new threats and risks, as well as new global rivalries.

These rivalries are prompting the US to introduce customs duties and restrictions on technology exports to China, in line with the Biden Administration’s strategy outlined by National Security Advisor Jake Sullivan when he referred to the ‘small yard, high fence’ approach. While there is an intention to remain open to international investment and trade, including with China, Sullivan’s remarks underscore the need for heightened protection measures—the ‘high fence’—in critical areas such as artificial intelligence, chips, biotech, and quantum computing—the ‘small yard’. Officially, these restrictions aim to prevent China from acquiring critical technologies, many of which have military applications that could threaten Western interests. Unofficially, they are designed to slow China’s rise and prevent its potential overtaking of the US in terms of economic, technological, and possibly military development. In response, China is also imposing restrictions on the export of critical minerals, such as gallium and germanium, which are essential for producing semiconductors and electric cars. Amidst this back-and-forth, the global economy is becoming increasingly fragmented.

Similar but differing views from Washington’s can be found in Europe, where the stance towards China has shifted over the last few years. Until a decade ago, China was seen as a rising and increasingly assertive power in the Pacific but largely benign in Europe, where it focused on exporting goods and making investments. Nowadays, European countries are more aware of the strategic objectives behind Chinese economic policies in Europe, particularly the new Silk Road initiative.

China has gained a foothold in strategic sectors like critical infrastructure, investing in seven of the top ten European ports and currently controlling a sizable share of container handling capacity in Europe. This represents both a challenge for European security and a potential threat to the development of European industrial capabilities.

Although Europeans do not aim for hegemony or inherently fear China's rise, the European Union seems to have gained a clearer understanding of China's strategic intentions, which can sometimes be predatory, in regions like Africa, Latin America, Europe, and the Mediterranean. This increased awareness is prompting the EU to develop a geoeconomic approach that envisages closer monitoring of Chinese imports and investments in Europe as well as potential restrictions on exports of critical goods to China. Additionally, there is a focus within the EU on finding options to better protect the European economy while ensuring these measures do not escalate into trade wars or regressive protectionism.

Total decoupling between geopolitically rival economies is almost impossible. The internationalization of value chains, finance, and trade have greatly benefited the entire world, including Europe. Indeed, the Old Continent accounts for only 3% of the earth's surface and possesses 6% of critical materials in its subsoil, yet it includes 6% of the global population and accounts for as much as 15% of the world's economy and 54% of social welfare expenditure. It is also the number one destination for foreign direct investment. While it is true that China has invested in strategic sectors posing risks to Europe's security and industrial development, it is equally true that Chinese investment in Europe has generated 24 million jobs, or roughly 16% of employment in the EU. Deglobalization would lead to higher costs, poorer quality, scarcer goods, fewer choices, job losses, reduced growth, and less innovation. In a deglobalized economy, it is estimated that world GDP would fall by between 8-12%, and Europe, having benefited more than others from integration into global markets, would likely lose more than the average.

Nevertheless, there is heightened emphasis on mitigating the risks associated with excessive and potentially hazardous dependencies. The era of extreme economic openness or hyper-globalization reached its peak in 2008. Today, rather than deglobalizing, the global economy has transitioned into a new phase characterized by a slowdown, marked by a plateau in investment and trade with a growing emphasis on diversification of supplies and regionalization of international trade. Diversification strategies are already being implemented regarding production and procurement locations, as well as transportation options. This shift places a greater emphasis on avoiding bottlenecks in value chains and cultivating economic relationships with closer, potentially amicable countries. This phenomenon, often referred to as 'slowbalization,' is the result of a gradual adjustment influenced by both government policies and the decisions of private companies aware of emerging risks. Ports play and will continue to play a pivotal role in these profound transformations.

Take the case of the Middle East, for instance. Against the backdrop of the Israel-Hamas conflict in Gaza, the pro-Iranian Houthi militias who control a large part of Northern Yemen used drones and missiles to attack merchant ships transiting the Bab al-Mandeb strait near the Red Sea, along the route between Europe and Asia through the Suez Canal. Before the war, the Red Sea accounted for 14% of international trade and the Houthis, despite enhancing their military capabilities in the ten-year long civil war in Yemen since 2014, were far from being considered a global threat. Yet, although this group had often been labelled as less effectively equipped than other organisations in the region such as Lebanon's Hezbollah and Palestine's Hamas, their actions have wreaked havoc in the global economy forcing companies whose goods transited the Suez Canal to halt voyages or opt for the longer route around the Cape of Good Hope. The Houthis, certainly not at the top of the list of global threats, have managed to leverage the fragilities of the interdependent world, precisely exploiting the bottlenecks in the global economy.

Such vulnerabilities could lead to disastrous consequences if conflicts were to arise between other players with greater economic, technological, and military capabilities. In today's international system marked by growing tensions between great powers, various triggers exist that could escalate the economic and technological rivalry between the US and China into a direct military confrontation. These range from the Taiwan issue to conflicts on the Korean Peninsula and in the South China Sea. Should a war break out in such contexts, an abrupt decoupling between the Western and Chinese economies would become unavoidable. Preparing for this threat, precisely to prevent it, is imperative.

Ports clearly illustrate the contradiction of our increasingly fragmented and divided world, which is simultaneously more interconnected and integrated than ever before. These facilities serve as crucial hubs in global connectivity. Due to their strategic importance, ports will continue to be focal points of geoeconomic and geopolitical conflicts. To navigate the contradictions of this fragmented international context, Mediterranean ports must transition from passive objects to active players on the global stage.

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Part One

Trends
and recent
phenomena

Chapter 1 | Shipping and ports: supporting the evolution of global trade

Once again in the year 2024, we find ourselves engaged in the analysis of a sector undergoing profound change. If for decades maritime transport could be defined as a rather stable sector, scarcely affected by economic events and phenomena, the numerous crises that followed one after the other in the 2000s have profoundly changed its structure. There have been sudden and far-reaching turns to business imposed by the geopolitical and commercial macro-questions that determine the sector's performance.

There are multiple variables involved in analysing growth forecasts in ports and the drivers of the various segments even in the short term. Even more so in a world where conflicts and protectionist tendencies are multiplying and which is also being influenced by other factors that are opening up structural changes, including climate change and energy transition, sustainability, digitisation and, last but not least, increasing market and industry consolidation.

The purpose of this paper is to analyse the main drivers of the sector and their repercussions on the Italian port system.

1. The macroeconomic context and the impact on shipping due to emerging geopolitical balances

The macroeconomic scenario of this 2024 is indeed complex, both economically, with a still modest growth that reflects the restrictive monetary policies aimed at countering the inflationary phenomenon, but also geopolitically, given that the current conflicts put the entire Middle East area in a precarious balance also for trade and maritime passages. If it is true that 'sustainability' is the watchword on which the development policies of the major economies are developed, it must also be emphasised that achieving climate change mitigation targets globally is becoming an increasingly complex challenge, also in light of the strong growth in emissions in India and China.

The visible effects of these complexities are changes in globalisation patterns, reconfiguration of supply chains and sea routes, and increasing environmental regulation. The easing of pressures on the global economy is expected to support demand for raw materials in some key regions, while heightened geopolitical tensions in Europe, the Middle East and in relations between China and the United States have directly affected global maritime transport both in terms of demand and the viability of some major transport routes, primarily the Red Sea, leading to an increase in the distances travelled.

In this complex landscape, seaborne trade continues to grow and support global trade.

It is not yet possible to predict how long the ongoing conflicts may last, but current estimates indicate a 'normalisation' of trade patterns that could limit tonne-mile growth to around 0.5%.

Annual percentage changes in world GDP, international trade, maritime transport volume, and tonne-miles of maritime transport for the years 2021-2025

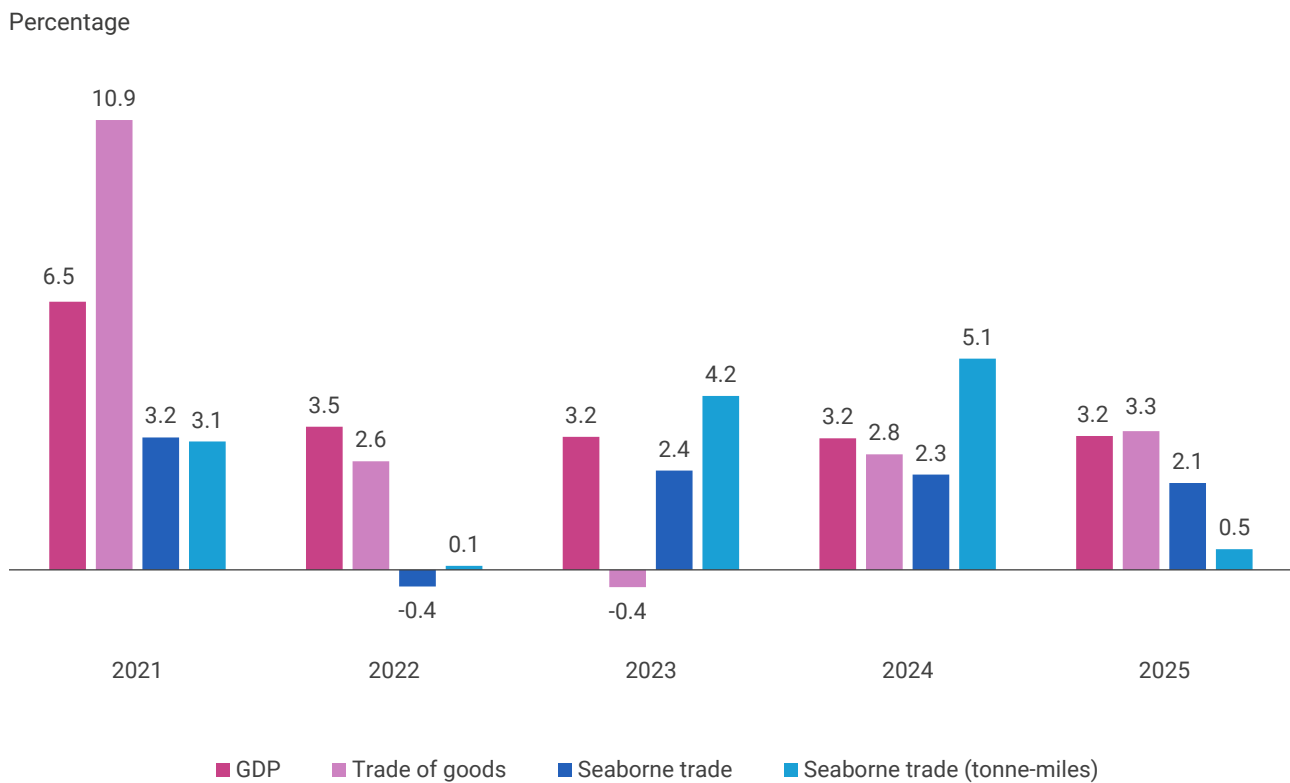


Figure 1 | Source: SRM on IMF (WEO April 2024) and Clarksons

In 2023, a total of 12.3 billion tonnes of goods were transported by sea; of these, 5.5 billion tonnes are dry bulk, which is the main category of goods travelling by ship. Oil, with 3 billion tonnes, is second among the goods transported, although its weight over the years has shrunk in favour of containers (1.8 billion tonnes in 2023), gas (0.6 billion) and chemicals (0.4 billion).

China remains the world's top player in maritime trade, handling a staggering 30% of global trade. Interestingly, seven out of the top 10 container ports worldwide are based in China.¹ Meanwhile, ongoing geopolitical tensions in the Middle East are causing ripples in maritime routes. The Red Sea and the Suez Canal, along with the crucial Strait of Hormuz, are facing heightened risks. These tensions are reshaping maritime networks and trade patterns, leading to longer routes and increased distances for shipping.

¹ For more details see: Assoport-SRM, Port Infographics UPDATE 2024 [<https://www.sr-m.it/it/cat/prod/322818/port-infographics-update-2024.htm>].

Maritime transport volume trends by freight category. Years 2013-estimates 2025

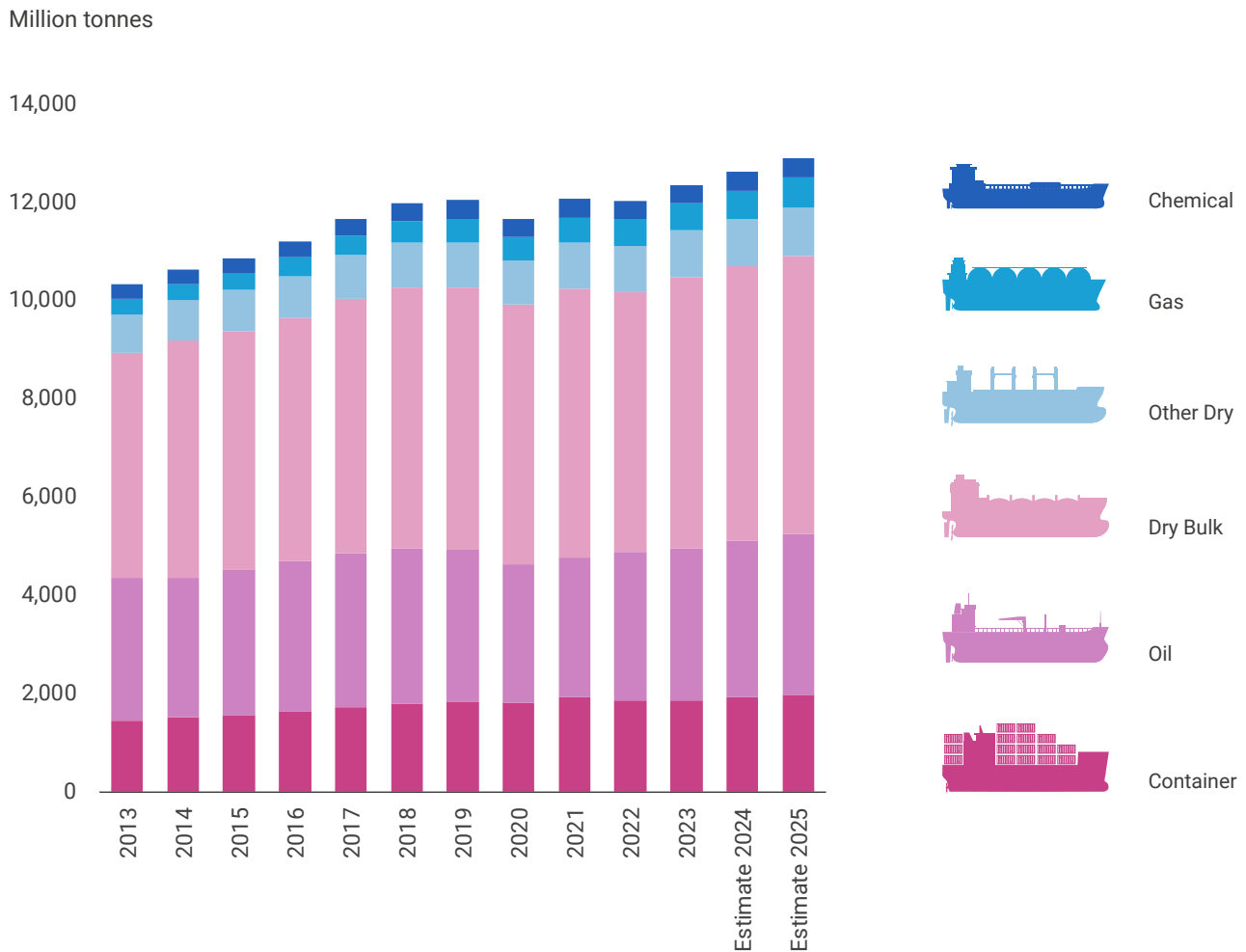


Figure 2 | Source: Assoport-SRM, Port Infographics UPDATE 2024

In an already tense and uncertain scenario due to the Russian-Ukrainian war and the Israeli-Palestinian conflict, the latest threat to international trade emerges from the 'Red Sea front'. Since the second half of last November, Houthi militias, controlling part of Yemen, have targeted several merchant ships in the Strait of Bab el-Mandeb, located at the entrance to the Red Sea. Approximately 12% of the world's trade and 30% of the world's container flows pass through this strategic passage, situated on the route connecting the Suez Canal and the Indian Ocean.

The escalating risks to crew safety and cargo security have prompted major transport companies to redirect ship traffic to the longer route circumnavigating the African continent via the Cape of Good Hope. This new, significantly extended route results in substantial delays for shipments. For instance, the journey from Singapore to Rotterdam via South Africa is approximately 40% longer, resulting in an additional 10 to 20 days of travel time. Consequently, maintaining the same frequency of liner services necessitates deploying more ships, leading to a redistribution of capacity from other trade routes. This, in turn, compels vessels to increase speed to mitigate sailing times, resulting in higher bunker consumption. An increase in ship speed from 16 to 17 knots generally means a 10% increase in bunker consumption per day for a mega container ship, resulting in higher costs and emissions.

Impact of Cape of Good Hope rerouting on navigation distance, total travel time and emissions for a typical Asia-North Europe weekly liner service

	Unit	Red Sea/ Suez route	Cape route	Increase (%)
Total roundvoyage sailing distance	Nm	24.000	31.000	29.2
Average sailing speed	Kn	16	17	6.3
Average total port time per call	Days	1.7	1.7	
Number of Asian port calls	No.	5	5	
Number of North European port calls	No.	4	4	
Total sailing time	Days	62.5	76.0	21.6
Total port time	Days	15.3	15.3	
Total roundvoyage time	Days	77.8	91.3	17.3
Required number of vessels for weekly service	No.	11	13	17.3

Table 1 | Source: PortEconomics, 2024

Between January and June 2024, 3,515 containerships opted to reroute through the Cape of Good Hope. The situation in the Red Sea, along with shallow water conditions in the Panama Canal, constitute additional critical elements to be considered in the broader context of global logistics chains. Despite overcoming challenges from previous years, these chains still face tensions as major economies work to establish and redefine new routes and relationships.

By the end of June, compared to the same period in 2023, the traffic of container ships, tankers, bulk carriers and LNG carriers through the Suez Canal had fallen by 70%, 38%, 34% and 93% respectively. This had immediate consequences on routes via the Mediterranean, and in general on freight rates and the reliability of liner services, a situation that again put pressure on global supply chains.

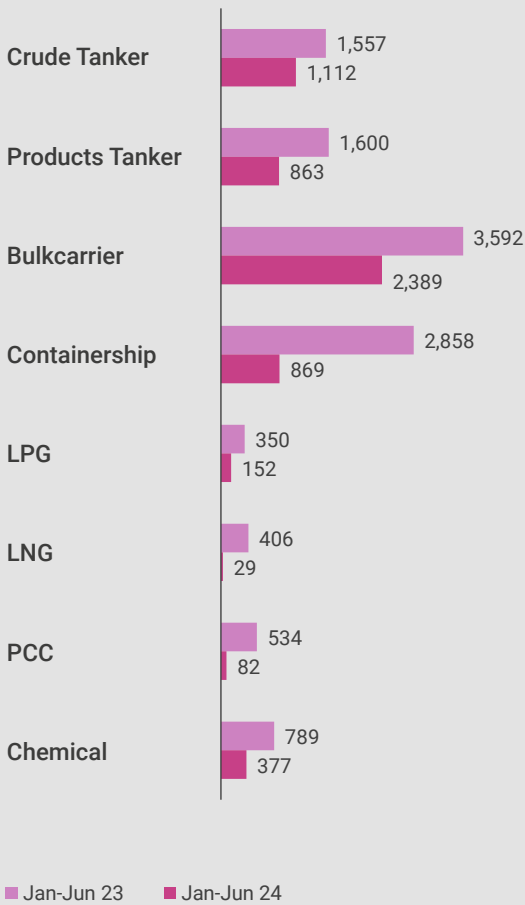
The difficulties in using the Suez Canal as a key transit point for connections along the east-west routes are an unknown factor weighing on the development of transport in the short term in relation to the potential duration of attacks from Yemen and the effects this may have in terms of freight rates, transit time and, therefore, repercussions on the final price of products.

Maritime transport, despite the challenges of the current historic moment, demonstrates remarkable resilience, helping to alleviate the adverse effects of logistical disruptions. The impact on freight rates has been swift, but they have not reached the levels seen in the post-pandemic period.

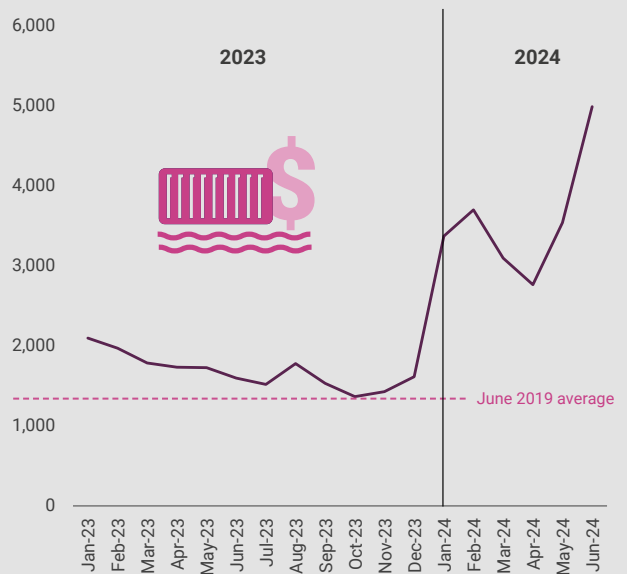
Since the end of April, freight rates have risen again due to increased fuel consumption, higher CO₂ emissions, and elevated insurance expenses related to the risks of attack or sabotage. This has led to an estimated nearly one million dollar increase in the round-trip price from Asia to Europe. All freight rates have surpassed those of the previous year. As of May 2, 2024, Drewry's composite index for containers (World Container Index) was 55% higher than at the same time in 2023, reaching \$2,725 per 40-foot container

The Red Sea Crisis: its impact on the Mediterranean

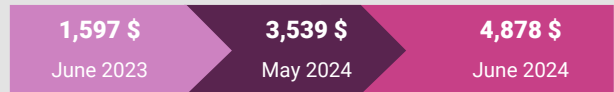
Number of ships transiting from Suez



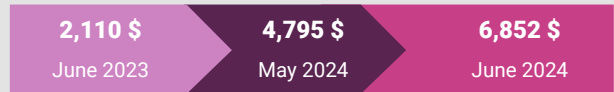
Drewry World Container Index (US\$/40ft)



World



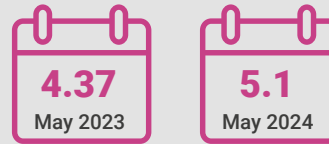
Shanghai - Genoa



Reliability of container liner services



Days of delay



More delays for companies on the Asia-Med route

Comparison May 23 - May 24



Changing strategies for companies



Source: SRM on various data

(FEU). On the Shanghai-Genoa route, freight rates now stand at \$3,717 per FEU, marking a 67% increase from last year and ranking second in cost only to freight rates on the Shanghai-New York route.

Tensions in the Red Sea have also influenced the reliability of container liner services: according to surveys by Sea-Intelligence in May 2024 was 55.8% (-11% compared to last year). The average delay for ship arrivals was 5.1 days.

Increased time and costs favour the development of alternatives to maritime transport. Trains from China to Europe, after a record number of 17,000 in 2023 with a handling of 1.9 million TEUs, set new records in the first 4 months of 2024 with 6,184 trains (+10%) carrying 675,000 TEUs. By the end of April 2024, train services from China had expanded to cover 223 cities in 25 European countries.

The tensions in the Red Sea also affect the Belt and Road Initiative (BRI), with participating countries such as Yemen, Egypt and Iran which are all central players in the tensions that have emerged in recent months. China's geopolitical and economic ambitions are closely intertwined with the BRI, which remains to this day one of the main catalysts of Chinese influence in the world. The route through the Red Sea represents one of the strategic hubs along the maritime Silk Road – one of the branches of the BRI extending from southern China to the Strait of Malacca, the Indian Ocean, the Horn of Africa, the Bab Al-Mandeb Strait, and the Suez Canal. In addition to connecting China with the Middle East, this route is crucial for relations between China and the countries of the African continent, with which Beijing cultivates very close economic and political ties.

What is happening in the Red Sea risks penalising the 'Made in Italy' system and the supply of products that are essential for the processing of Italian manufacturing. There is a risk that a reduction in traffic through Suez for a long time will cause a change in the final destination of some ships, especially those importing goods to Europe, which might choose to unload their cargo in another European port (e.g. Rotterdam) rather than enter the Mediterranean from Gibraltar to reach Italy.

For Italy, 28% of the value of trade is by ship, and 38% of this passes through Suez. Potentially vulnerable are maritime trade in textiles and leather products (28% from China and 8% from Bangladesh), machinery (mainly outbound to China, India and Saudi Arabia) and metals (13% traded with China, 8% with India and 4% with South Korea). In percentage terms, Italian goods transiting through the Suez Canal account for 14.3% of total foreign imports and 6.8% of exports. At the territorial level, there are considerable differences between one region and another in terms of exposure to a possible crisis. When considering import/export in relation to GDP, the most exposed regions are Sicily, with goods worth 11.5% of regional GDP transiting through the Suez Canal, Veneto (8.9%) and Friuli Venezia Giulia (8.8%).

It must also be taken into account that for Europe, the increased transport costs for goods and raw materials against the backdrop of the situation in the Red Sea must be added to the new requirements to pay for emissions from the maritime sector, i.e. for the pollution produced by ships transporting goods and bound for or calling at European ports. The new rules introduced by the EU directive, effective from 2024, require large commercial ships to pay a fee based on the CO₂ emissions they produce on their voyage to the European port of call. The ETS (Emission Trading System) charges will increase due to the increased CO₂ emissions from the longer route around the Cape of Good Hope.

2. The impact of shipping industry dynamics on the reorganisation of supply chains and on globalisation

With the escalation of disruptive phenomena, what clearly emerges are the risks and vulnerabilities of the current setup of global value chains which, in the presence of sudden shocks, jeopardise the resilience of the 'classical' globalisation model, forcing companies to rethink their supply chains and location decisions. Numerous uncertainties weigh on the future development of world trade, and heightened geopolitical tensions make even short-term forecasts more uncertain.

The trend that is already emerging is the growing interest in **the regionalisation of trade flows**, as a response to the need for a) shortened production chains that are less vulnerable to certain external shocks, and b) redesigned supply chains that are more neutral.

This obviously does not mean that it will be possible in the short/medium term to completely replace global supply chains with regional ones. Political reasons are pushing towards deliberate choices to decrease trade with China (so-called decoupling) on the part of Western countries, in order to reduce their dependence, particularly with regard to the supply of products identified as strategic. Indeed, some signs of this phenomenon are now evident, even though China continues to remain a major partner. The United States, for example, has reduced China's influence in recent years, especially in terms of imports. However, China remains the most important partner after Canada and Mexico. The situation with regard to the European Union is different, as in 2023 China accounted for 8.7% of exports and 20.5% of imports²; but in 2014 China's share of EU exports was 8% while its weight in imports was 15.8%. Thus, trade relations between the EU27 and China have strengthened over these 10 years. The costs of market fragmentation would be very high now, leading to a slowdown in trade and further paralysis along the main supply chains of manufacturing sectors. Crucial inputs for European economies would also be missing. In the medium to long term, the most likely scenario is a decoupling limited to strategic industrial sectors characterised by technology intensity and semiconductor use, which is already beginning to emerge.

The need for security exacerbated by conflicts is driving many governments to try to reduce their countries' dependence on key components from abroad. The United States, the European Union, and other major economies have announced plans to develop their industries particularly in sectors strategic to national interest and security.

These dynamics are fuelling a progressive regionalisation of trade and production chains, which in the European context would make it possible to strengthen economic cooperation in the Mediterranean and might result in a greater volume of maritime traffic within the basin.

The gradual consolidation of short sea routes, which is also evident in the growing offer of regular services and a dedicated fleet, is one of the factors behind the near-shoring choice of many companies, reducing part of their production in Asia and transferring it to industrial areas in the Mediterranean region, especially Turkey, Egypt and Tunisia, also to reduce the risk of future global shocks. This reinforces the process of vertical integration of shipping with production and makes the prospects for Mediterranean short sea routes more positive.

However, supply chains are difficult to establish and relocate and, to be efficient, they also require a good infrastructure endowment. Trade corridors only emerge when large investments in port and rail infrastructure are coupled with an industrial base supported by a manufacturing value chain.

² Eurostat [https://ec.europa.eu/eurostat/databrowser/view/ext_lt_maineu__custom_10519021/default/table?lang=en].

In this sense, great progress has been achieved with the creation of Free Zones, in particular in Morocco and Egypt, where special regulations and tax credits, as well as re-export orientation, have improved the economic prospects of the countries.

In addition to their geographical proximity, non-European countries on the Mediterranean shores offer a viable solution for reshaping EU production chains, capitalizing on the following aspects:

- Strong specialization in industrial areas of particular interest to European downstream companies.
- Competitive production costs.
- Significant strengthening of logistical and port infrastructure.
- Special Economic Zones that have attracted considerable foreign investment due to significant tax advantages and bureaucratic facilitations.

The opportunities presented by these competitive factors are intertwined with the need for careful monitoring of the economic and social instability prevalent in many of these countries, particularly in North Africa and the Middle East.

With regard to potential regionalization and nearshoring endeavors, ports and maritime infrastructure play a pivotal role in fostering North-South connectivity and underpinning regional integration, leading to a rise in short sea shipping. Over recent years, the Mediterranean region has seen the emergence of major ports, notably with the establishment of new transshipment hubs. These Mediterranean ports have enhanced their efficiency and allure, experiencing an average growth rate of 3.2% annually between 2008 and 2023, gradually narrowing the gap with Northern European ports.

The regionalisation of trade has triggered regionalisation processes in shipping.

All this is leading to a renewed centrality of the Mediterranean Sea, thanks also to the boost of the Suez Canal, a real chokepoint for world trade, which before the Red Sea crisis had broken all traffic records in 2023 with 26,000 transited ships (+10.5%).

To date, those benefiting most from a strengthening of the basin have been the port systems on the east coast, i.e. Greece and Turkey, and on the south shore, namely Egypt and Morocco. Tanger MED is leading the race among Mediterranean ports, establishing itself as the largest port with a 13% annual increase in containers handled in 2023, followed by Piraeus, Valencia, Algeciras and Port Said. Italian ports have struggled to capture the flow of maritime traffic, especially in the long-haul segment.

In 2023, intra-regional routes amounted to 86 million TEUs, or 43% of global container trade, a figure which in 2013 stood at 40%. When compared to ten years ago, in volume, intra-regional routes increased by 37% compared to 22% for East-West and 24% for North-South ones.

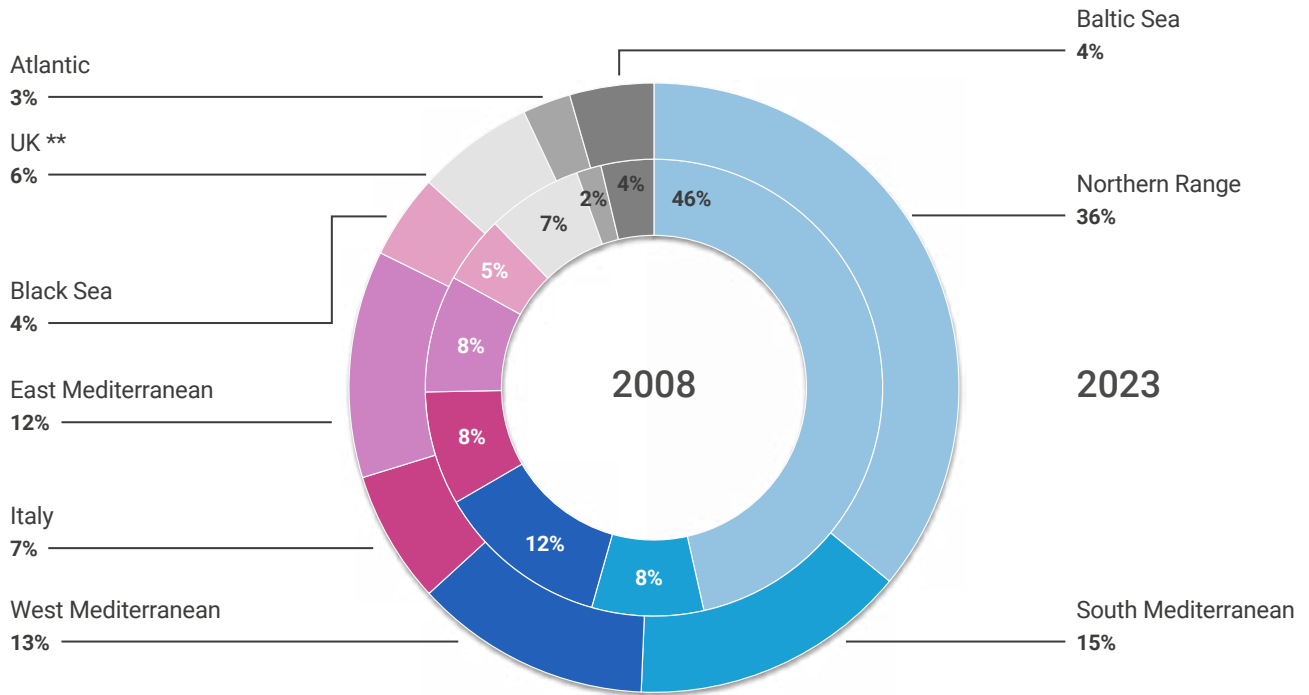
In forecasting terms, Clarksons Research predicts that container volumes will grow by 7% on all major routes by 2025.

In addition to its relevance in relation to large transoceanic flows (deep sea), the Mediterranean is also a privileged area for Short Sea Shipping (SSS), showing the most significant figure at European level with 595 million tonnes handled. SSS, due to its structural and flexibility characteristics, meets the needs of regional trade, and therefore, the evolving dynamics of shipping tend to strengthen this mode of transport in perspective.

Container transport within the Mediterranean is also growing, as intra-Med service capacity has grown by 17.6% in the past year, or by more than 75,000 TEU compared to December 2022, thanks to the deployment of more vessels by carriers (345 vs. 296).³

³ Alphaliner (2023), Weekly Newsletter 52.

Competitiveness of port systems. Comparison 2008-2023 *



* This visual only includes ports with 2023 throughput > 700,000 TEUs. ** UK figures are referred to 2022.

Figure 3 | Source: SRM on Port Authorities

Container volumes traded by route

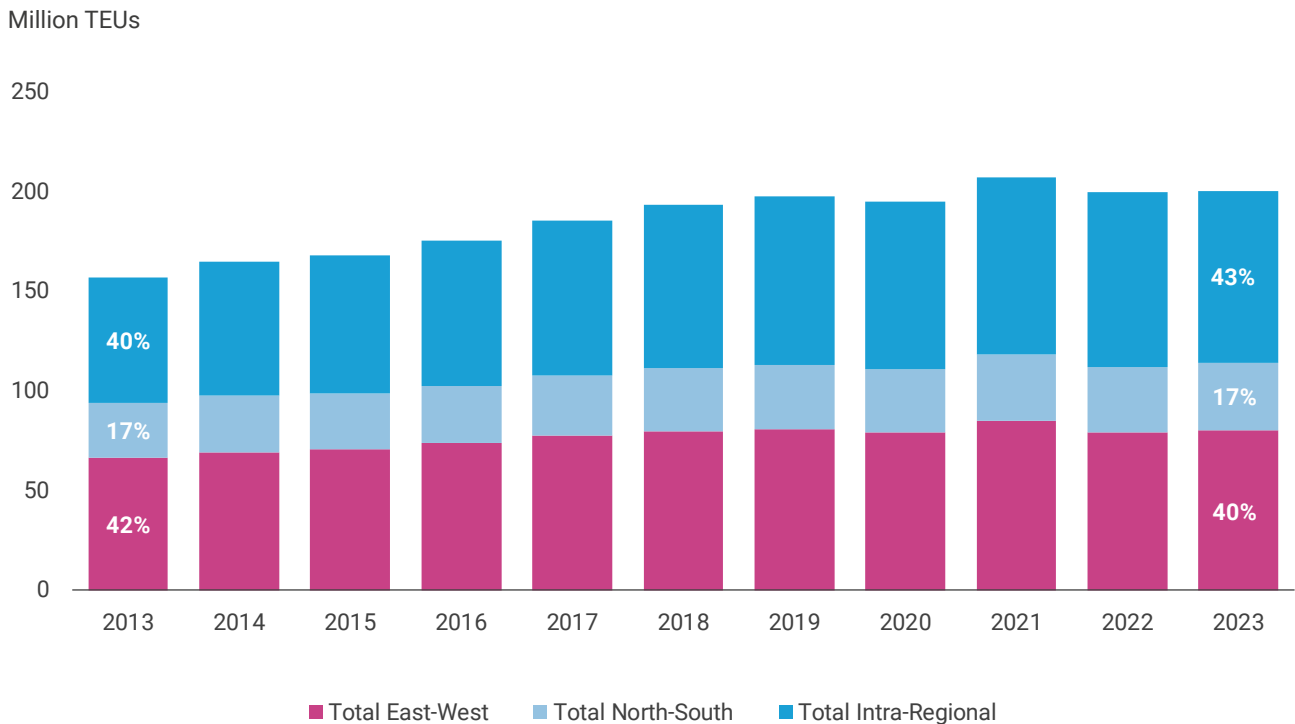


Figure 4 | Source: SRM on Clarksons

The reorganisation of trade balances in the Mediterranean represents an opportunity for Italy, which due to its strategic position could take on the role of logistics hub between North Africa and continental Europe, creating new opportunities also and above all for its ports. Italy can leverage its undisputed leadership in Short Sea Shipping as it ranks first in Europe by volume of goods handled in this way, amounting to 305 million tonnes, which gives it a market share of 17.4%, ahead of the Netherlands (16.1%), Spain (12.8%) and Germany (8.9%)⁴. Moreover, the Italian ferry fleet, made up of vessels best suited for Ro-Ro service, is a global leader.

Ro-Ro is an important lever for the development of short sea trades: its inherently intermodal nature, which allows for a combination of maritime and road/rail transport, gives it a high degree of flexibility with respect to the evolution of demand and to seize the opportunities related to the reshaping of trade flows. It is also the tool on which the European Union is relying to take goods traffic off the roads, with a view to making transport more sustainable. It is in this context that Italy once again confirms the 'Sea Modal Shift' incentive aimed at favouring the use of short sea routes by reducing traffic jams and pollution on the roads. The available funds amount to €39 million for 2022 and €21.5 million for each of the years 2023 to 2026.

Ro-Ro is a particularly important mode of transport for Italian ports; even in 2023, confirming a trend that has been recorded for some years, goods handled in rolling stock exceed those in containers. Of the top 10 European Ro-Ro ports in the Mediterranean, seven are located in Italy.

In order to fully exploit Italy's strategic position and its commercial and entrepreneurial commitment to Short Sea Shipping, it is important to overcome some possible limits to the competitiveness of the port system. In particular, action should be taken on the following four aspects, also addressed in part by the NRRP:

- **Improving the efficiency of port services by reducing ship docking times**, which are very high compared to main competitors. For instance, in 2023 the average waiting time in Italian ports is 1.28 days compared to 0.54 in the Netherlands and 0.86 in Spain.
- **Enhancing services and infrastructures for intermodality**, which are crucial for the revitalisation and marshalling of port cargo. Currently only two out of five major Italian ports are directly connected to the national rail network.
- **Developing back-port areas**, through the full implementation of Special Economic Zones (SEZs) and Special Logistics Zones (SLZs), two crucial tools for encouraging investment and new businesses.
- **Promoting the efficiency of ports from a green perspective**, focusing in particular on cold ironing, the development of infrastructure for the berthing of LNG/dual fuel or alternative fuel ships (ammonia, methanol, hydrogen) and enabling the use of renewable energy in port.

Generally speaking, the choice of one port over another by shipowners, logistics operators and port operators, no longer depends solely on the geographical factor, and in any case it requires that this factor be understood in an evolved sense. The port, therefore, is not a mere maritime infrastructure, but must be understood and looked at in this dynamic perspective that also enhances the efficiency and reliability of the entire intermodal connection. In conclusion, it can be said that in addition to the geographical location, other elements must be evaluated, such as the efficiency of the sustainable integration of the 'port system' in the back-port logistics network and all those additional factors that combine the traditional maritime and port safety aspects with the new and evolved commercial requirements underlying the entire shipping

⁴ Eurostat [https://ec.europa.eu/eurostat/databrowser/view/mar_sg_am_cw/default/table?lang=en&category=mar.mar_s].

sector. These include movement of ships, possibility of docking at the quay, operations that allow ships to carry out technical-nautical activities in safety, as well as all the bureaucratic, administrative and commercial procedures in the shortest possible time.

3. Development models for maritime transport supply in a constantly evolving economic scenario amidst progressive regionalisation

This complex economic framework coincided with some fundamental changes in maritime transport, including the digitisation of global supply chains, the continuing trend towards vertical and horizontal integration both on the sea side – shipping companies – and on the land side - ports, terminal operators and forwarders –, gigantism, the energy transition and, finally, the need to decarbonise maritime transport. All factors that affect fleet capacity.

Demand trends also affect supply in the shipping industry. By 2025, the global commercial fleet is expected to grow by 2.7%, the lowest rate ever recorded⁵.

Given that the sector is capital intensive, the uncertainty surrounding emissions regulations in shipping and new green fuels also affects the size of orderbooks.

No analysis of shipping can be complete without taking into account the high level of horizontal integration in the sector, particularly in container transport. Over the past 25 years, many shipping companies have disappeared as a result of mergers and acquisitions by larger companies, with the top 20 carriers almost doubling their market share from 48% to 91%. In 2012, the top 10 shipping companies accounted for 62% of the market. By 2024, this market share had increased to 84%. The four largest carriers now control more than half of the global container transport capacity. The concentration process then generated the three major alliances (2M, THE Alliance and Ocean Alliance) in the container market - organised as Vessel Sharing Agreements. The alliances, born in a market context characterised by an oversupply in terms of vessel and space availability with the consequent need to efficiently utilise it, had the objective of joining forces to recover economic margins by virtue of possible significant economies of scale.

This also allowed carriers to share cargo capacity to address strategic trade routes such as Asia-Europe, Transatlantic and Transpacific, while remaining independent in terms of logistics sales and pricing.

The phenomenon of alliances, after a decade of stability, is changing: the 2M will not be renewed at its natural expiry in January 2025, because conditions have changed since 2015. During this period, MSC has made huge investments in new ships, becoming the world's leading carrier. Maersk has not significantly expanded its fleet in recent years, because it has opted to expand its activities in logistics and other modes of transport, pushing another phenomenon that now characterises the container sector, namely the vertical integration of services provided ashore by logistics operators and forwarders in a door-to-door logic. According to Maersk's published financial results, the Logistics Division's turnover in 2023 amounted to \$14 billion, an impressive figure considering that the Group's overall turnover was \$51 billion.

In January 2024, there was the announcement of a new alliance between Maersk and Hapag Lloyd called 'Gemini Cooperation' starting in February 2025. Gemini will create a hub and spoke network with limited calls on deep sea routes, covering trade between Europe - Middle East - Indian Subcontinent, as well as East-West. The alliance will operate 26 main liner services and dedicated regional shuttles in Europe, the

⁵ The figure is reported by Clarksons based on reports dating back to 2004 and is expressed in terms of Dwt.

Middle East, Asia Pacific and the US Gulf. Maersk will contribute 60% of the ‘Gemini’ tonnage, while Hapag Lloyd will provide the remaining 40%, for a combined capacity of 3.4 million TEU. As a consequence of joining this venture, Hapag-Lloyd will leave THE Alliance at the end of January 2025. Gemini will become the second largest global container shipping alliance, after Ocean Alliance and surpassing MSC and THE Alliance. The aim is to achieve a timetable reliability of more than 90 per cent, minimising the number of calls per cycle and thus ensuring a faster turnaround.

Genoa, Vado Ligure, Leghorn and Trieste are the Italian ports scheduled to be visited by ships joining the alliance.

Alliances in containerised transport

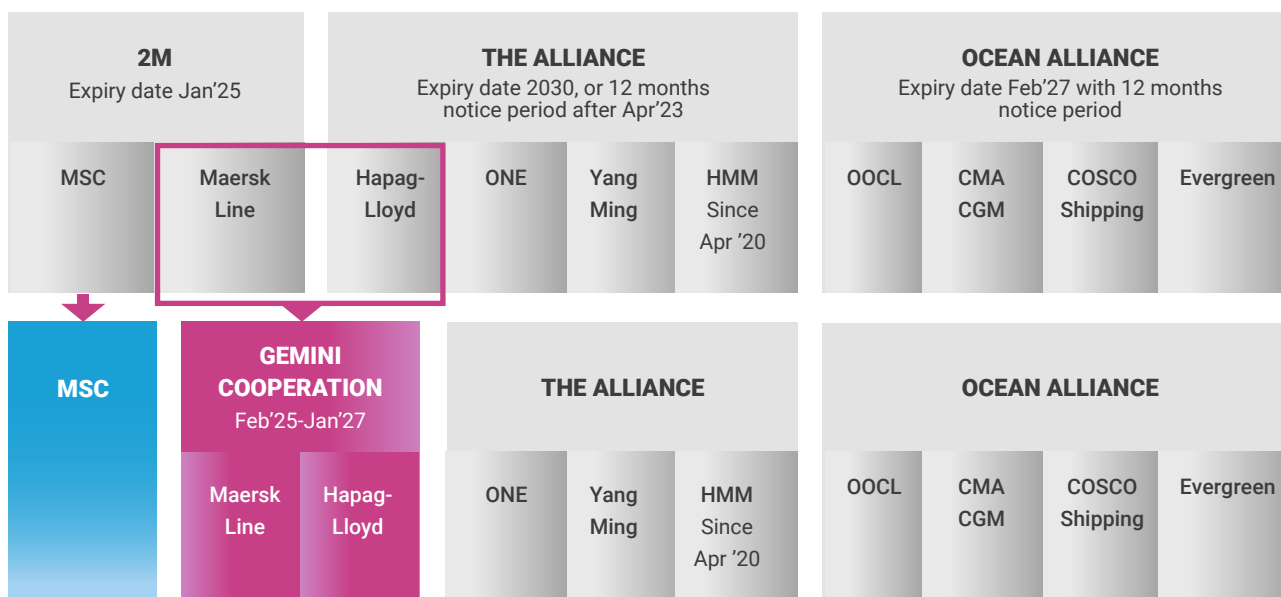
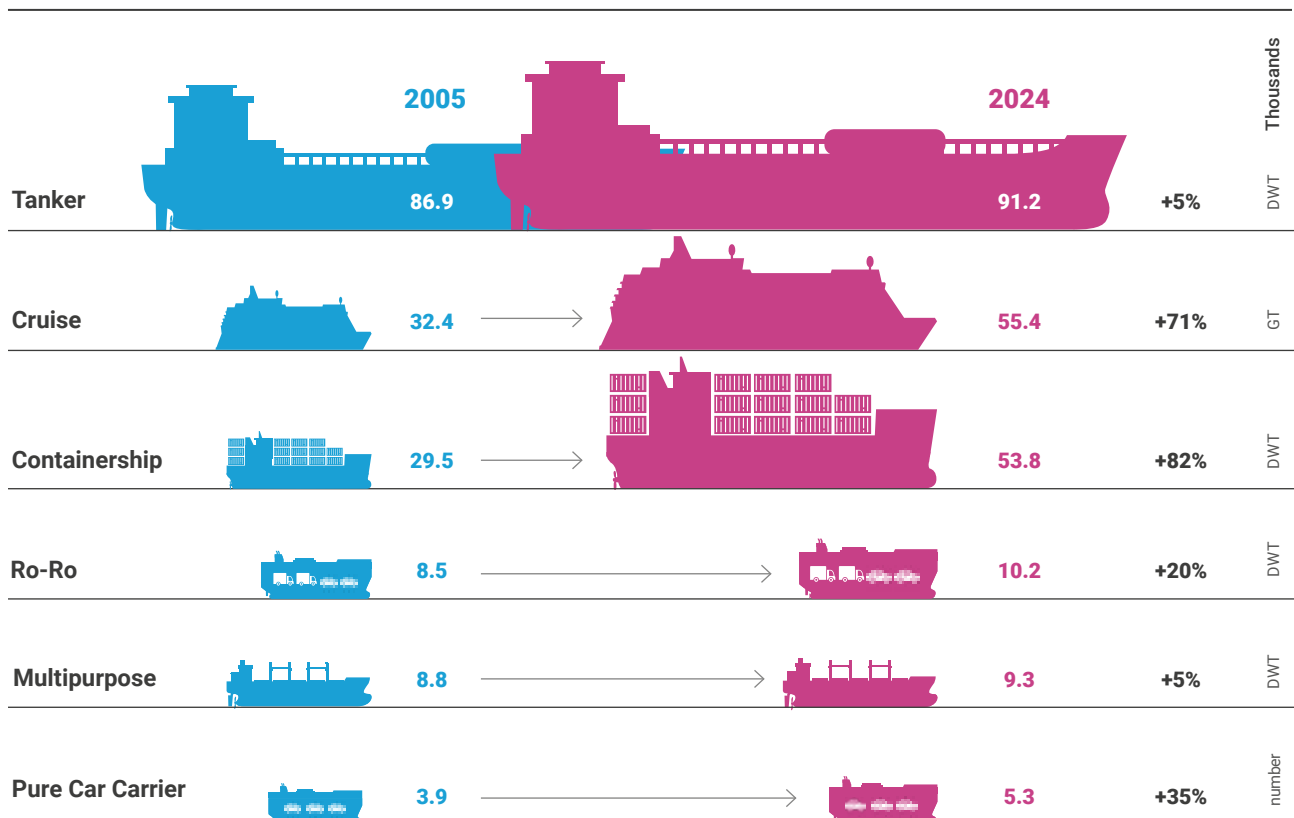


Figure 5 | Source: DHL Global Forwarding | OFR Market Update February 2024

The strategy of horizontal integration is also driven by the investment and operating costs associated with the increase in ship size, which has grown significantly over the past two decades. A ship with a larger capacity can transport more goods and reduce the unit cost, but this entails a more significant investment in the construction and operation of the ship itself, which translates into significantly higher costs for shipping companies. Not all market players can survive this trend, and this is a factor driving the industry towards concentration. The phenomenon of gigantism is common to all types of ships, as shown in Figure 6.

Evolution of average ship size by type of vessel in the period 2005-2024 *



* The unit of size is DWT for containerships, multipurpose, Ro-Ro and tankers; GT for cruisers and number of vehicles for pure car carriers.

Figure 6 | Source: Assoport-SRM, Port Infographics UPDATE 2024

The race for gigantism is also confirmed in the orderbook, particularly intense in the tanker and containership segment where Ultra Large will grow by 14% in 2025 compared to a growth in the overall container fleet of 6%⁶.

Increasingly larger ships pose a challenge to the capacity of ports and terminals, which have to invest in order to be able to handle goods in the most efficient and sustainable way at the quayside and in inland connections.

Vertical integration is also a strategic choice increasingly pursued by shipping companies, mainly because the growing demand for standardisation and digitisation of logistics processes can be better handled by an integrated logistics company. Possible bottlenecks or disruptions can be detected and solved earlier if the different parts of the supply chain are managed in a centralised manner. Precisely for these reasons, there has been a strong diversification of shipping business in the years since Covid, with major investments in adjacent sectors such as port infrastructure and air freight. Moreover, controlling these gateways has become even more important in the context of uncertainty and numerous conflicts that have characterised the last few years.

⁶ Banchemo Costa (April 2024), Containership Market Outlook.

It is no coincidence that shipping ranks as the second-largest sector within 'Transport and Logistics' in terms of mergers and acquisitions (M&A) in 2023. A total of 46 deals were struck, with 16 involving port infrastructure valued at \$4.2 billion. Notable among these was CMA CGM's acquisition of Bolloré Logistics for \$5.12 billion. However, compared to 2022, there appears to be a slowdown in the vertical integration of container shipping companies, likely due to a focus on maintaining liquidity in anticipation of forthcoming market challenges.

4. The energy transition

Over the past decade, the focus on sustainability has risen dramatically on the shipping agenda with environmental, social and governance (ESG) issues influencing funding decisions, fleet renewal and regulatory changes across the industry.

Shipping will produce 833 million tonnes and 2.2% of global CO₂ in 2024, making it the most carbon-efficient mode of emission.

Policies to reduce greenhouse gas emissions from international shipping have set very ambitious targets at both global and EU level.

In July 2023, the IMO decided to revise its initial GHG emission reduction strategy by setting a 'Net-zero' target for ships "by or around 2050" and establishing some monitoring steps, which can be summarised as follows:

1. **By 2030:** reducing carbon intensity (CO₂ emissions per unit of transport work) by at least 40% compared to 2008; reducing total annual greenhouse gas emissions from international shipping by at least 20%, aiming for 30 %, compared to 2008; zero/near-zero emission fuels must account for at least 5%, with a target of 10%, of the total energy used by the international shipping industry.
2. **By 2040:** reducing total annual greenhouse gas emissions from international shipping by at least 70%, aiming for 80%, compared to 2008.

Pressure to go beyond the IMO's current targets is mounting, with the European Union's regulation extending the ETS (Emission Trading System) to maritime transport from the beginning of 2024, to cover the CO₂ emissions of large ships (over 5,000 gross tonnage), regardless of the flag they fly.

The ETS is aligned with the EU's goal of achieving carbon neutrality by 2050 and a 62% reduction by 2030 compared to 2005 levels. The system operates according to the 'cap-and-trade' principle, progressively limiting total allowed emissions. There are no free allocations for the maritime sector. Emissions allowances will be allocated in full by auction

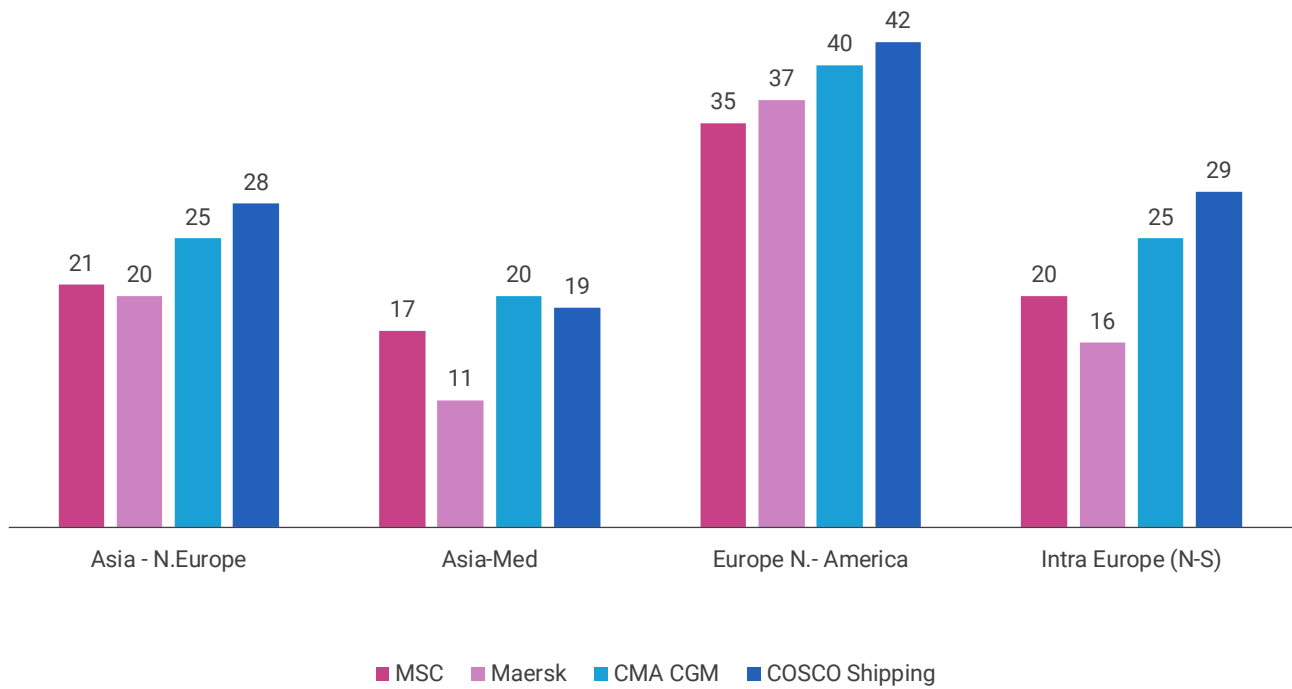
Obligations to surrender allowances apply as follows:

- 50% of the CO₂ emissions of voyages between an EU/European Economic Area (EEA) port and a non-EU/EEA port.
- 100% of CO₂ emissions of voyages between EU/EEA ports.
- 100% of CO₂ emissions during berthing in EU/EEA ports.

Emissions counted in this way (100% or 50%) are then subject to surrender according to a progressive schedule, with the exceptions provided for in the directive. In 2025, shipping companies are required to surrender allowances corresponding to only 40% of verified and reported emissions for 2024. This percentage rises to 70% in 2026 for emissions reported for 2025 and to 100% from 2027 for emissions reported for 2026 and subsequent years. European Union Allowances (EUAs) must be purchased and surrendered annually.

EU-ETS Surcharge by route and shipping liner in Q1 2024 *

€/TEU



* Europe - North America trades: COSCO and Hapag-Lloyd to ECNA, Maersk Med to WCNA, OOCL Europe to USA; Intra Europe trades: CMA CGM Intra Med.

Figure 7 | Source: Alphaliner, 50/2023

The EU-ETS covers emissions of CO₂, methane (CH₄) and nitrous oxide (N₂O), but the latter two only from 2026.⁷

In July 2023, the Council of the European Union adopted a new regulation to decarbonise the maritime sector, the **FuelEU Maritime**, to increase the uptake of sustainable fuels by ships and reduce their environmental footprint. The regulation is part of the 'Fit for 55' legislative package, which aims to reduce EU greenhouse gas emissions by at least 55% by 2030.

This measure will help reduce greenhouse gas emissions of fuel used by the maritime sector from 2% in 2025 to 80% by 2050 by promoting the use of cleaner fuels and energy, without specifying which is preferred.

This regulation aims to reduce the carbon footprint of the maritime sector in the EU and presents technical and logistical challenges both for ship owners, requiring innovations in fuel type, and for port infrastructure, in an area crucial to global trade.

In addition, with the **AFIR regulation** (No. 1803/2023), the European Union requires Member States to ensure an adequate number of LNG refuelling points in the main TEN-T ports from 2025 and the installation of shore-side electricity supply from 2030, at least in the main European ports touched by passenger ships and container ships.

⁷ For a more in-depth analysis of the ETS, see Chapter 4.

Timing and technology uncertainty remains for the shipping industry: new technologies and fuels are emerging, but the timing of the transition poses a huge investment challenge. Uncertainty about the alternative energy source for the future (LNG, hydrogen, ammonia or other) still poses a risk for operators who have to make investments with a 20-30 year timeframe, which means that it will probably be 2030 before a significant transition to clean fuels is seen. At the same time, the shipping industry needs to mitigate its carbon emissions with other technologies, such as better design of ships and their propulsion systems, with a transition to engines powered by low or zero carbon fuels.

The shift in fuel usage is underway, evident in the consistent rise in orders for alternative fuel ships over recent years. Currently, half of the order book in terms of GTs (49.5%) is geared towards alternative fuels or battery hybrid propulsion, marking a significant increase from 33.9% in early 2022 and merely 10.9% in 2017.

Orderbook (number of vessels) as of April 2024 for dual-power ships by type (size >100 GT)

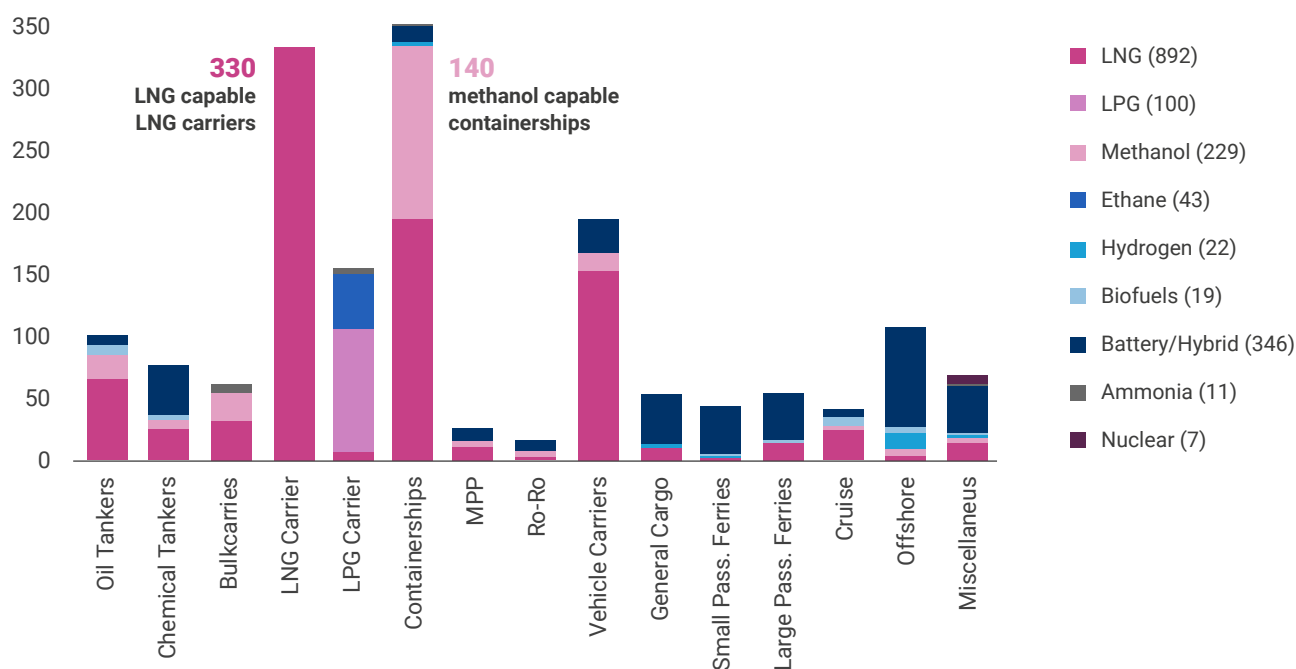
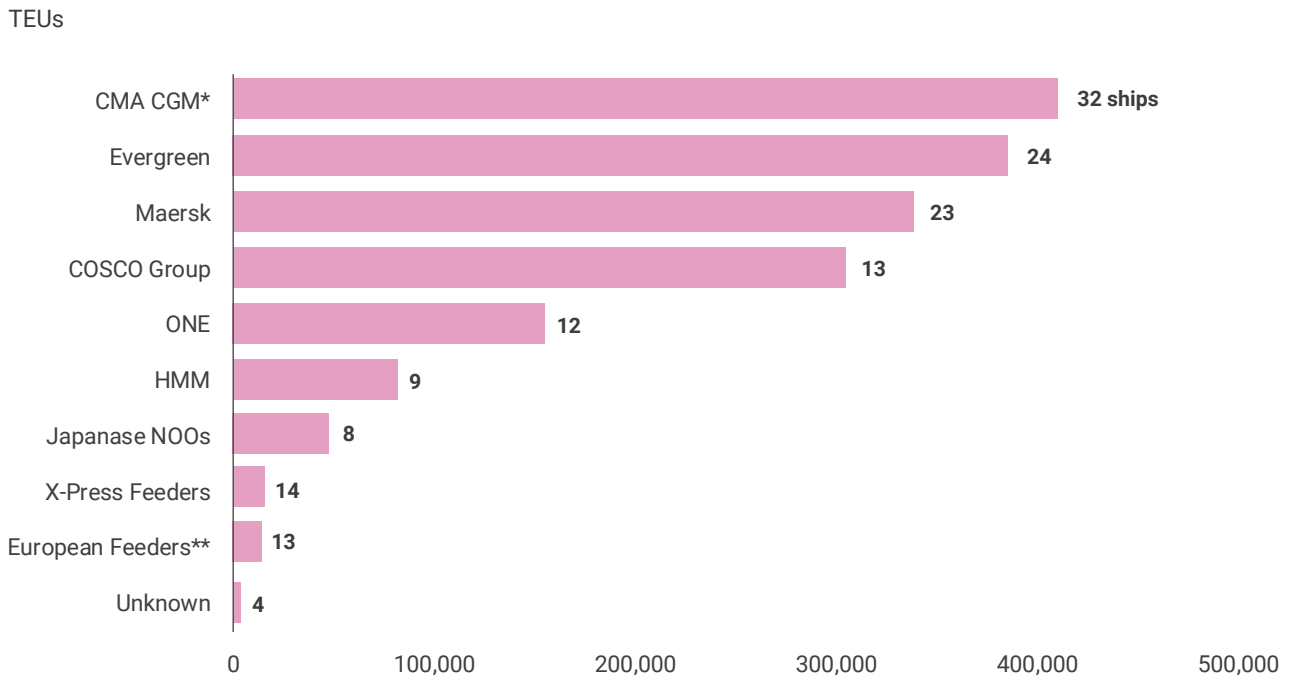


Figure 8 | Source: Clarksons

Meanwhile, 6.5% of the fleet at sea in terms of tonnage is already capable of using alternative fuels or propulsion, with this figure that stood at 4.6% at the beginning of 2022 and 2.4% in 2017. LNG has remained the most popular choice, but there has also been growing interest in methanol especially for the containership sector.

Orderbook of dual-power methanol vessels by liner as of January 2024



* CMA CGM figures include 8 x 9,200 TEU ships which might sail on LNG

** Orders for Unifeeder, NCL, A2B and Zephyr & Boree.

Figure 9 | Source: Alphaliner

Tuesday, February 6, 2024, marked a significant milestone in container transport with the inaugural voyage of the ANE MAERSK, weighing 16,592 tons, from Ningbo. This vessel stands out as the pioneer in employing dual methanol fuel propulsion.

In addition to this groundbreaking development, the Maersk Group has introduced C2X, a subsidiary of AP Moller Holding and AP Moller-Maersk, entities representing the financial and operational arms of the Maersk Group's principal shareholders. Their joint endeavor aims at establishing a green methanol production and distribution network tailored for maritime applications. Under this initiative, C2X has inked an agreement with the Egyptian government to construct a €3 billion 'hydrogen-to-marine fuel' plant within the Suez Canal Economic Zone. Scheduled to commence operations between 2027 and 2028, the facility, overseen directly by C2X, will leverage wind and solar power for H2 green generation, subsequently combined with CO₂ to yield methanol. Initially capable of producing 300,000 tonnes annually, the plant's capacity is projected to incrementally scale up to 1 million tonnes.

Alternative fuels also include LPG, ammonia, ethane, hydrogen, biofuels and batteries.

It is the pure car carrier category that is pushing hardest on alternative fuels, accounting for 83% of the orderbook, followed by cruises with a 71% share, containerships with 59%, Ro-Ros with 40%, tankers with 18%, and finally bulkers with 9%⁸.

⁸ Clarksons Research (February 2024), Alternative Fuels Installations by Vessel.

Fleet renewal options to date include newbuilding programmes, the purchase of modern ships or retrofitting with energy-saving technologies (ESTs): all options requiring huge investments in new construction, retrofitting and onshore. Looking ahead, emission policies could create upward market volatility by disrupting supply: lower speeds, more recycling, irregular fleet renewal, complex charter and S&P markets. In the long term, the energy transition will therefore have an impact on maritime trade.

Decarbonising the sector requires large investments: \$1.4 trillion may be needed just to halve emissions from shipping by 2050. Existing estimates indicate that decarbonising ships by 2050 requires additional investments of between \$8 and \$28 billion per year. Ashore, about \$28-90 billion per year is needed to increase production, fuel distribution and bunkering infrastructure to supply all zero-emission fuels by 2050. More expensive energy sources and onshore investments could increase annual fuel costs by more than \$100-150 billion in the event of full decarbonisation or a 70-100% increase compared to today (DNV, 2022).

The negative externalities of maritime transport occur not only during navigation but also while stationary in the port. Engines cause not only a high level of pollution and noise within the port area, but also in the wider surrounding area. Port investments in this field still seem to be lagging behind: according to data provided by Clarksons, the list of ports with alternative fuel bunkering worldwide is 200 out of about 6,000 and only 205 have shore power.

In this green transition, energy-related traffic will make ports more competitive. Ships and shipping companies, increasingly concentrated and global, will decide which ports to call, also based on the services they will be able to guarantee.

5. The role of logistics and shipping for the Italian economy. Port performances, the impact of changing trade models and of the green transition

A modern and efficient logistics system is a key lever for increasing the competitiveness of the manufacturing sector and improving the prospects of the national economy.

Manufacturing, transport and logistics are inseparably linked by a functional interdependence that has undergone profound changes over time as a result of market dynamics and the evolution of trade.

The evolution of the economy, the organisation of international supply chains and the growing role of shipping in Italy highlight the need for the country to put shipping and logistics at the centre of policy.

Ports and shipping are, in fact, indispensable for Italy given their weight in terms of added value and employment. The direct value of what is defined as the Blue Economy in Italy was €59 billion.

The Blue Economy is a long and articulated supply chain that embraces various sectors ranging from fishing, mining, manufacturing with shipbuilding, and above all, services. Among services, first and foremost, there is the maritime transport of goods and people, which covers 20% of the overall value and is the aspect that requires the most in-depth study because it is the central link in the chain that gives life to the entire sector. Research for the green economy, which currently accounts for the largest share (29%), also belongs to the services segment, followed by sea-related tourism, which is another major economic component, and shipbuilding.

Within the maritime cluster, Italy's ports, as diverse and complete multipurpose facilities, play a priority role, regardless of the economic value directly produced, amounting to €8.1 billion or 17.5% of the total sea economy⁹. Ports are the privileged gateway for raw materials and the marketing of finished products for the national production system, for which they represent an indispensable strategic support, indirectly contributing to much of the wealth produced in Italy. Ports also support tourism, since Italy is the second country in EU27 (after Greece) in terms of the number of passengers transported by sea.

Italian ports managed more than 474 million tonnes of goods in 2023, marking a 3.2% decrease from 2022. This decline mirrors the economic slowdown, particularly evident in household consumption (+1.4% compared to +5% in 2022) and investment (+0.6% compared to +9.7% in 2022). Among the various types of cargo, Italian ports predominantly handle liquid, container, and Ro-Ro shipments. Notably, Ro-Ro cargo emerged as the primary category among solid goods, being the sole type to register a positive change in 2023.

Tonnes of goods of the Italian port system by type. 2021-2023 trend

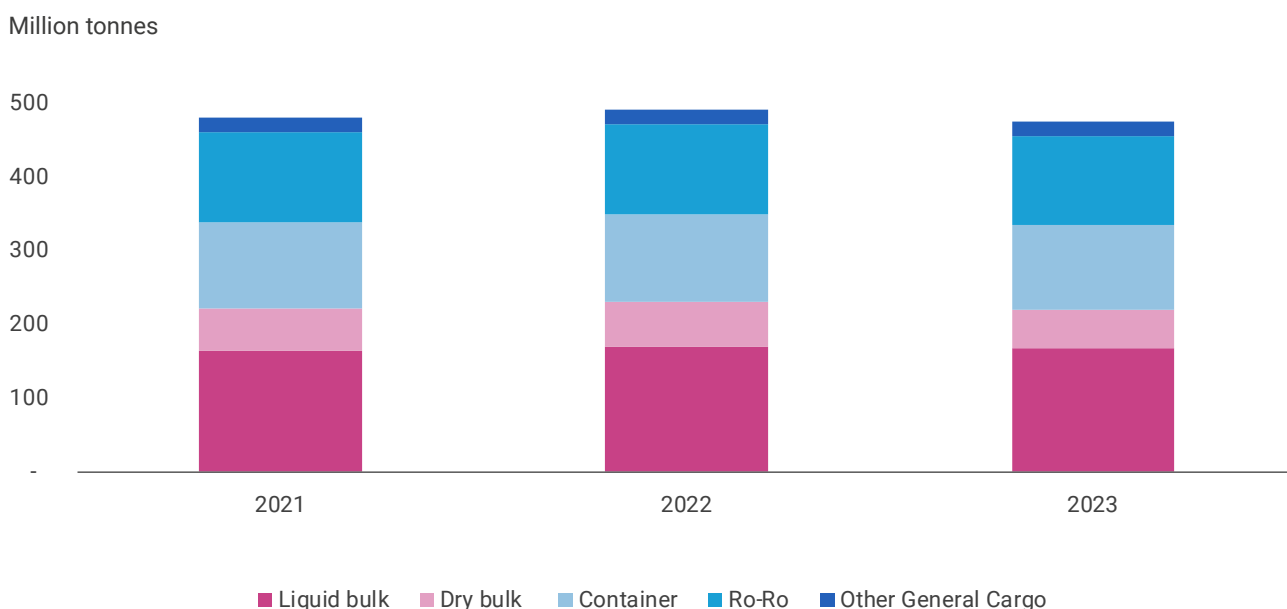


Figure 10 | Source: SRM on Assoport

On a different note, passenger traffic tells a contrasting tale, surging by a significant 16% countrywide. Particularly, cruise enthusiasts saw a remarkable 48% increase. Italy's dominance in Mediterranean cruise traffic remains unchallenged, capturing a solid 40% share of the region's total.

Italian ports are not just geographical points, they are deeply integrated into the nation's landscape, connecting with production hubs and providing a boost to small and medium-sized enterprises. They play a crucial role in Italy's import/export dynamics, accounting for 28% of value and a hefty 50% of volume.

⁹ 9th Standing Committee for Transport, Post and Telecommunications, 15th November 2023.

Italian import-export in value by mode of transport - 2023 data

Billion euros

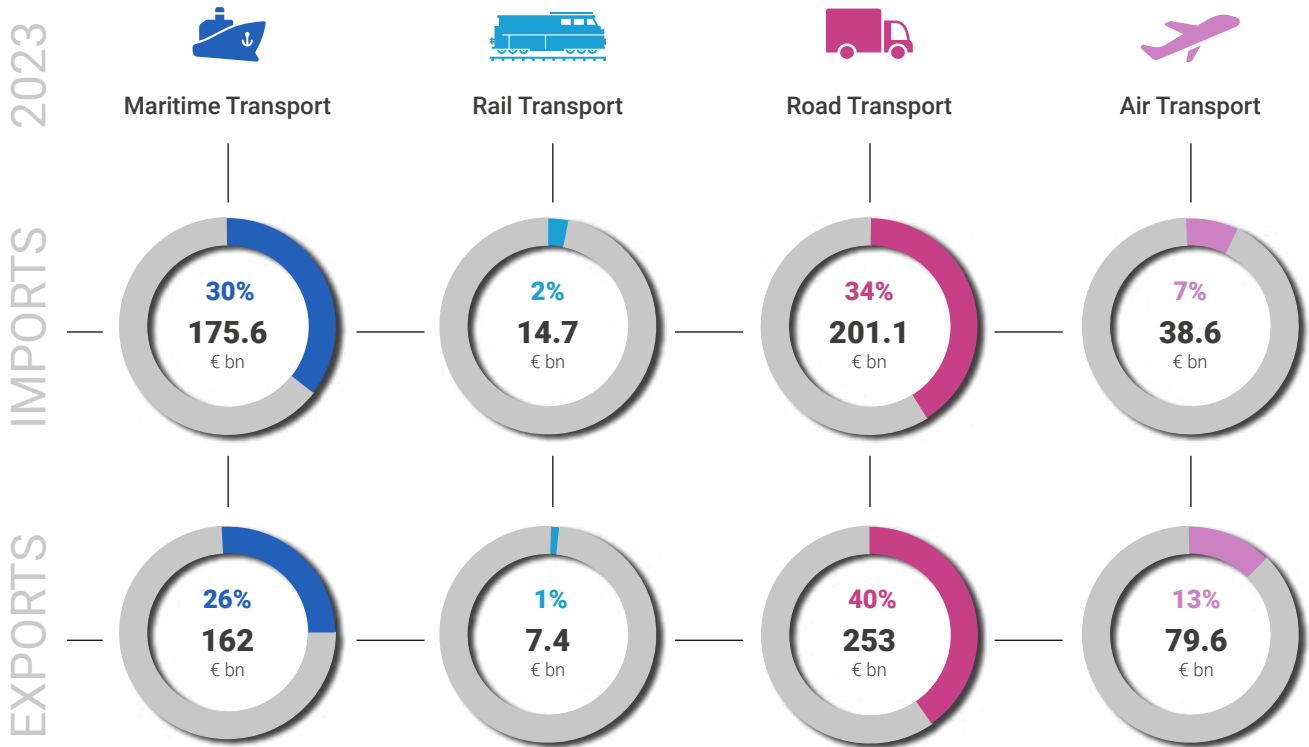


Figure 11 | Source: Assoport-SRM, Port Infographics UPDATE 2024

As for ports, across the 16 Port Network Authorities, each one brings its own unique characteristics to the forefront. Ranging from liquid cargo dominance in the Eastern Adriatic Sea to container specialization in the Southern and Ionian Tyrrhenian Sea, and Ro-Ro focus in the Northern Tyrrhenian Sea and Eastern Sicily, to a diverse mix of goods in the Ionian Sea and Northern Central Adriatic Sea (Figure 12).

Italy stands as one of the world's major exporters, ranking sixth globally, following China, the United States, Germany, the Netherlands and Japan. Notably, among large nations, Italy boasts one of the highest export+import/GDP ratios, indicating a significant openness to foreign markets. It's worth noting that generally, smaller nations with robust industrial and commercial sectors tend to exhibit greater openness to foreign markets compared to larger counterparts, where the domestic market carries more weight (as seen in the case of the United States).

Italian foreign trade has played a crucial role in supporting the national economy in recent years. Particularly, exports have been instrumental in bolstering aggregate demand, compensating for sluggish domestic household consumption and investment.

Italian ports, renowned for their specialization in rolling stock transport and accounting for 61% of container traffic in the gateway category, clearly demonstrate their commitment to serving local businesses and consumption needs.

Goods handled by Port Network Authorities in 2023

Million tonnes

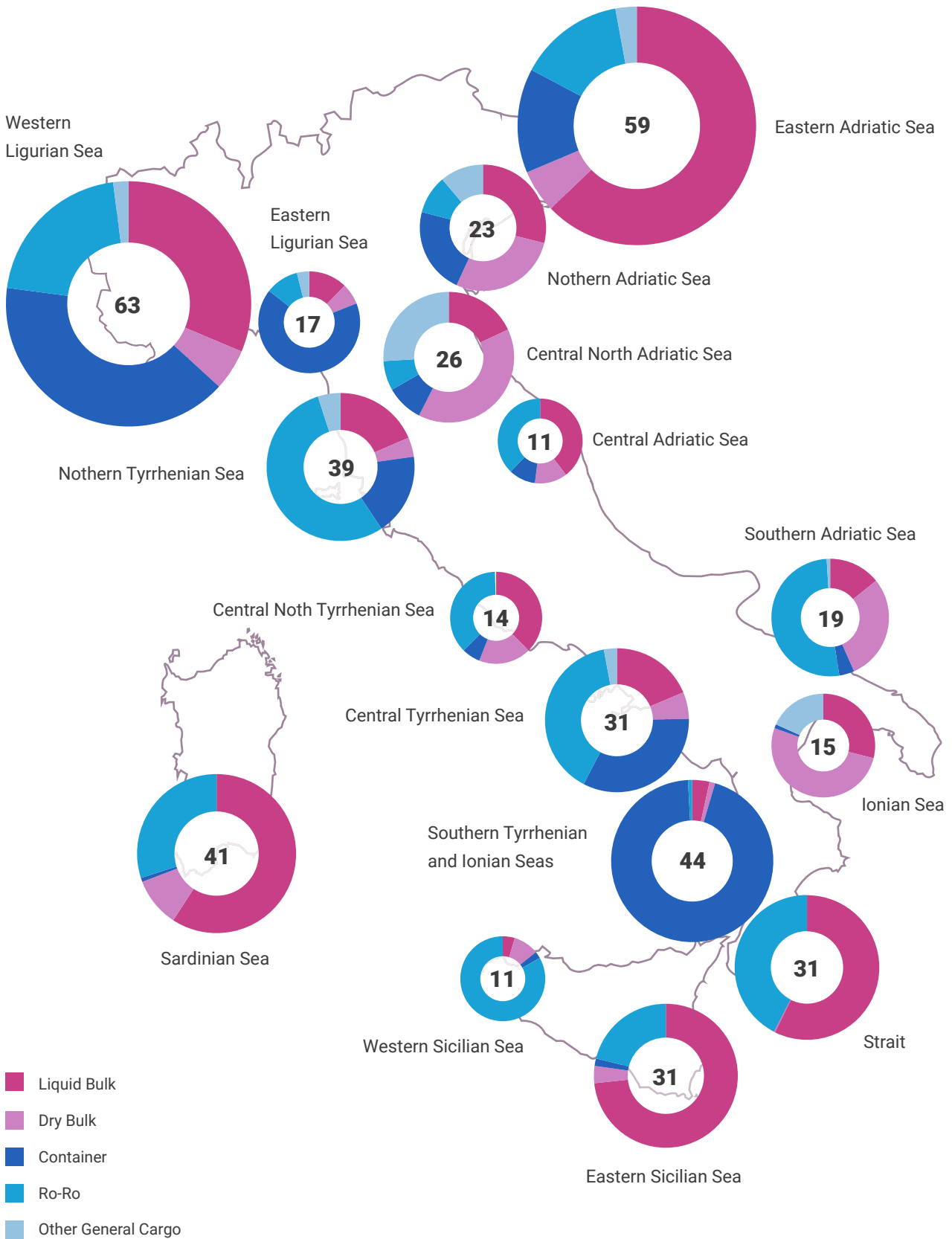


Figure 12 | Source: SRM on Assoporti

Given the inherent nature of the Italian economy, the port system emerges as a pivotal asset for enhancing competitiveness. It must effectively adapt to accommodate the evolving dynamics of trade and maritime traffic to maintain its relevance and effectiveness in facilitating economic activities.

Nonetheless, Italian ports must increasingly leverage intermodality. In fact, modern ports were born with the modal shift and are key to the development of the manufacturing-transport link. Competitiveness is, as has become evident especially during these last few years of concentrated disruptive phenomena, increasingly driven by maritime connectivity, speed of delivery and the effectiveness and efficiency of logistics processes. Significant actions are planned in Italian ports, grouped in investment programmes, aimed at meeting these needs, which are financed with PNRR and national funds.

Port investment programmes (million euro)

	Name Programme	Cost	Allocation by DM 353 and 'port decree' 332	NRRP funds	PNC funds	Other sources	Remaining needs
1	Maintenance of public assets	446.29	101.46	7.63	-	189.22	147.98
2	Digitalisation of logistics and ICT	32.18	-	32.18	-	-	-
3	Last/Penultimate Railway Mile and Connections to the Port Network	718.63	44.20	52.61	230.00	260.79	131.03
4	Last road mile	818.36	109.04	46.21	20.00	543.05	100.06
5	Maritime accessibility	3,393.92	139.12	-	1,140.35	867.14	1,247.31
6	Resilience of infrastructure to climate change	640.73	-	107.50	315.50	163.40	54.33
7	Energy and environmental efficiency	1,188.20	29.40	74.17	693.95	118.64	272.05
8	Waterfront and cruise and passenger services	503.84	20.10	-	10.17	209.13	264.44
9	Industrial activities in ports	1,244.57	121.00	8.20	-	949.01	166.36
10	Targeted increase in port capacity	2,947.22	244.23	20.00	390.00	1,335.56	957.43
	TOTAL	11,933.94	808.55	348.50	2,799.97	4,635.94	3,340.99

Table 2 | Source: 'Strategies for Infrastructure, Mobility and Logistics' Annex to the Economic and Financial Document

6. Conclusions

It is evident that 2023 posed numerous challenges for the maritime industry. From geopolitical and economic shocks to supply chain disruptions, inflationary pressures, and the impact of climate change on routes, the industry faced a myriad of obstacles. Additionally, ongoing conflicts and the global trend of social and political fragmentation further complicated matters. As we reflect on the situation at the end of 2023, several significant trends emerge that are poised to shape the industry in the near future.

The first aspect to consider concerns geopolitical developments. As repeatedly acknowledged, even in the short term it is not possible to make predictions on the development of the current conflicts; what

is certain is that they have had a considerable impact on maritime traffic. The war in Ukraine was a significant factor, with negative effects on dry bulk and positive consequences on tankers. The Red Sea front has changed trade patterns impacting trades, especially for transshipment ports. A potential increase in trade protectionism (or 'friend-shoring') could also lead to changes in trade flows and limit demand for some high-margin or critical products.

From a strictly economic point of view, some key trends that are very likely to shape the dynamics of maritime transport in the EU, and thus in Italy, are outlined below.

Naval Gigantism has been developing for a while. Although mega-ships have also been the subject of strong criticism in terms of economic sustainability – especially from the point of view of ports and the infrastructure investments they bring with them – these vessels represent for shipowners the investment to be made in the immediate future.

Technological innovations are reshaping the maritime industry landscape. The push for digitization stands out as a crucial trend, with major players leading the charge by integrating technology into their operations to enhance efficiency and achieve cost savings. Throughout 2023, the maritime technology sector witnessed significant activity, marked by numerous large start-up acquisitions and increased investment from shipowners and operators in start-ups, as well as partnerships with venture capital funds aimed at operational improvement.

The widespread adoption of advanced technologies, including artificial intelligence and robotics, is poised to revolutionize operations for all shipping stakeholders, from terminals to inland connections. This transformation is essential for maximizing efficiency and enabling charterers to respond swiftly to crises while enhancing decision-making processes.

In the Mediterranean, which remains a strategic hub for global trade, there is growing awareness of the importance of deeper cooperation and improved coordination in technological and digital innovation. Such collaboration has the potential to mitigate threats and vulnerabilities in supply chains while also addressing inflationary pressures. Leveraging the Mediterranean's status as a global communications hub is crucial, given that one-third of the world's submarine cables are located in its seabed.

Environmental sustainability is gaining greater significance within the maritime industry. It has been noted that financial and environmental regulations have a significant impact on business decisions in this sector, with regulatory shifts towards decarbonization already in progress. The growing emphasis on environmental considerations seeks to mitigate the ecological footprint of maritime transportation and foster the development of sustainable port-city relations. This is particularly relevant in our country, where ports are often situated within densely populated urban areas. Addressing this challenge will involve implementing strategies geared towards adopting more sustainable practices and reducing the carbon footprint of port operations.

These macro trends will naturally also influence Italian port activity, which follows a multipurpose strategy and which, while serving major international lines, shows a growing Mediterranean activity. In addition, it boasts some significant niche specificities, and the role of growing activity in the energy sector should not be overlooked.

Our ports face challenges in terms of both sea and land-side infrastructure, as well as limited intermodal capacity. What is crucial is to foster a broader vision of systemic collaboration, along with organizational and logistical coordination between the business ecosystem and infrastructure. In Italy, there's a disconnect between manufacturing and logistics sectors. While manufacturing entrepreneurs excel in creating high-quality products, they often refrain from delving into logistics, leaving it to other, frequently

foreign, entities. Furthermore, they don't typically view logistics as a core aspect of their business, though they acknowledge its functional importance.

Despite this gap between infrastructure and manufacturing, the growing interest in Ro-Ro as well as containers highlights that there are changes taking place as a result of new trends in nearshoring, sustainability and the growth of e-commerce.

However, these elements of infrastructural and above all organisational nature need to be improved in terms of delivery times, storage costs and the loading/unloading and handling of goods. This is intended to avoid the movement of goods to other Mediterranean and Northern European ports.

Moreover, Italian ports, particularly those with a significant focus on the energy sector, are experiencing an energy revolution and will continue to play a central role in this realm. These ports must prioritize efforts to make their operations more environmentally friendly, evolving into genuine energy hubs. They are poised to play a pivotal role in facilitating the transition towards sustainable energy by fostering synergies between the Mediterranean's shores. This includes leveraging the abundant renewable energy sources in North Africa.

If Italy were to overcome its limitations, it could seize a significant opportunity within the Mediterranean region, particularly during a time marked by increasingly shortened production chains and regionalization trends.

The Italian port system has its unique trajectory for development and growth. The more it fosters seamless connections with production stakeholders, such as through the proactive engagement of Special Economic Zones (SEZs) and Logistic Zones (LZs) strategically positioned for business development, the greater its potential for expansion.

Chapter 2 | **Commodities and logistics.**

Inflationary risks

The global macroeconomic landscape this year has been marked by a moderate economic slowdown and disinflation. However, it has also been influenced by uncertainties stemming from monetary, economic, political, and climatic factors. Overall, forecasts indicate downward risks to growth and upward risks in inflation, driven by ongoing tensions in commodity markets and global logistics chains.

For instance, the future trajectory of reference interest rate cuts implemented by the Federal Reserve and the ECB will hinge on several factors. These include: a) the evolution of significant inflationary risks, driven by commodity prices remaining higher than pre-Covid levels; b) geopolitical risks, such as potential further damage to oil and gas infrastructure in Russia, Ukraine, or the Middle East; c) disruptions to logistic flows through key passages like the Red Sea, the Black Sea, the Panama Canal, and the US following the collapse of Baltimore's Francis Scott Key Bridge. Consequently, it is possible that higher-than-anticipated inflation could prompt central banks to exercise greater caution, potentially delaying the next cuts or reducing the number of interventions planned for 2024 and the beginning of 2025.

As for political risks, these are mainly linked to the next US Presidential Elections. In particular, markets appear concerned about the possible implementation of more restrictive trade policies alongside protectionist interventions and a re-adjustment of policies aimed at energy transition and combating climate change.

It is maintained that less stringent emission reduction or mitigation measures, as well as the adoption of less ambitious climate targets, might exert downward pressures on metals prices due to expectations of less marked increases in future demand. However, these downward pressures might be offset by upward pressures on prices driven by a growing need for commodities. Specifically, metals will benefit from the necessity to invest in new infrastructure to accommodate demographic growth, urbanization processes, and varying climatic conditions. Indeed, a significant increase in global demand for commodities is expected in the next 3 to 10 years, which can only be met if supply is increased, and technological advancements are pursued.

Indeed, the levels of supply, both currently available and planned, will only be able to meet future demand if two significant negative factors are taken into account.

Firstly, for Western countries, supply security is a political priority and implies the development of new extraction and refinery capacity in countries seen as more politically reliable and closer to consumer markets. It would therefore be necessary to keep prices high so as to foster increases in global supply while also encouraging the development of more resilient supply chains.

Secondly, tactical considerations related to the current economic and financial scenario are, on the contrary, pushing for an immediate reduction in supply, with many producers and exporters of fossil fuels, industrial metals, and agricultural commodities already implementing production controls aimed at bolstering prices and profit margins, while inventories of many of these commodities are at historically low or declining levels.

In the industrial metals sector, news intensified of supply cuts, voluntary or otherwise. As for the copper market, there was the forced closure of the Cobre mine in Panama, one of the most important open-pit mines in the world, ordered by the Supreme Court at the end of 2023, and in 2024 there were downward revisions of production estimates from Zambia due to insufficient power generation, and the announcement by the China Nonferrous Metals Industry Association of possible restrictions on the development of new refining capacity by the Chinese government and voluntary cuts in the supply of refined copper by smelters. In fact, in March, major Chinese players in this sector agreed to extend maintenance periods, reduce plant utilisation rates and delay new projects in order to protect margins. As for the nickel market, Indonesia and China, which together control about 70 per cent of world supply, plan to reduce production to curb falling commodity prices. Some of the western mining giants have also delayed the start of new nickel mining projects, revising production estimates downwards and decommissioning some plants to mitigate losses.

As downward adjustments to world supply estimates occur amidst historically low average world inventories, the global supply of metals may soon prove insufficient to meet demand. Should consumption growth accelerate again—driven by a more favourable macroeconomic scenario, the energy transition, and the necessity to address population growth, urbanization, and climate change—market deficits would likely expand. Consequently, it is anticipated that prices of most non-ferrous metals will rise by the end of 2024 and in subsequent years, prompting a necessary increase in supply to restore comfortable inventory levels.

Supply issues have also afflicted agricultural commodity markets, exacerbated by logistical challenges, particularly in the Red Sea region, as well as the enforcement of protectionist policies and export restrictions by governments. Additionally, speculation by brokers, notably prominent in some soft commodity-producing countries, has further worsened the shortage conditions, limiting deliveries to ports.

1. Oil: cuts to crude production, geopolitical risks and logistic problems limiting the availability of refined products

The OPEC+ is the most evident example of the efficacy of tight controls on production and exports in maintaining price stability at high levels. After the first unprecedented 10-million-barrel cut was announced on 9th April 2020, this marks the fourth consecutive year of significant collective cuts. Although compliance among members of the organisation has been uneven – with a Saudi Arabia-led party implementing voluntary additional reductions – and despite serious geopolitical risks in the Middle East and Russia,

the Brent price stability in Q4 2023 and Q1 2024 indicates that supply adjustments have yielded positive results. This is also due to a generalised slowdown in global economic growth.

In fact, OPEC+ adopts proactive oil policies aimed at curbing supply surpluses and in H1 2024 it implemented major supply cuts, a combination of shared mandatory reductions for all members and additional voluntary cuts. The latter, amounting to 2.2 million barrels per day (mb/d), are 'aimed at supporting the stability and balance of oil markets', as outlined in the official communiqué, and 'will be returned gradually subject to market conditions'. As in previous instances, Saudi Arabia shoulders the largest share of the burden, committing to a cut of 1 mb/d. Other participating members contributing to the supply cuts include Iraq (-0.220 mb/d), United Arab Emirates (-0.163 mb/d), Kuwait (-0.135 mb/d), Kazakhstan (-0.082 mb/d), Algeria (-0.051 mb/d), and Oman (-0.042 mb/d).

The Saudi commitment is not surprising, given the country's medium and long-term needs: in the medium term, it would be desirable to keep the price of oil as close as possible to the budget breakeven-price, i.e., the level that allows fiscal spending to be balanced, estimated by the International Monetary Fund (IMF) at \$96 for this year. In the long term, it is necessary to have oil prices as stable and high as possible to incentivize foreign investment and finance projects to diversify the economy, which are essential to ensure a future for the country when peak oil demand is reached, and oil revenues may start to decline.

Russia has also pledged to cut its supply by 0.471 mb/d in Q2, but with varying percentages of crude oil production and product exports. Specifically, in April the reduction will affect 350 thousand b/d of production and 121 thousand b/d of exports, in May 400 thousand b/d of production and 71 thousand b/d of exports, and in June 471 thousand b/d from production. It is believed that this supply adjustment from Russia could bolster refining margins and oil product prices in Europe during Q2 2024. These markets are already experiencing significant strain due to multiple factors, including frequent attacks on Russian refineries by Ukrainian drones, Western sanctions limiting Russian product exports to Europe, and logistical challenges stemming from Houthi rebels' attacks on ships transiting the Red Sea.

It is worth noting that Ukrainian attacks on infrastructure in Russia have been very effective in reducing the country's refining capacity, at least temporarily. For instance, industry sources estimate that refining capacity of about 0.9 million barrels per day (mb/d) was taken offline in Russia in March. In the week of 14-20 March alone, average daily volumes of crude oil processed by Russian refineries reportedly fell by as much as 0.4 mb/d to around 5.3 mb/d, the lowest in 10 months. Moreover, the damage to infrastructure is likely to have negative medium- to long-term implications, as international sanctions limit Russia's access to essential technologies and components for both extraordinary repairs and routine maintenance.

Transit problems in the Red Sea for oil and LNG tankers are also heightening the risk of further rises in the prices of key energy commodities. In fact, according to data from the International Monetary Fund (IMF), cargo volumes transiting through both the Suez Canal and the Strait of Bab el-Mandeb plummeted by 50 per cent in the first two months of 2024, while volumes transiting the Cape of Good Hope increased by about 74 per cent year-on-year.

The disruptions are even worse in the oil and gas world. For example, in Q1 2024 only 7 LNG carriers from the US bound for Asia passed through the Suez Canal, compared to 26 in the same period in 2023, but within this timeframe all cargoes were delivered in January, and none in February and March. The global share of LNG transiting the Red Sea plummeted from 8% to 0% in just a few weeks. These figures raise awareness of the importance of secure infrastructure and logistical corridors for energy supply.

In addition, these disruptions bring about an increase in global demand for shipping fuels, as ships consume more to travel longer alternative routes while increasing speed to limit delivery delays.

As a result, there are greater volumes of oil and LNG in transit. The International Energy Agency (IEA) estimates that in February alone seaborne oil volumes rose by 85 million barrels to 1.9 billion barrels, the highest since the Covid crisis of 2020.

Prices of Brent Oil (USD/barrel) and Diesel (USD/ton, right-hand axis)



Figure 1 | Source: Intesa Sanpaolo on Bloomberg data

2. Gas and energy markets: from the energy crisis to a new balance

In Q1 2024, Europe experienced gas and energy prices that were notably lower than the average levels recorded in 2021, 2022, and 2023. This decline can be attributed to exceptionally favourable temperature anomalies, alongside reduced consumption and ongoing diversification processes in both supply and generation mix.

On the one hand, consumption continues to steadily and structurally contract due to efficiency measures, electrification efforts, and fuel-saving initiatives implemented by households and companies. On the other hand, the diversification of gas supply sources and electricity generation has accelerated, particularly since the war in Ukraine. This trend is expected to persist in the coming years, driven by further increases in the percentage of gas demand met by LNG and pipeline shipments from Russia, as well as the rising share of generation from renewable sources.

Favourable weather conditions, ample supplies, and declining consumption enabled European storages to achieve an all-time high fill level of 99.6% on November 5th. As of March 16th, storages remained at seasonal highs, boasting a fill rate of 59.7%, surpassing the previous record of 56.4% set in 2020 during the height of the Covid crisis, and well above the five-year average of just 35.1%. Consequently, Europe will enter the injection season with above-average reserves, and filling requirements during the summer are expected to be minimal, thanks to the structural decline in consumption.

Consequently, it is anticipated that any upward pressure on prices will be mitigated throughout the summer, although there will still be a few risk factors. These include persistent concerns regarding the security of supply, the potential disruption or cancellation of LNG shipments due to transit issues in the Red Sea, heightened competition with Asia spurred by an unprecedented heatwave in South-East Asia, potential declines in pipeline import volumes due to unforeseen maintenance or infrastructure vulnerabilities, uncertainties surrounding power generation from renewables, nuclear, and coal, as well as thermal anomalies that could amplify final demand.

In the baseline scenario, the TTF, the benchmark for European natural gas, is anticipated to fluctuate significantly over the coming months, trading between a support level of €20/MWh and a resistance level of approximately €45/MWh. The support level is a significant one for coal-to-gas switching, but is also justified by geopolitical risks and the vulnerability of European and Ukrainian infrastructure. The resistance level is explained by the current good storage fill levels.

Following potential upside risks in the winter of 2024/25, amplified by the unwillingness of Ukraine and Russia to renew the transit agreement expiring at the end of the year, from 2025 onwards a process of price moderation is anticipated in all scenarios, explained by the expected increase in global LNG supply, which will help to restore a 'new normal' in energy markets.

However, this new equilibrium is likely to be characterised by volatility and wider price ranges than the pre-Covid equilibrium. This is due to the increased dependence of European and Asian economies on international LNG flows, meteorological risks (which impact both energy demand and production) and geopolitical risks (which will continue to fuel potential negative impacts on fossil fuel transport and production).

It is important to note that the gas market has become global in nature, which has led to prices being influenced by two key factors: the constant competition between various consumption centres to secure

Prices of LNG TTF (European benchmark) and LNG JKM (Asian Benchmark) in USD/MMBtu

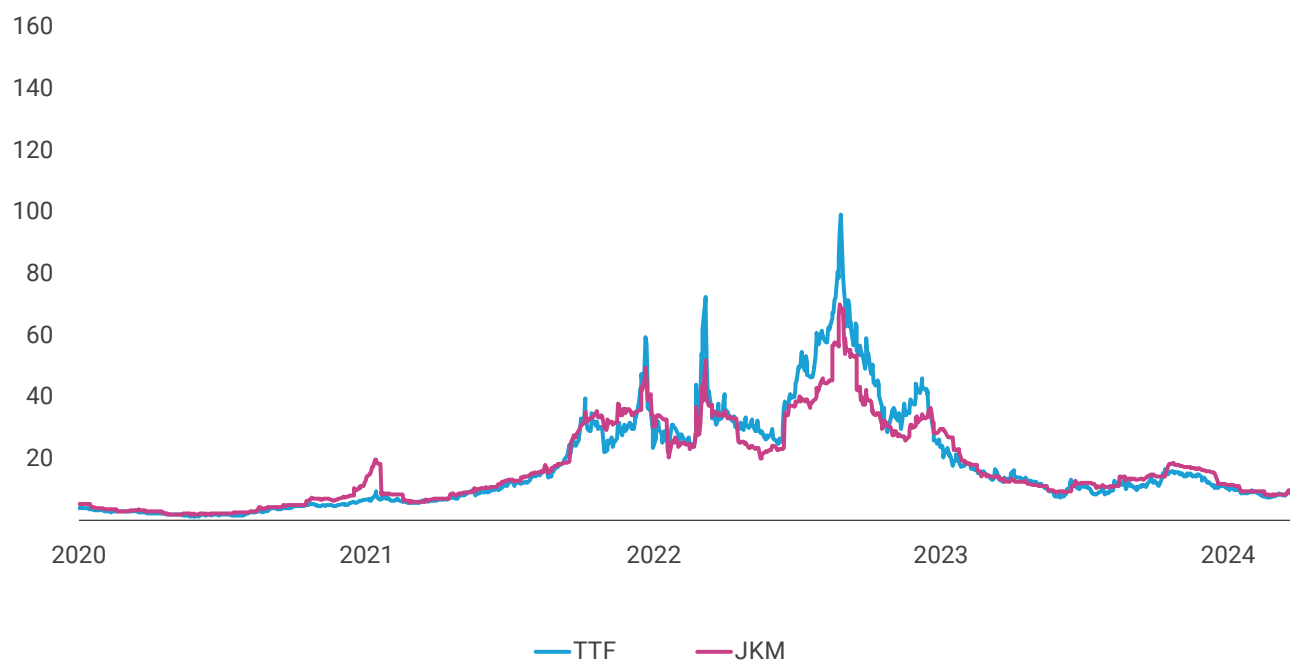


Figure 2 | Source: Intesa Sanpaolo on Bloomberg data

LNG supplies, and the tactical decisions of producers, who are interested in protecting their margins. For instance, in the early months of 2024, several shale oil and gas producers in the United States announced downward revisions to their planned spending on new capacity and delays in the development of some LNG export projects, which were originally scheduled to come on stream in late 2024. Additionally, the Biden administration has placed a temporary halt on the approval processes for new liquefaction plants in order to conduct a more comprehensive assessment of their potential environmental impacts. The reduction in investment in new capacity, project delays and the suspension of new permits imply a reduction in the potential growth of US oil and gas supply, which in turn implies an upward risk on prices.

3. The shipping sector enters the EU emissions trading market

The European Union established the EU Emissions Trading System (EU-ETS) through Directive 2003/87/EC of 13 October 2003. Each allowance permits the emission of one metric ton of carbon dioxide (CO₂) or the equivalent in nitrogen oxide (N₂O) and perfluorocarbons (PFCs). The market operates on the 'cap-and-trade' principle, whereby the regulator sets a limit on greenhouse gas emissions permitted in regulated sectors. Regulated companies may then trade their emission allowances allocated for free (referred to as European allowances, or EUAs) obtained from the primary market through periodic auctions, or on the secondary market.

The EU-ETS is currently operational in 31 countries (members of the European Union plus Iceland, Liechtenstein and Norway). It regulates emissions produced by over 11,000 energy-intensive industrial plants. The sectors of electricity and heat production, oil refining, steel, iron, metals, cement and lime production, glass and ceramics, paper and chemicals which in Italy total about 1,200 plants responsible for about 40% of national emissions, are included in the scope of the EU-ETS. Since 2012, the EU-ETS has also regulated emissions from civil aviation. From 2024, it will be extended to maritime transport.

The objective of the legislation is to encourage the use of renewable or low-emission fuels and to gradually reduce emissions and energy consumption in the maritime transport sector. Initially, only vessels with a gross tonnage of 5,000 tonnes or more will be affected on routes for the transport of passengers or goods for commercial purposes travelling between European ports or whose departure or destination lies within European borders. From 2026, the obligation will also be extended to ships above 400 tonnes. The percentage of emissions to be surrendered varies by route. Emissions are considered at 100% if both the port of departure and the port of arrival are under the jurisdiction of a member state. However, if one of the two ports is not under the jurisdiction of a member state, emissions are considered at 50%. There are some exceptions for specific cases, such as small islands, territorial continuity, berthing for refuelling only or repairs.

It should be noted that there is no free allocation of allowances; all certificates are auctioned or traded on the secondary market. Furthermore, the percentage of emissions for which allowances must be surrendered will gradually increase from 40% for 2024, to 70% for 2025 (to be surrendered in 2026), and to 100% of emissions in subsequent years.

The regulations stipulate that from 1 January 2024, shipping companies are obliged to record their emissions during the year, report them to the authorities by 31 March of the following year, and surrender the corresponding allowance certificates by 30 September 2025. In the event of a failure to surrender allowances, penalties include a fine of €100 (indexed to inflation) per EUA. However, in the case of a failure to surrender allowances for more than two consecutive years, expulsion orders or confiscation may be imposed.

3.1 Market regulation and impact on EUA prices

The legislator has implemented a series of adjustments to the regulation of this market, with the aim of ensuring its optimal functioning and fostering an effective emission reduction process. Indeed, in the current Phase 4 (valid from 2021 to 2030), EUA prices are responsive to changes in supply and demand fundamentals, providing indications of the expected market balance.

The legislator has set a 2030 emissions reduction target for regulated sectors of 62% below the 2005 level. A number of instruments are employed in order to achieve this goal, but the most significant of these include: a) the linear reduction factor (LRF) of the 4.2% emission cap, b) the Market Stability Reserve (MSR), designed to restore market stability through the transfer of unallocated allowances at auctions and a reduction of oversupply, c) the gradual reduction of free allocations.

It is therefore clear that the market is designed to be balanced or in deficit in the medium to long term, and consequently EUA prices should see a bullish trend in the coming years, although this is not necessarily the case in the short term.

For instance, following the initial breach of the €100/tonne threshold in February 2023, EUA futures prices experienced a significant decline approximately one year later (on 23 February 2024), reaching a low of €51.08, the lowest since May 2021. This sharp drop was driven by two main factors, namely speculative movements related to uncertainty about the climate policies to be adopted by the new Commission, and an imbalance between supply and demand, which resulted in a temporary market surplus. In fact, demand for allowances at auction has been lower than expected due to the economic slowdown, while supply has been subject to upside risks due to uncertainty over the number of allowances that could be sold to meet the funding targets of the RepowerEU plan.

EUA Futures, 1st month rolling and December 2025 expiry, in EUR/ton

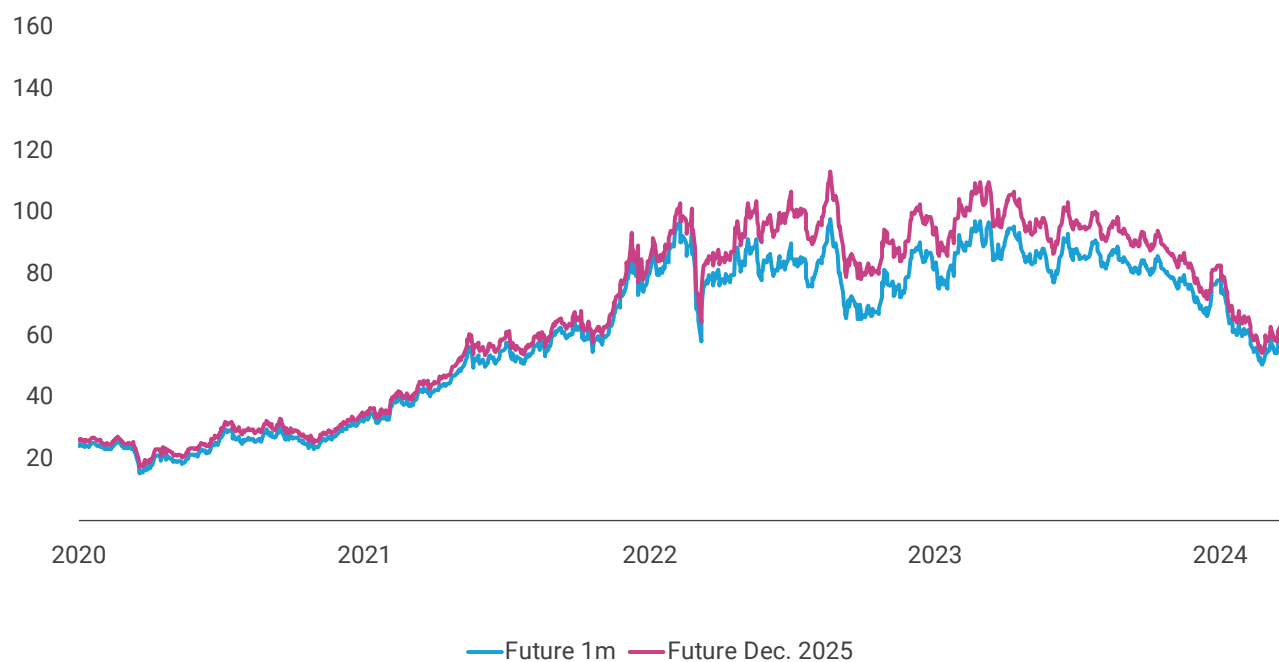


Figure 3 | Source: Intesa Sanpaolo on Bloomberg data

Despite these concerns, the €50-60 range is still a very important support. It is believed that after this temporary phase of weakness, bullish pressures on prices may return to prevail both in the second half of 2024 and in the following years. Indeed, on the one hand, demand for rights should increase due to the expected economic recovery. Conversely, the Phase 4 regulation outlines a series of measures to be implemented in a timely manner to address any surplus. Consequently, it is anticipated that EUA futures will reach the €100 threshold by the end of 2025 and maintain this level in the following years.

It should be highlighted that emissions from the maritime sector for 2024 run the risk of exceeding initial estimates due to higher fuel consumption associated with the need for some operators to circumnavigate the Cape of Good Hope instead of transiting the Suez Canal. This factor may also play a role in reducing the current surplus.

Chapter 3 | Italian ports and Intermodality: the role of Port Network Authorities between the market and regulations

The interaction of ports with the hinterland and the modal transfer to the railway represent a pivotal theme. This topic is repeatedly debated but remains current in the context of the strategies and actions of public and private players in the transport-logistics chain, as well as the guidelines and regulations drawn up by policymakers at both national and European levels.

This chapter aims to offer an overview of the interaction between ports and the hinterland and the modal transfer to the railway from the perspective of Italian ports, particularly the Port Network Authorities (AdSP). The objective is to contribute by framing the phenomenon and analyzing some strategic approaches and possible proposals at the port policy level.

1. Italian Ports and their target markets

The national port market depends primarily on the development dynamics of its natural hinterland, which has largely coincided with the Italian territory over the years. The development of port activities has, therefore, followed the trends of international trade between Italy and overseas economies, as well as the consequent evolving demand for maritime transport.

From 2005 to 2023, according to data from Assoport, the overall volume of international trade by sea, measured in terms of weight, decreased from over 286 million tons to about 224 million tons. This decline is mainly due to a reduction in imports of raw materials (crude oil, coal, and metal ores), which saw a decrease of about 64 million tons during this period.

International seaborne trade, Italy, 2005-2023 (million tons)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Import	224.6	230.0	231.9	218.7	180.4	200.1	194.7	178.9	164.4	155.1	166.9	170.5	174.9	173.5	171.5	145.0	160.8	172.2	166.0
Export	61.9	62.7	66.9	65.1	55.8	61.4	58.8	64.7	59.5	57.9	63.9	64.0	66.1	62.4	59.3	55.5	61.2	60.4	58.3
Total	286.5	292.6	298.7	283.9	236.2	261.5	253.5	243.5	223.9	213.0	230.8	234.5	241.0	235.9	230.8	200.5	222.0	232.6	224.4

Table 1 | Source: Coeweb, ISTAT

Changes in the relevance of the different commodities in international trade involving our country have also affected relations between Italy and other overseas economic areas. Indeed, in the period considered, the weight of other European countries (-7.4%) and North Africa (-3.9%) has significantly decreased, while the importance of relations with North America (+4.7%) and East Asia (+3.0%) has grown.

International seaborne trade by area, Italy, 2005-2023 (million tons)

	% of total in 2023			2023 vs 2005 (in million tons)		
	Import	Export	Total	Import	Export	Total
Europe	17.6%	41.4%	23.8%	-32.94	-3.02	-35.96
Middle East	22.0%	7.5%	18.2%	-0.26	-2.02	-2.28
North Africa	13.4%	12.0%	13.1%	-18.92	-0.44	-19.36
North America	11.3%	16.6%	12.6%	5.04	0.50	5.54
East Asia	10.6%	8.8%	10.1%	1.91	0.49	2.40
Central Asia	8.6%	3.7%	7.3%	6.54	1.35	7.88
Central-South America	8.0%	4.8%	7.1%	-12.82	-0.12	-12.94
Other African Countries	7.7%	3.8%	6.7%	-1.09	-0.42	-1.52
Oceania	0.9%	1.4%	1.0%	-6.05	0.14	-5.91

Table 2 | Source: Coeweb, ISTAT

The changes in the origin-destination matrix, driven over the time horizon in question by the emergence of globalisation processes and the relocation of production activities, are even more evident if the same analysis is carried out excluding the commodities that most directly include raw materials, starting with energy.

In this context, the weight of relations with East Asia grew by 8.9%, accounting for 22.0% of total sea trade (26.7% of imports, +12.2% compared to 2005). Conversely, trade with Europe decreased, both in terms of weight on the total (-10.5%) and in absolute value (-8.65 million tons).

The change in the weight of commodities and maritime traffic flows has naturally also produced changes in the composition of handling in ports: against a substantial constancy in volumes measured in tons and a progressive reduction in the weight of bulk, the importance of miscellaneous goods has grown, both containerised and in rolling stock. Liquid bulk, whose volumes fell by 17.7% from 2005 to 2023, now accounts for about one third of traffic volumes in national ports (35.3%). An even more marked trend was recorded in the dry bulk market in which movements fell by 44.3%, thus coming to represent less than 11% of port volumes at national level.

Conversely, in the period considered, the container and rolling stock sectors grew both in terms of volumes (respectively +29.6% and +63.4%) and in comparison with overall movements: in fact, the two modes accounted for 49.9% of national traffic in 2023 compared to 33.2% in 2005.

International seaborne trade by area, excluding energy commodities, Italy, 2005-2023 (million tons)

	% of total in 2023			2023 vs 2005 (in million tons)		
	Import	Export	Total	Import	Export	Total
Europe	30.1%	26.6%	28.9%	-4.46	-4.19	-8.65
Middle East	3.3%	10.3%	5.7%	-0.43	-0.19	-0.61
North Africa	8.0%	8.9%	8.3%	0.95	-0.17	0.78
North America	7.2%	20.6%	11.8%	-1.27	0.06	-1.21
East Asia	26.7%	13.2%	22.0%	8.07	0.38	8.45
Central Asia	7.7%	6.0%	7.1%	3.30	1.25	4.55
Central-South America	13.6%	7.6%	11.5%	-0.50	0.36	-0.15
Other African Countries	3.0%	4.2%	3.4%	-0.07	-0.35	-0.41
Oceania	0.6%	2.5%	1.3%	-0.35	0.13	-0.22

Table 3 | Source: Coeweb, ISTAT

Port handling activity by type of traffic, Italy, 2005-2023, tons (100=2005)

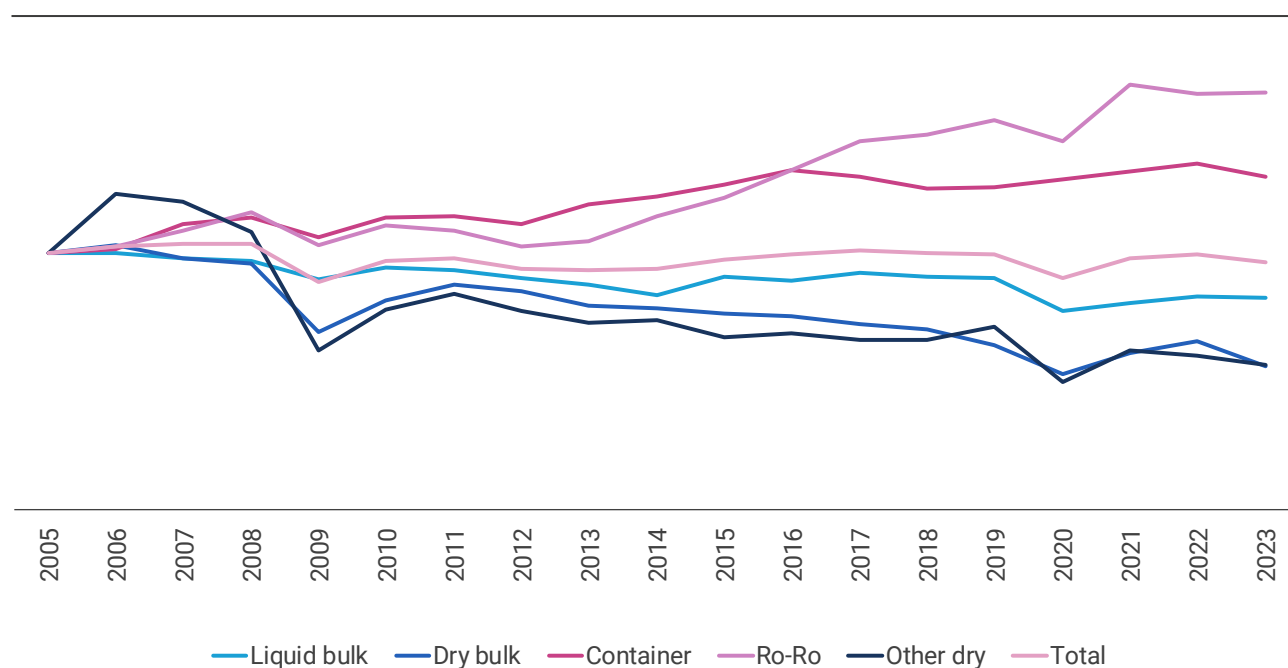


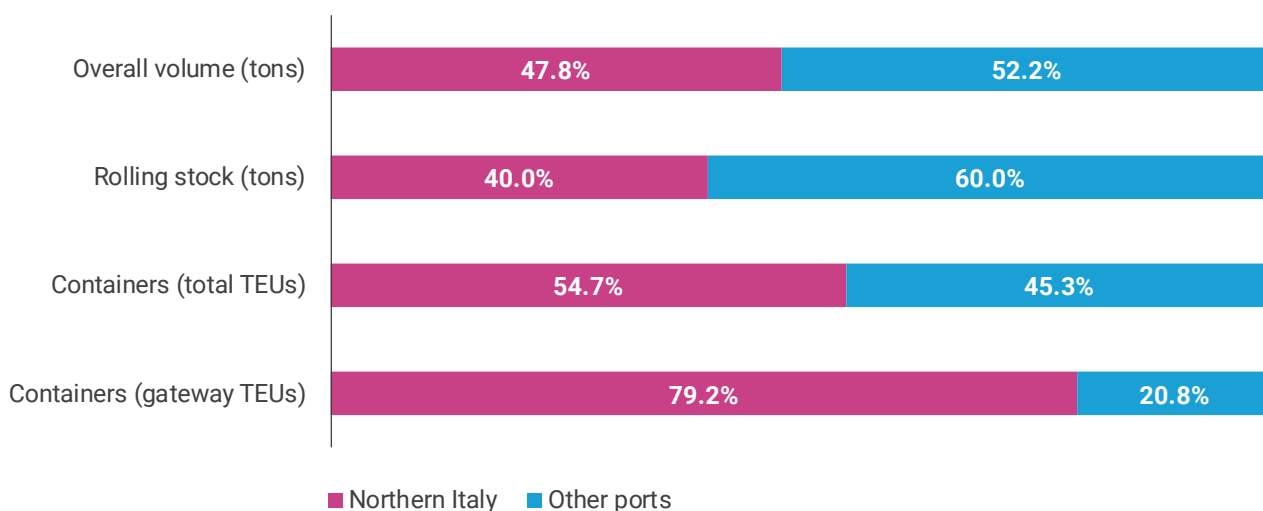
Figure 1 | Source: authors' elaboration on Port Network Authority, Assoport

The role assumed over the years by goods transported in containers or on rolling stock along short-haul routes is particularly relevant in the port context of Northern Italy, both on the Tyrrhenian and Adriatic sides.

This relevance derives from the fact that the aforementioned geographic ranges, which include Italy's northernmost ports, have as their natural hinterland the areas of the country that concentrate the highest percentage of industry and production, as well as the distribution of products and the consumption of goods: in 2023, in fact, the regions included in the North-West, North-East and Tuscany areas represent 49.9% of foreign trade measured in weight (72.9% if raw materials are excluded¹).

Northern Italian ports, in the range between Savona and Leghorn on the Tyrrhenian side and between Ravenna and Trieste on the Adriatic side, account for about half of the total traffic at national level, 40% of the rolling stock and 80% of the gateway container traffic measured in load units.

North Tyrrhenian and North Adriatic Ports* on total port handling activities, 2023



* Port Network Authorities of the Western Ligurian Sea, Eastern Ligurian Sea, Northern Tyrrhenian Sea, Central-Northern Adriatic Sea, Northern Adriatic Sea, Eastern Adriatic.

Figure 2 | Source: authors' elaboration on Port Network Authority, Assoport

The operations of Northern Italian ports and the transport demand that the ports of call in the area regularly satisfy are, therefore, strongly connected to the economic fabric of reference. In this context of close correlation between the two dimensions, the offer of intermodality plays an important role in allowing the connection between ports and places of loading and delivery of goods, even over longer distances.

The combination of the geographical position of ports with the layout of the territory of Northern Italy also determines the supra-regional relevance of individual ports of call, especially those in Liguria, which, far beyond regional borders, represent a gateway connecting the main production areas of the country and overseas origins and destinations.

¹ Foreign trade statistics from Coeweb, ISTAT.

Inland destination of container traffic by Northern Italian port network (% tons)

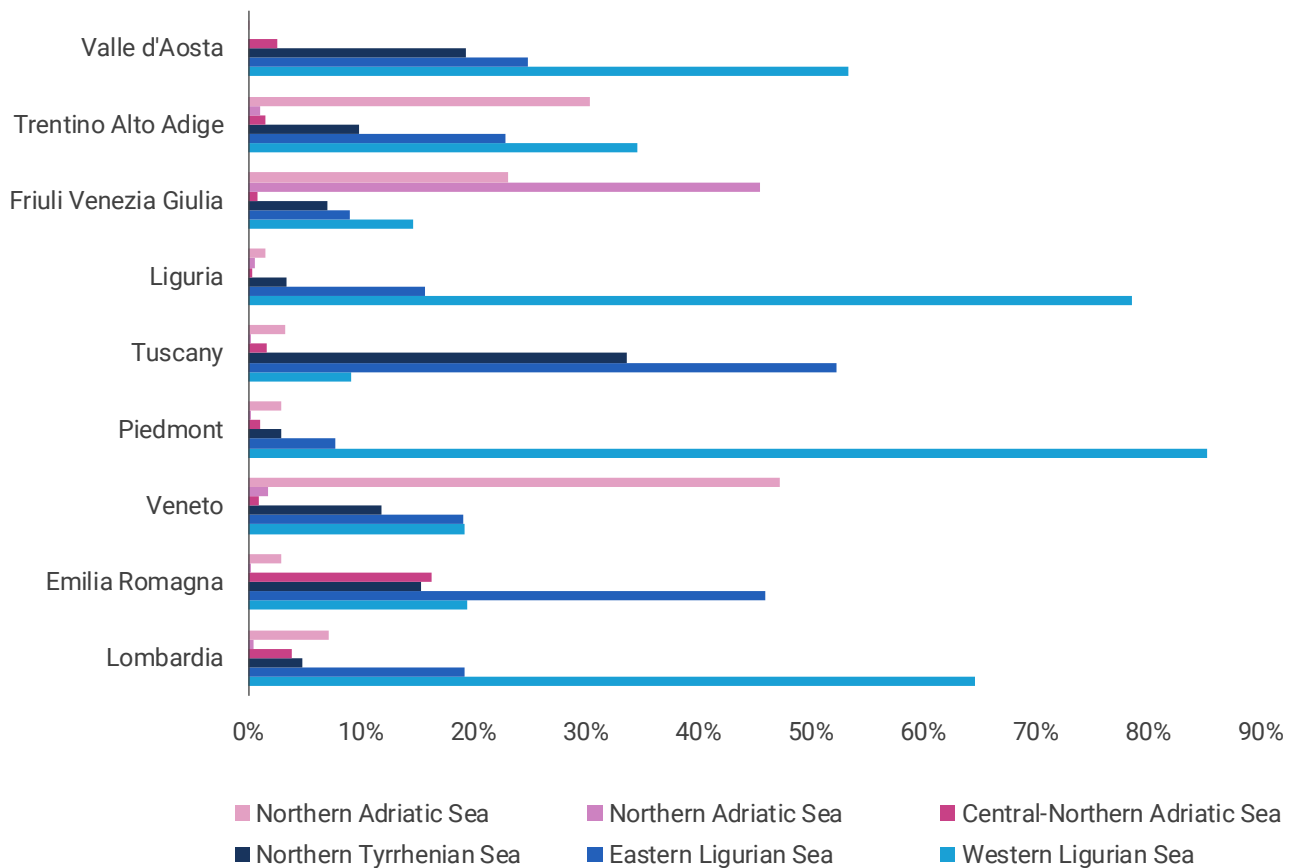


Figure 3 | Source: authors' elaboration on CIELI

Therefore, considering the role that Italian ports play on a scale that goes beyond the borders of the individual regions, it is important to frame them in the context of the logistics chain as the fundamental link between maritime routes and land lines, in particular the railway infrastructure, which makes it possible to extend the area of influence of the ports beyond the natural limits of individual inland areas..

2. Italian ports and rail transport

Over the last three decades, the European Union has pursued a policy aimed at developing the maritime infrastructure of the trans-European transport network, especially through actions aimed at 'modernising and extending the capacity of port infrastructure' and 'fostering the development of connections with the hinterland', highlighting that, especially with reference to the current phenomenon of naval gigantism, investments are needed to adapt port infrastructures and facilities to new logistic and transportation needs.

This need for infrastructural adaptation is most felt in those gateway ports that are the origin/destination of the great transoceanic trade routes, especially between Asia and Europe, which take up most of the hold capacity of the newly built mega-ships.

Regarding the need to strengthen port connections with the hinterland, and with particular reference to port networks, the Commission has set itself the goal of ensuring that ‘by 2050 all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system’². To this end, in fact, the European Commission has launched an extensive reform process of the railway sector with the objective of creating a single European transport space and overcoming the main barriers to the development of rail transport, which can be summarised as follows:

- Railway infrastructure unable to offer trans-European services
- Lack of interoperability between the different national rail networks
- No competitive market for trans-European services

The liberalization of the European railway market, initiated with Directive 440/1991, along with the system of incentives implemented at the national level, has fostered the growth of rail freight transport over the years³. Today, new entrants hold more than half of the market share in this sector.

Between 2010 and 2021, the market share of competitors, i.e., alternative operators to national incumbents, increased in most EU countries, despite a temporary decline in 2020 due to the pandemic. In nine EU countries, including Italy, new entrants have collectively achieved a market share of more than 50%.

Total market share of freight operators different from the incumbent, 2010-2021

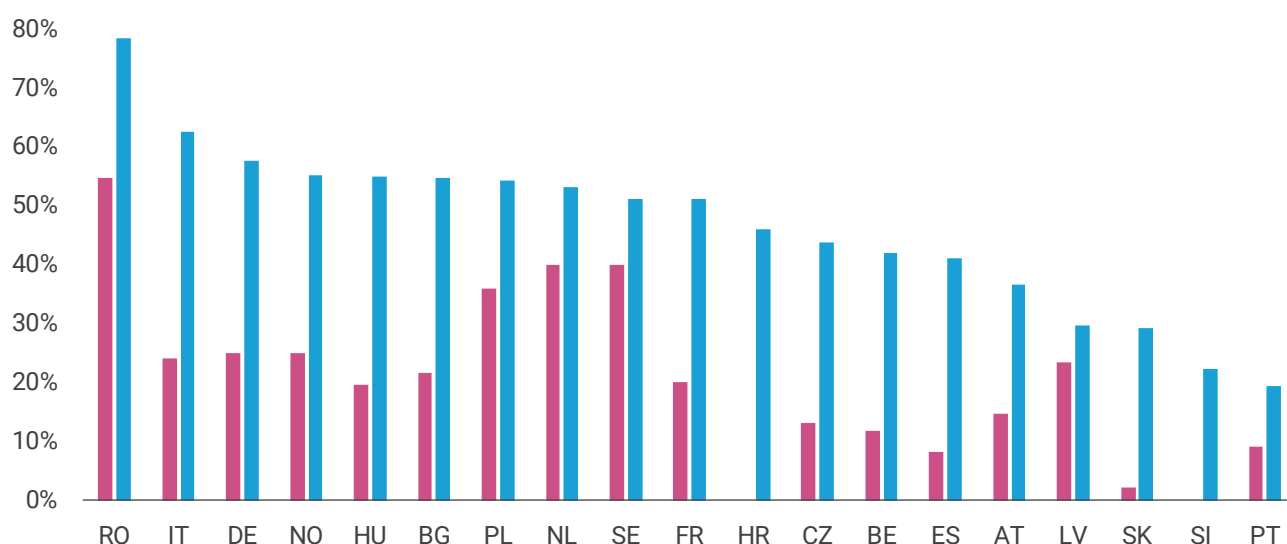


Figure 4 | Source: authors' elaboration on EU Commission, DG Move, Transport in Figures 2023 ■ 2010 ■ 2021

Despite increased competition following railway liberalisation, European road transport has continued to grow at a much faster rate than rail, with an average annual increase of almost 2% in the EU-27 between 1995 and 2021, compared to 0.3% for rail and 1.2% for intra-EU maritime over the same period.

² 2011 Transport White Paper 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system'.

³ It should be emphasised that the following paragraphs consider European rail freight transport as a whole so they do not exclusively focus on the type with a port as origin/destination.

The lower growth of rail freight was reflected in the modal share of the sector, which decreased to 11.9% (it was 14.1% at the beginning of the millennium), while road transport increased from 48.8% in 2000 to 54.3% in 2021.

Freight transport in the EU-27, 1995-2021 (billion tonnes-km)

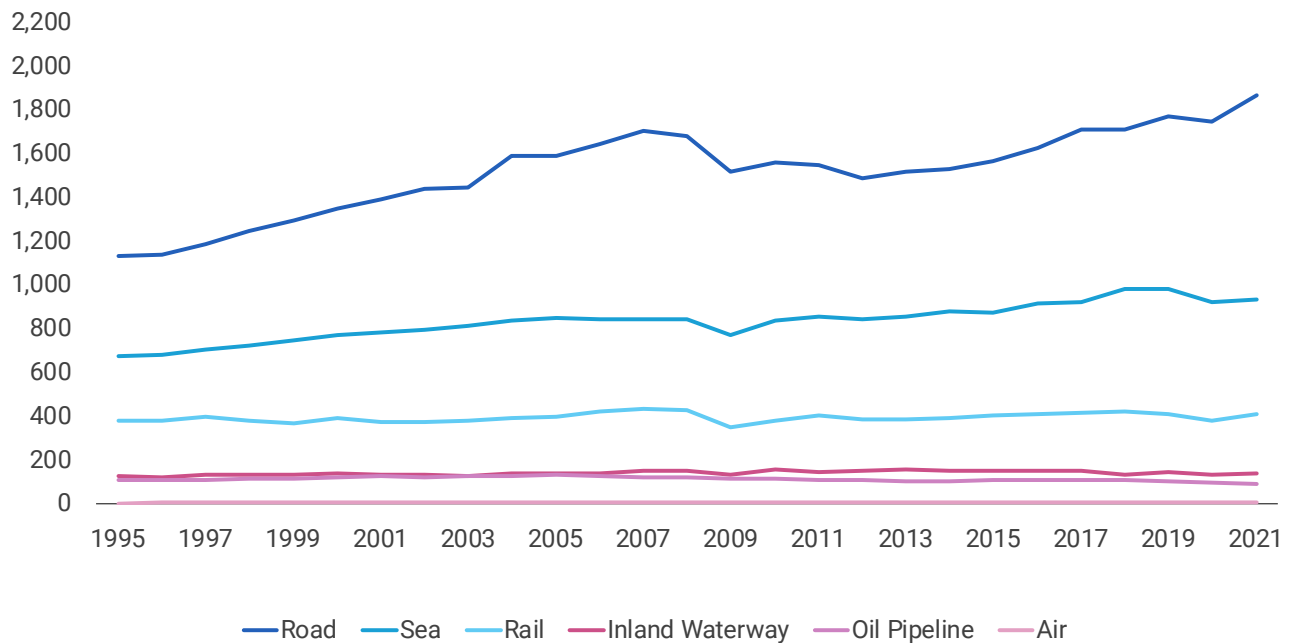


Figure 5 | Source: authors' elaboration on EU Commission, DG Move, Statistical Pocketbook 2023

It can be seen, therefore, that the liberalisation process only initially slowed the fall in rail's modal share, which stabilised over the past few years.

The modal share in the different countries sees the Eastern European countries, historically characterised by a greater role for rail transport, as particularly virtuous, with the Baltics above 40% and the others between 20 and 35%, including Austria, Switzerland, Sweden and Finland. Of the remaining Western EU countries, Germany is still the only one approaching 20% and also the only one above the European average figure of 16.4% (year 2021). Italy, with 12%, is significantly below this average, but ahead of other large countries such as France and Spain.

With specific reference to Italy, in the first years after liberalisation, new entrants contributed to the increase in quantities transported by rail. The recession period, which began in 2008 with significant impact on the entire sector, has led to a context characterised by a substantial rebalancing of the weight of freight railway companies, following the downsizing of the national incumbent.

Rail freight transport in Italy by type of operator, 2005-2022 (billion tons-km)

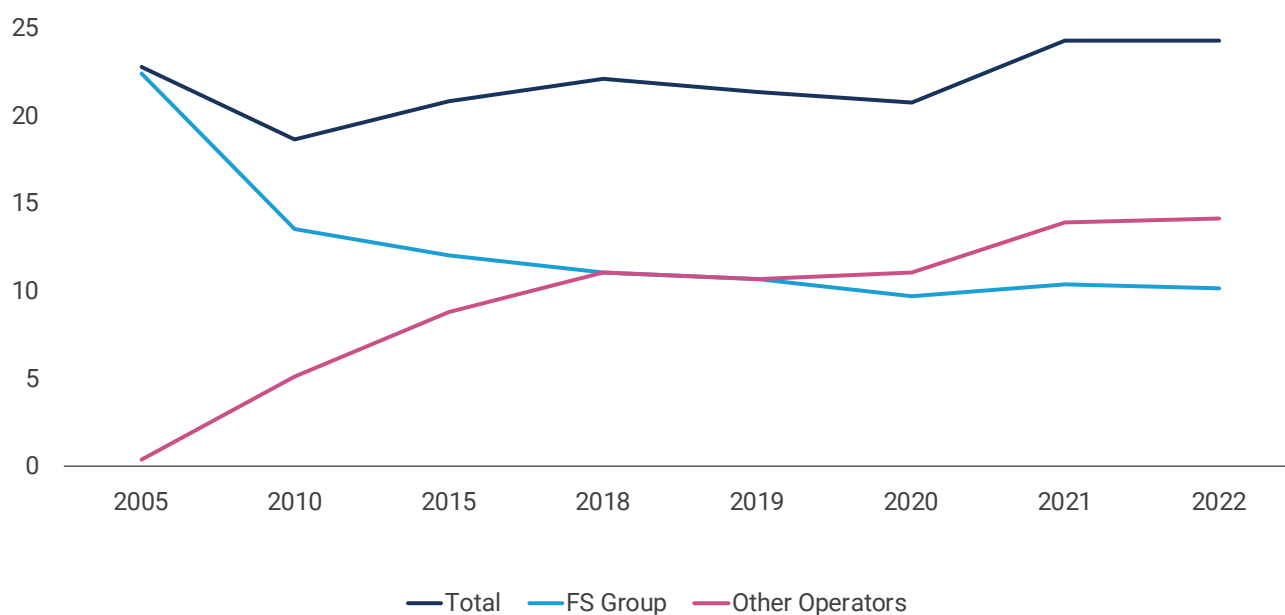


Figure 6 | Source: authors' elaboration on Conto Nazionale delle Infrastrutture e dei Trasporti, years 2021-2022

Estimates based on the latest Eurostat and Conto Nazionale data from the Italian Ministry of Transport (MIT) indicate that the modal share of rail in Italy in 2021 was a tenth of a point higher than that recorded in 2014. This has, however, narrowed the gap with the European average, which in the same period, again according to Eurostat, showed a reduction of a couple of percentage points.

This trend in the modal distribution of freight transport in Italy is most evident when comparing rail with the road mode, as there is a marked divergence in the growth/decrease dynamics of traffic between the two modes. Although road freight traffic maintains a clear predominance (in terms of ton-km moved), a completely opposite trend between the two modes of transport was observed in the period between 2010 and 2015. During this period, in fact, there was a steady decline in road freight transport (-34%), while there was a gradual increase in rail freight transport (+12%).

However, in the period between 2015 and 2022, despite a continued growth in goods transported by rail (+17%), a recovery in road traffic (+30%) was observed, to the detriment of the increase in the rail modal share.

Moreover, a comparison of the trends in the two measures for analysing rail traffic – 'train-km' and 'ton-km' – reveals an improvement in the efficiency of rail transport. In fact, in the period between 2006 and 2022, ton-km transported grew by 0.1% against a clear reduction of train-km, which decreased in the same period by 14.4%. This is explained by the technological improvement of the network and the use, over the last two decades, of longer trains with greater load capacity, together with an organisational improvement in flows.

Developments in rail freight traffic in Italy, trains-km and ton-km, 2006-2022

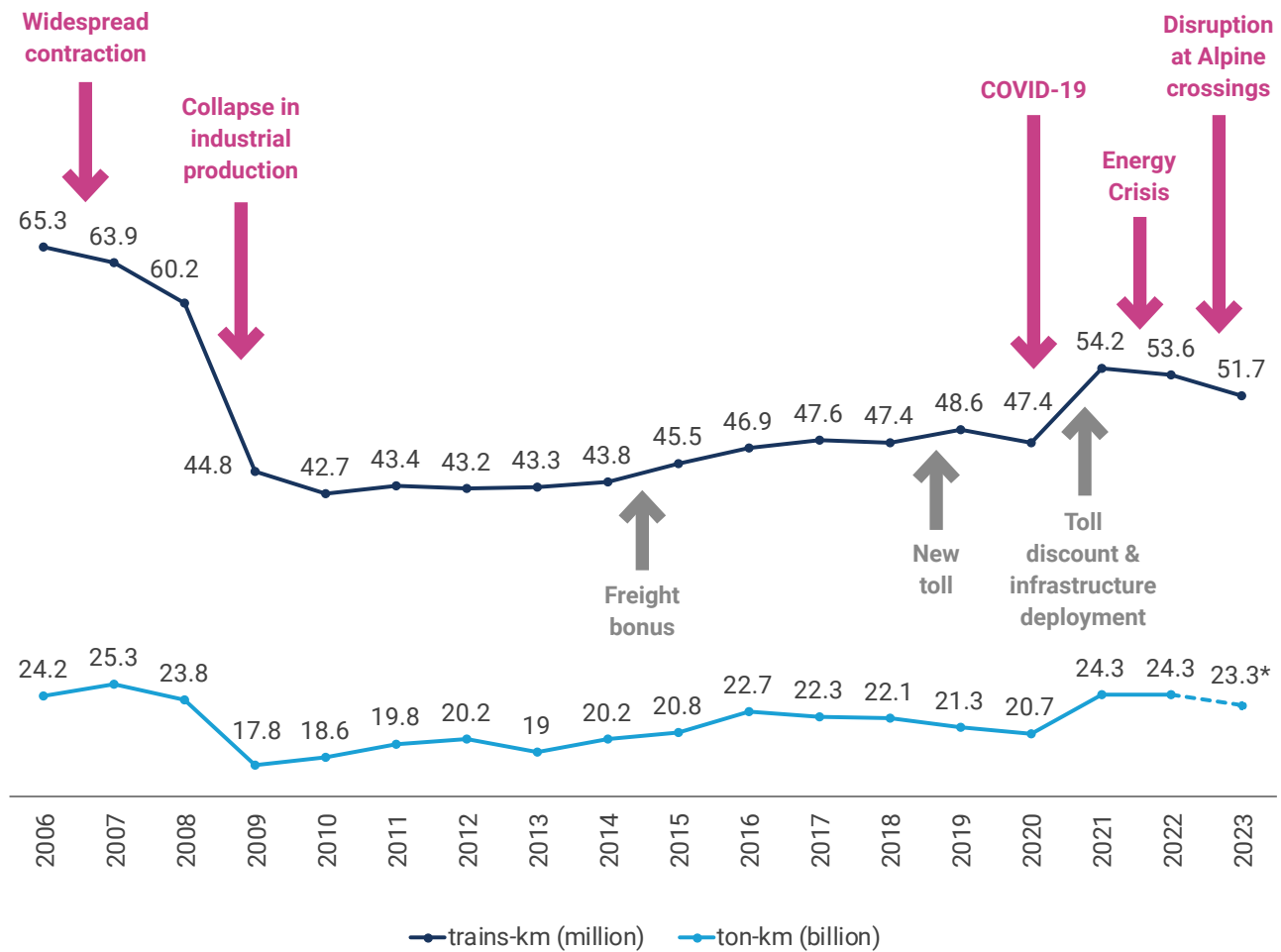


Figure 7 | Source: authors' elaboration on ISTAT and RFI

* Provisional data.

In Italy, in 2021-2022, a more robust recovery was recorded, which was partially interrupted in 2023, also due to the problems of network usage and the disruptions that affected two of the four main railway tunnels of the Alps⁴, as well as the multiple infrastructural interventions of enhancement and adaptation pushed by the NRRP resources.

After the stagnation phase recorded at the end of 2022, the year 2023 has in fact led to a retreat in the process of modal transfer – from road to rail – in particular of traffic through the Swiss Alps.

⁴ Interruption of the Fréjus tunnel due to a landslide and of the Swiss Gotthard tunnel due to a derailment that impaired the tunnel's viability, resulting in a reduction in capacity of approximately two-thirds due to the need to use the remaining accessible tube alternately in both directions.

According to the latest report published by the Swiss Federal Office of Transport⁵, at the end of last year rail freight accounted for 72% of total transalpine goods volumes, showing a 1.9% decrease on the 2022 figure of 73.9% which was the same as the previous year⁶.

The above considerations, however, refer to the entire rail freight sector, which, as is well known, encompasses multiple types of loads and relationships, including international and intra-European O/D. This broad scope does not fully capture the current and potential developments that most directly affect combined transport⁷.

Conversely, when focusing solely on rail traffic in combined mode, a broadly positive trend emerges. While rail freight transport in Europe has remained almost stable over the past decade, the intermodal traffic component has increased by nearly 30% in terms of ton-kilometres during the same period.

Anche in Italia l'incremento del traffico intermodale è stato costante e rilevante, con un leggero In Italy, the increase in intermodal traffic has been steady and significant, despite a slight slowdown at the beginning of the pandemic crisis, within the overall growth of national rail transport. Since 2016, combined traffic has grown significantly, with an annual increase of almost 3.5 million ton-kilometres until 2022, compared to the average of the previous period (2009 to 2015). In contrast, conventional traffic has decreased by about 400,000 ton-kilometres per year over the same period.

Between 2015 and 2022, the increase in intermodal traffic in the country has led to a substantial shift in supply relative to overall rail traffic. Previously, supply was more oriented towards conventional demand (67% conventional vs. 33% combined transport in 2015), but it is now much less unbalanced (56% conventional and 44% combined in 2022⁸).

Focusing on the rail and intermodal traffic of freight villages, data from the Ministry of Infrastructure and Transport⁹ for 23 nodes surveyed show a 17% increase in the total number of trains over the past five years, reaching over 51,700 trains in 2021. Of these, the majority (85%) were intermodal trains, with the remaining 15% being conventional trains. It should be noted that 80% of these trains were generated by the top 6 freight villages mainly located in Northern Italy.

⁵ Swiss Confederation (29 November 2023), Rapporto sul trasferimento del traffico July 2021-June 2023.

⁶ According to the UTF, one of the causes of the decline in volumes transited by rail is the 'difficult economic situation in Europe caused by the war in Ukraine', the 'energy crisis' and 'supply problems', which are combined with 'poor reliability mainly due to the numerous construction sites on the north-south axis'.

⁷ For the purposes of this paper, and to simplify matters, the commonly used distinction in the literature between combined and intermodal transport is not delineated here.

⁸ Source: EUROSTAT Database, [<https://ec.europa.eu/eurostat/web/main/data/database>].

⁹ Source: Italian Ministry of Transport (October 2022), Mobilità e Logistica sostenibili - Analisi e indirizzi strategici per il futuro.

Developments in total and combined rail transport – EU 27 and Italy, 2011-2022

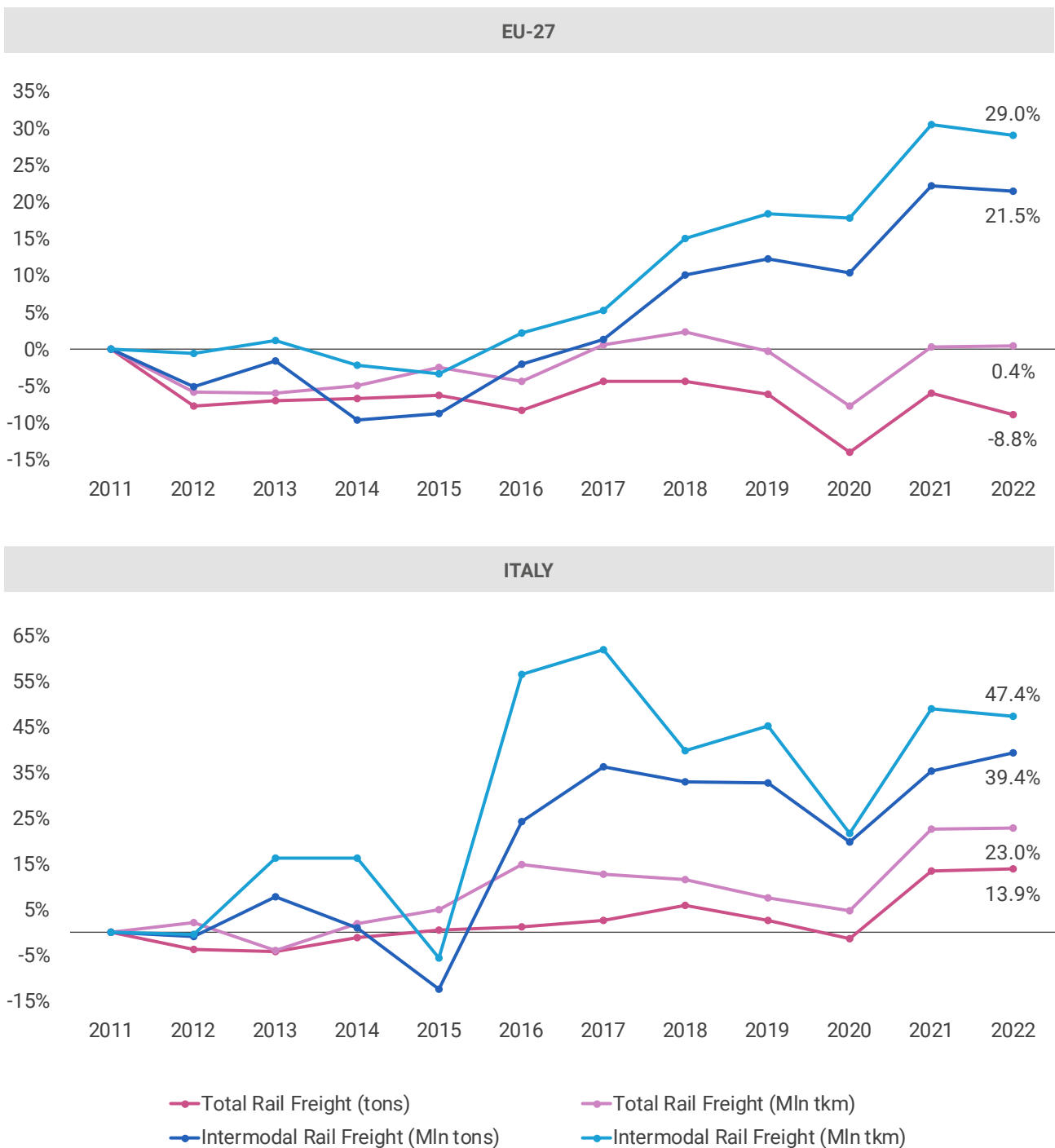


Figure 8 | Source: authors' elaboration on EUROSTAT database: total rail Traffic (rail_go_total – 22/3/2024), intermodal rail traffic (rail_go_contwgt – 14/03/2024)

As for Italian ports, the main hubs with stable rail connections include, among others, Genoa, Savona-Vado Ligure, La Spezia, Trieste, Venice, Ravenna, which are currently involved in numerous investments aimed at increasing rail capacity. These are in addition to the interventions on the national network and the last rail mile projects planned by RFI to improve connections between the ports themselves, inland terminals, and the network.

The development of intermodality between maritime and rail transport is indeed essential to strengthen the logistics network for freight transport to and from ports and thus expand the market for port networks, also with a view towards environmental sustainability and resilience to climate change linked to reducing emissions from freight transport activities.

In 2022, the Italian Port Network Authorities, all involved in container handling to varying degrees, recorded a total container traffic of 11.57 million TEUs, of which 7.36 million was hinterland traffic, with origins and destinations mainly concentrated in Italy. A very significant share (around 73%) of this traffic was handled at the 7 ports indicated in the graph below.

These ports, located in the Ligurian-Tyrrhenian and North-Adriatic arc, handled a total of about 43,000 trains in 2022, almost equivalent to the rail traffic (in train numbers) handled by the aforementioned top six Italian freight villages.

Hinterland traffic (TEU) and modal share (%) in the main Italian gateway ports, 2015-2022

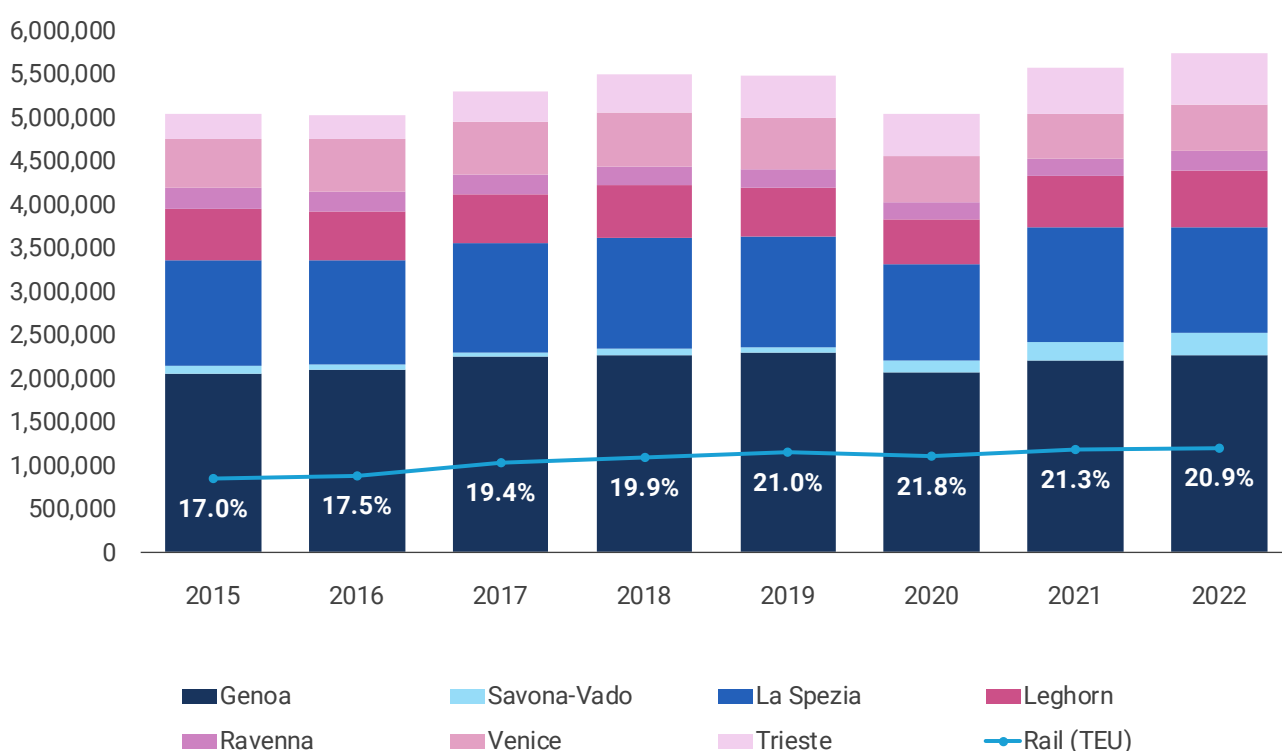


Figure 9 | Source: authors' elaboration on Assoporti and Port Network Authorities

As far as inland container transport is concerned, the modal shares of freight transfer by rail from/to the main gateway ports are in line with the average of the most performing countries in Europe, although still far from the medium-term objectives set by the European Union (30% by 2030).

The above scenario highlights the results of the progressive intervention at infrastructural level by both the national infrastructure manager (RFI) and the Port Network Authorities (AdSP). At the same time, an important contribution was given by the various incentive measures introduced at national and regional level, aimed at transferring an increasingly significant share of goods from road to rail, in order to achieve the sustainability objectives set by European directives and to ensure greater competitiveness of national ports of call with respect to a wider European market.

The infrastructure interventions are focused particularly on resolving certain bottlenecks related to the main dimensions (weight, gauge, and module) of transport, in order to facilitate access of ports to markets beyond the Alps and enable more efficient management of the main inland routes, where road currently remains the solution most utilized by end users.

In this context, on the demand side, significant transformations are occurring in the container transport and logistics market. Public decision-makers must take these into account when planning infrastructure investments and any operational measures to promote intermodality to and from the national port systems.

3. The logistics and intermodality market

In recent decades, the global container transport market has been characterized by processes of horizontal and vertical integration of carriers that have led the sector to a situation of increasing concentration, favoured over time by merger and acquisition operations and entry into other businesses of the transport-logistics chain.

This path has accompanied the process of globalization over the years, with respect to which the containerization of maritime shipments has played a key role, modifying the dimensions and geographic coverage of commercial and transport relations. The container has contributed to reshaping international supply chains, favouring a different model of production and consumption and can rightly be considered a fundamental driver of modern economic globalization.

As part of these vertical integration processes, many global carriers have entered the terminal market since the 2000s, in support of their core business represented by container liner transport and more recently they have also acquired further services along the transport-logistics chain.

The pandemic provided further impetus to this trend insofar as it emerged that unified control of the logistics supply chain could be a strategic element in mitigating the risk of possible disruptive events along the transport chain. In this way, the tendency that drove liner shipping companies to vertically integrate became more important: the strategic need to create a single entity with which the shipper could interact, creating value and building customer loyalty.

Also due to the pandemic, the considerable profits made by carriers, through freight rates reaching record levels in 2021, were another important accelerating factor in the vertical integration processes.

The pathway of vertical integration of carriers in the logistics sector is therefore a trend of particular interest, as in recent years it appears to be consolidating and spreading, at least at the level of the major European operators, who are particularly dynamic, having been the protagonists of a series of acquisition operations in the logistics market aimed at consolidating this integration pathway¹⁰.

¹⁰ As an example, see CMA CGM's acquisition of CEVA Logistics in 2019. CMA CGM then reinforced its geographical presence with acquisitions in the US and European markets including Oxatis (2020), Ingram Micro (2021), Colis Privé (2022) and Bolloré Logistics (2024).

Likewise, MSC would seem to follow the same strategic approach (see Bolloré Africa Logistics acquisition), although at the moment the focus on the European market is mainly on intermodality (through Medlog and Medway). In 2023, Medway was the fastest growing operator in the Spanish rail freight market (source: Comisión Nacional de los Mercados y la Competencia) and intends to expand into the French market. Other European countries, including Portugal and Italy, already see a strong presence of these two operators.

Maersk has pursued a series of acquisitions including Vandergrift (2019), Visible Supply Chain Management (2021), Pilot Freight Services (2022) and Performance Team (2020), which strengthened the presence in the North American market; the acquisitions of KGH (2020), B2C Europe (2021) and HUUB (2021) consolidated the presence in Europe. Finally, the

Of particular interest for the European market today is the divestiture of DB Schenker by Deutsche Bahn, where a possible takeover by a carrier (as of today there seems to be an interest from Maersk) or a port operator would represent another important piece in the strategic design outlined above.

As far as the Italian market is concerned, we propose a brief overview useful to understand how the phenomenon of vertical integration has been applied in some of the main national port realities. This phenomenon, in fact, despite the various facets assumed at the level of the port sector, seems to represent one of the keys to success in achieving rail performance that meets European benchmarks. This is even more relevant if we take into account that, as also seen in the previous paragraphs, in most cases the reference market of Italian ports is rather limited from a geographical point of view, with distances travelled by the forwarding/receiving land route largely shorter than 300 km, if we want to conventionally assume this distance as the threshold of convenience between road and rail transport.

Adopting an inevitable simplification and schematisation, one can identify various 'models' of vertical integration in the national port landscape.

The most well-established model over time is that of the port of La Spezia, where there is close integration between the port terminal, MTO, the railway company and the inland terminal (with a marked polarisation on Melzo). In that port the share of rail transport has been steadily above 25% for several years, with a peak close to 30% in 2020 and values around 35% if only the LSCT terminal managed by Contship Italia S.p.a. is considered. In this case, unique at the Italian level, it was the terminal operator that led the vertical integration process. However, it is important to emphasise that over time, the terminal has been joined by a global carrier (in this case MSC), which first entered the terminal phase of the transport-logistics cycle and then the railway phase, representing today the main operator in the port.

A different model has been adopted by APM - Maersk at the Vado Ligure terminal. Although still with limited volumes in absolute terms, this terminal handled more than 27% of its traffic by rail in 2023. In this case, the carrier acts as an integrator by organising and selling also the intermodal overland route, without, however, making direct investments in the segment of rail traction and/or management of inland nodes, but relying on third-party operators (Mercitalia as the main railway company and Milano Smistamento, Rubiera, Piacenza and Padua as the main inland nodes).

Another example that we wish to highlight is that represented by Ignazio Messina & C., both as one of the first Italian operators to vertically integrate and as a regional operator not belonging to the global carrier segment. In fact, starting from its activities as a shipping company, the Messina group has integrated by expanding to terminal activities (today with the IMT terminal in Genoa) and inland terminals in Milan, Brescia, Vicenza and Dinazzano (RE). As early as the mid-1990s, Messina was among the few shipping players to also operate as an MTO in Italy. This vertical integration made it possible to achieve good performance in terms of modal split that over the years have reached peaks of over 50%, a figure of absolute importance in the international arena. Today, about 33% of the traffic of the IMT terminal travels by train with the main O/D being Milan, Reggio Emilia and Vicenza.

At the opposite end of the spectrum of options in the approach to vertical integration is the model adopted by the port of Trieste, which has achieved significant results in terms of modal split (50% of traffic by rail in 2022) and penetration of medium to long-range markets, specializing in international traffic primarily

acquisition of LF Logistics (2021) enabled Maersk to strengthen its presence in the Asia-Pacific region.

Hapag-Lloyd does not seem to have a similar preference for large investments along the transport chain. This can be partially explained by the presence of logistics companies (Kühne & Nagel) among the carrier's shareholders. However, the carrier's renewed interest in terminal activities (see the case of Genoa) and the GEMINI alliance with Maersk could be a sign of a new strategic orientation that might also include the provision of integrated services.

through the Tarvisio crossing. The Trieste model is distinguished from the others mentioned above because it originates from the railway phase, rather than from the maritime or terminal phase, and is characterized by a public-driven impetus.

Trieste's path began in conjunction with the liberalization process of the freight railway sector triggered by Directive 440/1991, with the establishment of Alpe Adria S.p.A to promote the development of multimodal traffic to and from Central and Eastern Europe. Today, Alpe Adria is equally controlled by the Friuli-Venezia Giulia Region, the Eastern Adriatic Sea Port Authority (AdSP), and Mercitalia. The integration process at the port of Trieste continued in 2002 with the founding of Adriafer, which was 100% controlled by the then Port Authority of Trieste, with the aim of consolidating and boosting the port's railway vocation. In 2004, this company began railway shunting activities solely within the port area, and in 2017 it also started operating line services as a railway company. In the first months of 2024, the AdSP obtained the qualification of certified infrastructure manager, marking another step in a long-term strategic path.

Alongside the vertical integration model and strong public governance of the port of Trieste, there is also a public initiative, namely a railway incentive provided by the Friuli-Venezia Giulia Region amounting to €30 million (from 2022 to 2027) to so-called 'multimodal transport operators' who combine a railway or waterway segment as an alternative to the more polluting road transport. This aid scheme has been in place for several years, first approved in 2006 and most recently in 2022, providing €50 per transported ITU¹¹ (with a possible increase up to €55 per ITU). It is therefore evident that the significant railway performance of the Friuli cluster is linked to this dual track of support and intervention by the public entity (also in financial terms), thus outlining a completely different but equally effective model compared to those mentioned above.

From the brief and non-exhaustive analysis reported above, it emerges that vertical integration, despite its various forms, is currently the trend most capable of driving the development of the railway mode. While this may seem rather obvious, for Italian ports, it still represents a somewhat new element, considering it is a phenomenon that has been established in parallel with global trends, with the gradual expansion of operators from the sea phase to the port phase and then to the land phase. This progressive evolution has seen some early movers, such as Contship and Ignazio Messina & C., followed by other operators. As already mentioned, this scenario now includes a very significant role of the MSC group, which, also thanks to its control of volumes as a carrier and its management of port and inland terminals, competes in many Italian ports through Medlog/Medway for the position of leading operator with other railway companies.

Compared to the cases presented above, vertical integration appears to be a factor capable of 'overcoming' some of the typical economic elements generally considered fundamental in the choice of an inland transportation mode:

- transportation distance,
- volumes involved.

Short distances and/or small volumes do not seem, in fact, to negate the possibility of opting for rail transport, where the intermodal supply chain is managed in an integrated manner by the operator. Obviously, not all trades and commodities are suited for this transportation option, but the evidence suggests that a significant portion of the demand can still be met through rail and intermodal transport, where other economies can be generated from the unified control and management of the logistics chain.

¹¹ Intermodal Transport Unit.

In this context concerning vertical integration in Italian ports, with a particular focus on the rail phase, shunting operations currently seem to remain excluded from the operators' integration strategies, with the sole exception of the port of Trieste (which, however, is a case strongly driven by public initiative). In the most recent tender procedures conducted at several Italian ports (Leghorn, La Spezia, Ravenna, and Genoa), which could have represented an opportunity for integration for the carriers, there has been no interest from the market, particularly from operators in the container sector.

Shunting operations seem to remain excluded from the strategic perspective of vertical integration, perhaps due to their nature as a service provided to multiple operators. With the exception of Trieste and partially La Spezia, shunting is never integrated and is typically managed by an operator such as Mercitalia Shunting & Terminal (part of the Logistics Hub of the Ferrovie dello Stato Group). This operator has so far viewed the port sector more as a service provider (offering traction, shunting, etc.) rather than as a competitor to carriers within a vertical integration framework.

It is also important to consider the role of the incumbent in the port supply chain, especially in light of the gradual liberalization of the rail freight market. Over the years, new operators have entered the rail services sector at ports, some of which are directly connected to the shipping and port industries.

If in the market of continental traffic (traditional or combined national/international), Mercitalia has always played a leading role, in the sea-based traffic sector, particularly in containers, it will be interesting to observe how the competition (or collaboration) with shipping operators, who are capable of controlling significant volumes of traffic, will evolve. From this perspective, Mercitalia Logistics' new industrial plan for 2022-2031 seems aimed at creating a 'national (and European) logistics champion' capable of providing integrated solutions and competing (or collaborating) both with carriers and with major international logistics and shipping players. In this strategic perspective, the recent acquisition of Exploris and the recent agreements with Amazon, Logtainer, and MSC appear to be some of the first pieces of a picture that will take shape in the coming years, with results that can already be measured in the medium term.

4. The role of Port Network Authorities in the development of intermodality

In the briefly outlined Italian and European context, the port node undoubtedly represents a fundamental link in the transport chain to/from the main inland markets served, whether they are national or international.

As is well known, the management of rail transport within ports involves a complex number of entities (both public and private) that participate in various capacities in the organization and management of forwarding and receiving operations.

Within the port boundaries, the Port Network Authorities (AdSP) play an important role in planning, investing, and regulating to benefit the development of rail transport, in close coordination with both the terminal operators and the network manager.

In line with the model outlined by the port reform law no. 84 of 1994, the port area represents a strategic connection point between overseas markets, where there is a progressive and more intense concentration of major global carriers, and the hinterland served by the network managed by RFI and the entities involved in the transport cycle.

Due to its characteristics, rail logistics, unlike road transport, is marked (in Italy as well as in Europe) by the presence of fewer operators involved in providing services to the final customer (RFI, railway companies, shunting companies, and MTOs).

In this context, the Port Network Authorities (AdSP), in line with their specific regulatory mandates, perform various functions, including:

- Planning and constructing railway infrastructure within the boundaries of their jurisdiction;
- Making port authority areas available to concessionary companies under Articles 18 and 16 for loading/unloading goods by train on dedicated infrastructure;
- Providing 'common' infrastructure for managing the interchange between train arrival/departure and terminal operations;
- Acting as the 'grantor' of the service of general interest (SIEG), where applicable, for managing port shunting operations.

The situations described above fall under the umbrella of what's known as the 'last-mile port logistics,' closely tied to the external feeder system overseen by RFI. RFI is a public entity empowered by the concession act outlined in DM 138-T of October 31, 2000, and its subsequent amendments. RFI exclusively handles activities such as designing, building, commissioning, managing, and maintaining the national railway infrastructure, as well as overseeing the control and safety systems associated with train operations.

Looking at it from the perspective of planning and constructing railway infrastructure, it becomes clear that the intervention strategies mapped out by the Port Network Authorities (AdSP) have the network manager as their primary and essential partner. This manager operates outside of the port boundaries. This aspect should be considered within the broader national framework, also represented by the Programme Agreements (CdP). These contracts align with centrally outlined planning, in harmony with national and EU directives, concerning the development and management of railway infrastructure.

It is an intervention scale that, involving the lines and related services, covers both passenger and freight transport, activating significant economic resources. For example, the latest 2022-2026 Programme Agreement is worth around €120 billion in investments.

In this context, the Port Network Authorities include 'last port mile' interventions in their programming that must be closely interconnected (both from an infrastructural, organizational and technological point of view) with those on the network to ensure effective and interoperable management of the routes to benefit the growth of the rail freight component.

The increasingly sustained development of plant and signaling components, also from a regulatory point of view, in fact makes investment in this type of infrastructure highly 'specialized', requiring an increasingly close and coordinated relationship with the network operator.

For this reason, and in relation to fields of strategic interest for the country such as port areas, solutions involving the signing of agreements, protocols and conventions between the Port Network Authorities and RFI (Italian Rail Network) are increasingly frequent, with a view to resolving, as early as in the design phase, all the issues arising from the management of rail services to/from port terminals.

However, if these forms of collaboration allow greater integration between the last port mile and the national network, the competitiveness of ports is increasingly played out on a progressive widening of the reference market and therefore on the completion and development of the main European rail corridors. The port, in fact, representing the connection point between the maritime and land phases, must be able to plan its infrastructure developments consistently with the choices translated into the Programme Agreements and with a long-term perspective.

This consistency can be obtained through closer coordination between the instruments adopted at national (General Transport and Logistics Plan) and local level (Port Master Plan and subsequent programming), precisely to ensure that modal shift objectives can be achieved in line with market and demand developments.

The aim of what has been mentioned so far is to create conditions for effective railway penetration towards Southern European areas, shifting the logistical centre of gravity to/from national ports. Given the developing infrastructure scenario, another essential component for the competitiveness of rail transport to/from ports is the management phase of the forwarding and receiving route, both in terms of service levels and in terms of tariffs and pricing.

As is known, within the port area, railway handling activities are generally entrusted to an operator who ensures the operational connection between the infrastructures inside the terminals (often under concession to the authorized company according to Article 18 of Law No. 84/94) and the national network, also through interchange yards located in public areas.

From the perspective of the 'model' adopted for the management of shunting activities, the national port system presents a particularly diversified situation due to the evolving regulations that have occurred over time, starting with the first port reform law, and that have influenced the definition of services of general interest.

In fact, while in some port areas there are still residual cases of 'control' by the Port Network Authorities over this phase of the transport cycle, in others, due to the initiation of public procedures for the selection of a new operator, the service has been confirmed as a SIEG (Service of General Economic Interest).

This designation stems both from a broader definition expressed by EU legislation on the matter – where SIEGs are considered economic activities whose outcomes contribute to the general public interest and would not be provided by the market without public intervention – and in relation to port sector legislation, which, prior to the amendment introduced by Decree-Law No. 232 of December 13, 2017, included shunting activities among the services of general interest in the port sector, listed in specific ministerial decrees.

Regarding the economic conditions under which rail and intermodal transport is provided in a free market regime, the cost of shunting constitutes a fixed component whose impact decreases as the distance between the points of origin and destination increases. Therefore, it contributes to the competitiveness of a port insofar as it does not significantly affect the overall cost through efficient management and scaling according to activity volumes.

In an Italian port market where international reach (especially in the container segment) is still not sufficiently developed and the modal split has not yet reached the levels required by European sustainable mobility strategies, increasing the intermodal share in ports is currently also linked to the implementation of appropriate incentives for rail services.

With the European Commission Decision C(2022) 9697 of December 19, 2022, the notification process for State Aid concerning the new measures of the national Ferrobonus for the period 2023-2027 was successfully concluded, providing an allocation of €110 million to support the sector.

The document reports the positive effects on the freight rail traffic trend in the previous period of 2017-2021.

Italian national 'Ferrobonus' – main figures 2017-2021

Period	Traffic trains-km	Change	Beneficiaries n.	Contribution €/train-km
2017-2018	25,886,324	-	56	0.687
2018-2019	27,459,960	6.1%	58	1.276
2019-2020	29,025,238	5.7%	70	1.164
2020-2021	33,755,761	16.3%	70	1.472

Table 2 | Source: European Commission, C (2022) 9697 final, State Aid SA.103856 (2022/N) – Italy “Ferrobonus” – Incentives for rail transport

As shown in the table, traffic during the period grew at an average annual rate of 9%, with a corresponding increase in the number of beneficiaries.

During the notification phase of the measure, the Italian authorities provided updated data for quantification:

- Eligible costs in terms of reducing negative externalities associated with the modal shift from road to rail, calculated at €15.3 per train-km.
- Total transport costs calculated at €20 per train-km.

Based on the data provided above, the Commission conducted the relevant investigation in accordance with points 107 (b) and 109 of the Railway Guidelines, which require verification regarding necessity, proportionality, and absence of overcompensation, setting the following maximum limits:

- 50% of eligible costs – in the Italian case, €7.65 per train-km;
- Up to 30% of the total rail transport cost – in the Italian case, €6 per train-km.

The new Ferrobonus, which set a maximum of €2.5 per train-km, therefore remains significantly below the aforementioned limits, especially considering that total transport costs likely experienced further increases in 2023 due to rising energy prices.

In the context outlined above, and parallel to measures adopted at the national or local levels within individual regions in networks under their jurisdiction, the focus is on ports as strategic hubs serving the target market, identifying specific actions that can effectively boost rail mode growth.

The model, already partially experimented with in implementation of the provisions of the so-called 'Genoa Law' (Law 130/2018) to support the infrastructural crisis resulting from the collapse of the Morandi Bridge, could target the same types of beneficiaries as the national Ferrobonus (companies using rail services and operators of combined transport), and could include the following:

- Financial coverage borne by the Port Network Authorities (AdSP);
- Application to all railway services arriving/departing from port terminals;
- Varying contribution intensity (per train-km) to stimulate:
 - » the establishment of additional trains compared to existing ones and the opening of new services to/from new railway origins/destinations;
 - » the organization of railway services on economically less competitive routes compared to road transport;
 - » shuttle services to/from inland terminals near the port that also serve as buffer function;

- Different delivery methods to beneficiaries to enhance the timeliness and effectiveness of the support intervention.

Considering the decision made by the European Commission regarding State Aid, the potential impact of the intervention is evident. Consistently with the resources that can be activated by the Port Network Authorities (AdSP), it could represent a significant stimulus for intermodal connectivity and the development of port traffic both nationally and on routes connecting to markets across the Alps.

Lastly, within the spectrum of intervention policies under the jurisdiction of the Port Network Authorities, it is worth recalling what is already provided for by the regulatory provisions of Law 84/94 which, in Article 6, identifies the following two paths that characterize its institutional duties and possible actions:

- 'promotion and coordination of connections with retro-port and freight village logistics systems' (paragraph 4, letter f);
- 'The System Authorities [...] may also acquire minority shareholdings in initiatives aimed at promoting logistical and intermodal connections, functional to the development of the port system, pursuant to Article 46 of Decree-Law No. 201 of December 6, 2011, converted, with amendments, by Law No. 214 of December 22, 2011.' (paragraph 11).

It is evident, therefore, that the Port Network Authorities (AdSP) can effectively extend their 'control' beyond borders, aiming to support and coordinate the ongoing transformations in the logistics and transportation market, both towards hubs (retro-ports and freight villages) and in the intermodal connections leading to port systems.

5. Conclusions

Within the framework outlined above, where a summary of recent developments in European and Italian rail traffic was provided, the push for a modal shift – after stabilization of the effects of liberalization in the sector – seems to have settled mainly on the combined traffic component which showed significant growth performances also supported by various incentive measures both at Italian and European level. Ports, although accounting for a minority share of Italian combined traffic, have shown more positive traffic dynamics over the last 20 years in the container and rolling sectors which are precisely the types that can better contribute to further growth in intermodal transport and thus to achieving the objectives of transfer from road to rail.

Italian ports, as strategic hubs for modal interchange between maritime and land phases, must address the evolving dynamics characterizing both the infrastructure network and the market of user enterprises. From the network perspective, ongoing investments along the main European corridors, also driven by resources made available by the National Recovery and Resilience Plan (PNRR), undoubtedly represent a significant opportunity to definitively remove bottlenecks that still affect freight transportation to/from ports and to allow for effective and increased penetration into Southern European markets.

The coordination between interventions of the so-called 'last-mile port' and the railway feeder system is therefore the first key element for development.

In terms of the transformations affecting the market and transport demand, the phenomenon of volume concentration on the maritime side and ongoing land integration strategies by major global shipping and logistics players impose significant considerations on port governance entities regarding intervention policies, both short-term and long-term.

Vertical integration, in its various forms, appears to be the strategic trend most capable of contributing to the development of railway mode today, particularly in the market segment represented by combined transport. Evidence suggests, in fact, that there is a significant portion of demand that can still be satisfied through railway and intermodal transport, where additional economies can be generated from the unified control and management of the logistics chain.

Where operators' economies have not yet reached a sufficient scale to promote effective and efficient use of rail transport, the public sector should be able to play a role in promoting modal shift, also to pursue a gradual development of port traffic that is more environmentally compatible with the served areas.

Indeed, if the objective is to accompany and support a progressively stronger growth of the intermodal component, pending the completion of major infrastructural corridors and in a context where road transport still represents a very significant share, possible responses from the Port Network Authorities depend on:

- *Ad hoc* incentives for rail transport that can serve as commercially effective tools to strengthen the domestic market and begin to target overseas markets.
- A more defined role of the Authority in intervention policies in the logistics market through the acquisition of stakes in activities strategically linked to port terminals.

The successful outcomes of these potential pathways are further confirmed by case studies involving some of the national ports most focused on intermodality development, as depicted in the preceding paragraphs.

This situation is awaiting the full realization of RFI's infrastructure development plan, which aims to facilitate effective penetration of intermodal freight traffic beyond national borders and across the Alps into European markets. It is within this context that the development forecasts of the main national ports are positioned. They will compete to expand their user base and pursue goals of rebalancing flows at the European level, all while adhering to the environmental targets set by the EU.

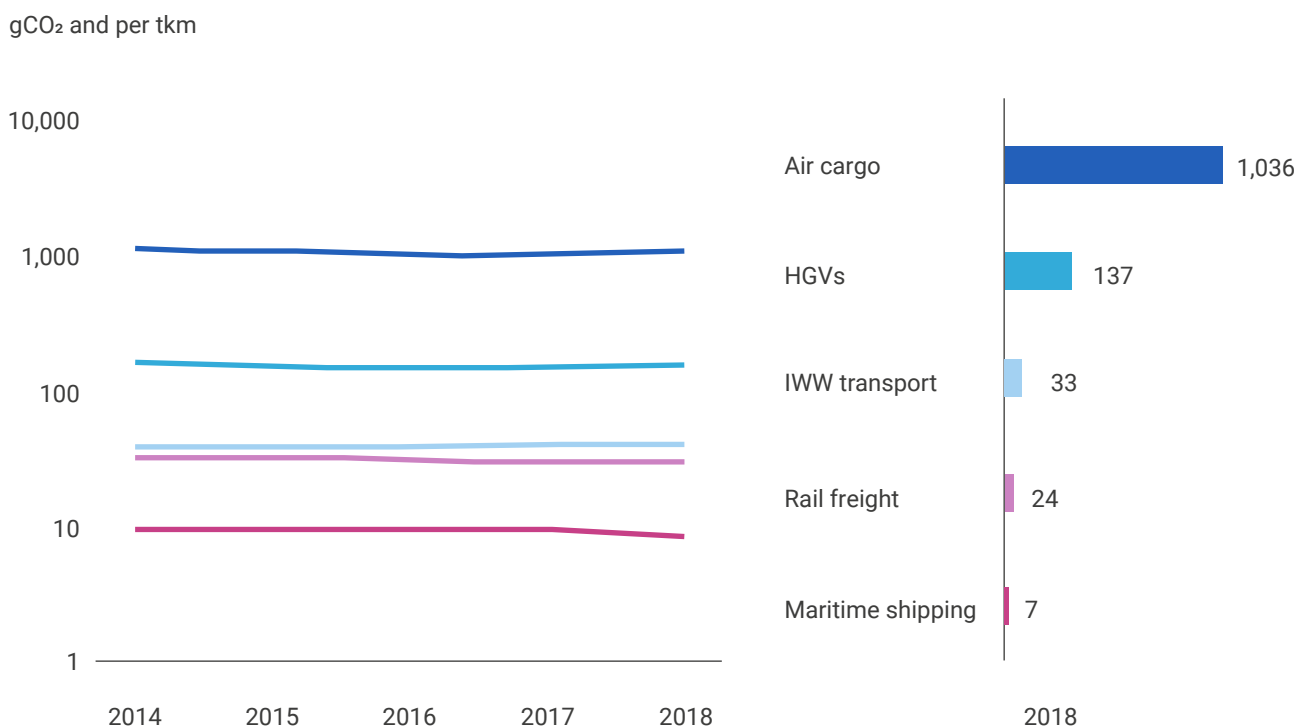
Chapter 4 | Impact analysis of the EU-ETS and proposals to avert relocation of transshipment ports. The case of Gioia Tauro

1. What is at stake: environmental and economic issues

1.1 Pollution by type of freight transport

Figure 1 below shows GHG emissions by type of freight transport at equal payload per distance unit. From top to bottom, the resulting emissions are shown for transport by air, road, river, rail and sea, respectively. A load unit transported by sea results in emissions 20 times lower than by truck and 3.5 times lower than by train.

Average GHG emissions by motorised mode of freight transport, EU-27, 2014-2018*



* GHG efficiency rates for freight transport vary much more than those for passengers. So much so that a logarithmic scale was used in the left-hand graph. The relevant unit is tonne-km, which means moving the payload of one tonne over one kilometre.

Figure 1 | Source: Fraunhofer ISI and CE Delft, 2020

In the EU-EEA, maritime transport accounts for 77% of external trade and 35% of intra-EU trade by value of goods. This means almost 4 billion tonnes of goods are handled in EU ports annually, along with 400 million passengers transported per year, which underscores the strategic importance of this mode.¹ However, it is safe to say that sea transport, despite using fossil fuels, is the most environmentally friendly transport method, especially when considered in terms of emissions per load unit.

1.2 Reasons for the strategic importance of a transshipment port like Gioia Tauro

Global-level reasons

- The port of Gioia Tauro (GT) is the only one in Italy that allows our country to participate at all levels in the container interchange system. GT can also receive the largest ship that can today operate in this kind of business.
- The phenomenon of naval gigantism is mainly driven by transport cost levels. Therefore, in light of the current (Suez Canal) and future economic situation, we can expect it to be further increased/consolidated. A reversal of the trend is certainly not to be expected.
- Naval gigantism, rather than being constrained by technical or constructive limitations, finds its boundaries determined by the navigability of key geographic isthmuses, particularly, in our case, the Suez Canal. GT limitations are better than the Suez ones.

Regional-level reasons

- Within the range of ships covering trans-oceanic routes (deep-sea vessels), there are also ships smaller than the largest container ship, between 17,000 and 24,000 TEU. Depending on the various ports, some of these ships may stop at other ports in the region and not only GT for transshipment purposes. However, Italy's historic ports (particularly those in Liguria, but not only) suffer from the scarcity of space for the logistical operations that necessarily take place adjacent to the ship. The peculiarity of transshipment, unlike other logistics-commercial operations related to containers, is that it needs large yards adjacent to the ship. In this respect, GT has the valuable role of a transshipment pole for the entire downstream port system, which allows the optimisation of traffic but also of the quay space of the entire regional logistics chain.

Market-level reasons

- At the time, the sector's economic policy identified (with active investment support policies) three ports with a transshipment vocation, to play that role as a strategic 'pole' for downstream regional ports. These were GT, Cagliari and Taranto. Based on statistical data on cargo volumes, published annually by Assoport, ² we can see how the market has subverted economic policy, imposing the role of GT as the 'only' transshipment player. The table below shows that the second port after GT, in terms of transshipment traffic share, shows a three digit difference in the number of movements. Moreover, **GT's movements alone account for almost 28% of the overall total national container segment and 77% of the transshipment container segment.**

¹ EMSA-EEA (2021), Maritime Transport Environmental Report 2021 [<https://www.eea.europa.eu/publications/maritime-transport/download>].

² The Italian Association of Ports, port handling 2021 [https://www.assoport.it/media/10423/adsp_movimenti_portuali_2021_agg28022021.pdf].

Transshipment in Italy: the role of Gioia Tauro. 2021 and 2022 data from Assoporti

Million TEUs

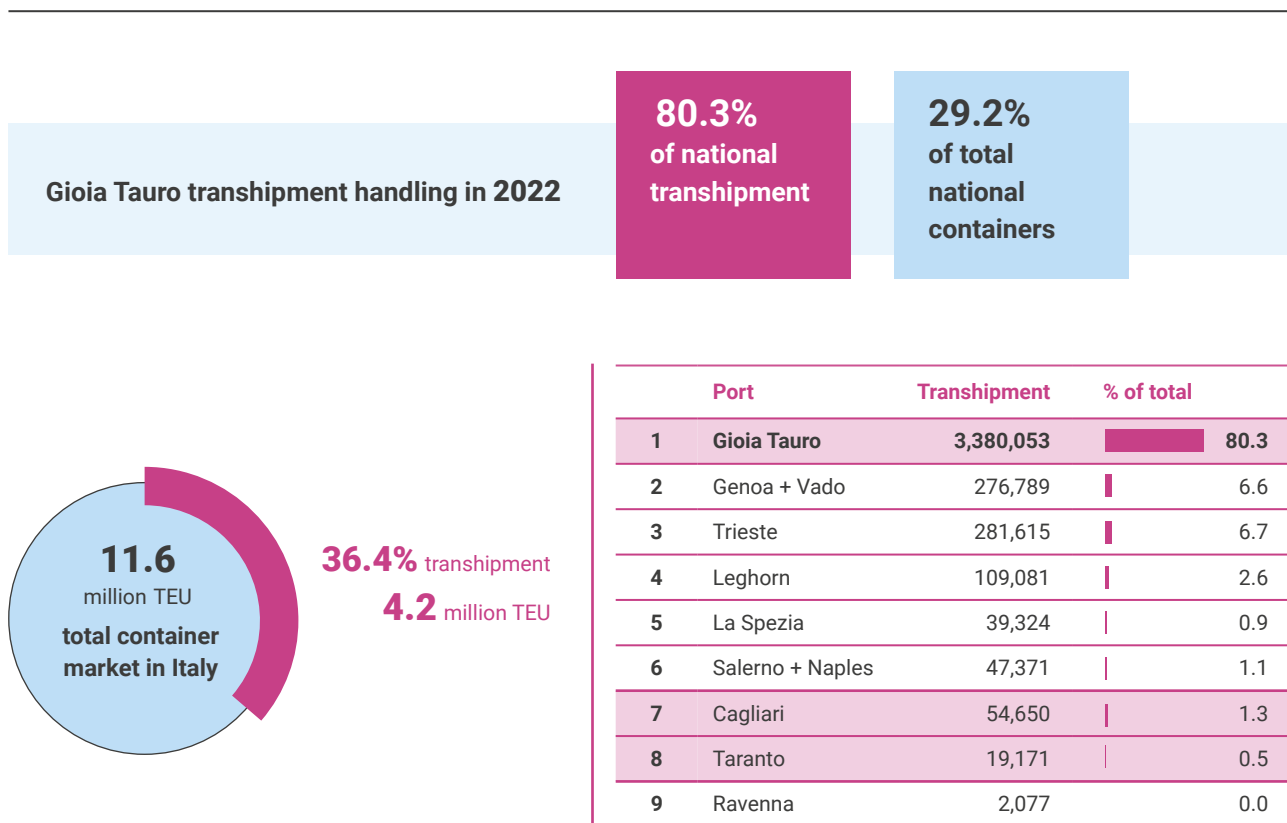
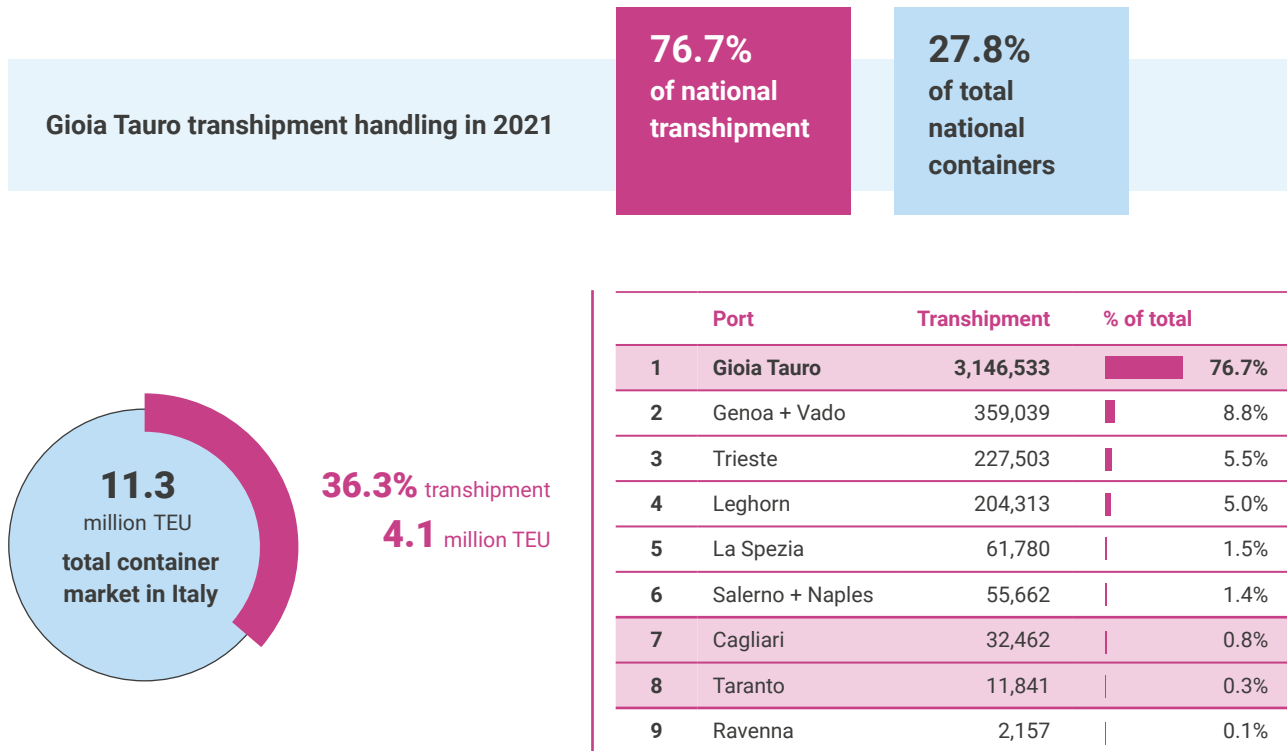


Figure 2 | Source: SRM on author's elaboration

- Again, the market decided that GT was suitable for the logistical-productive setup presently in place, due to its geographic location. GT's maritime deviation³ was found to be compatible with the global logistics system. GT, in particular, is included in the AE11 Westbound trade route⁴.

AE11 Westbound

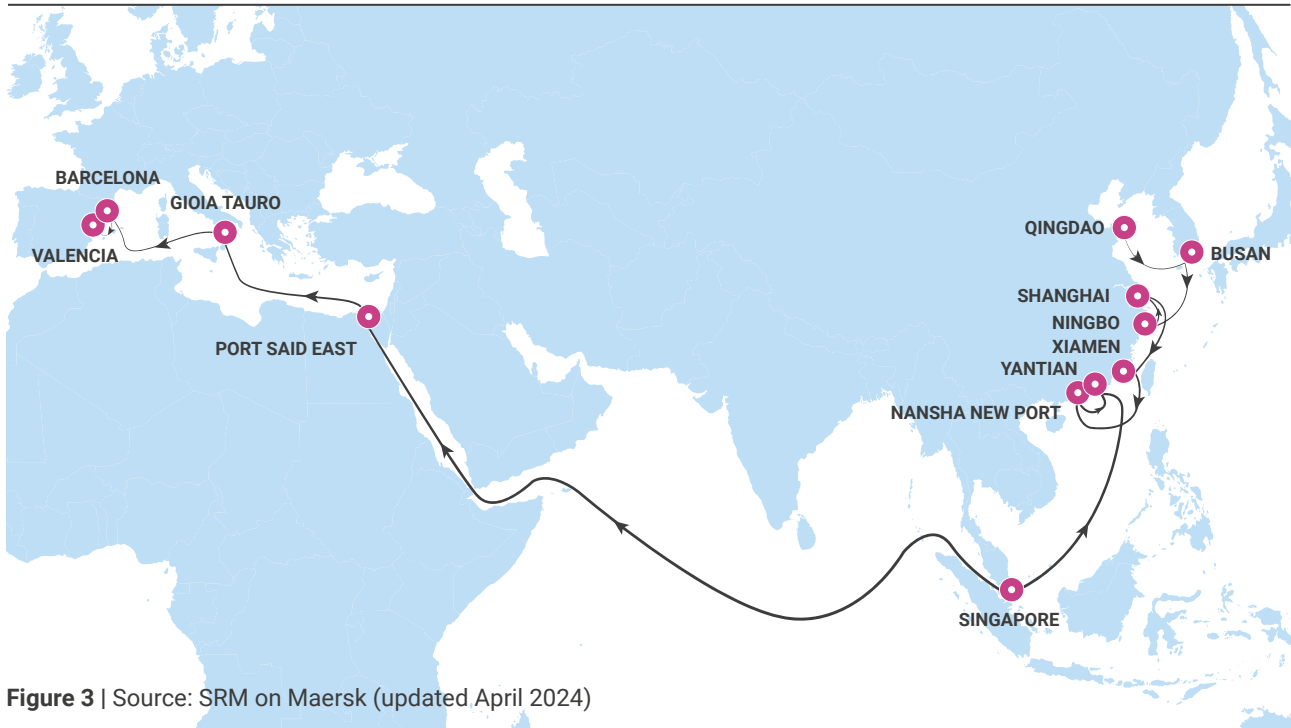


Figure 3 | Source: SRM on Maersk (updated April 2024)

Economic reasons

- Positive direct and indirect fallout on employment both locally and at national level.
- Significant revenue for the state budget, both from direct and indirect taxation.

Strategic reasons

- Extra-EU-EEA ports in the European region, excluding UK ones, are considered moderately stable from a geopolitical standpoint.
- The transshipment market remains competitive and footloose and thus constantly evolving and subject to swift changes⁵. The introduction of the EU-ETS, as currently proposed, would imply an extra cost in the market of transshipment ports hitting exclusively the European ones with equal or even higher emissions at wider regional level.

³ Notteboom T., Pallis A., & Rodrigue J-P. (2022), Port Economics, Management and Policy, New York, Routledge [<https://porteconomicsmanagement.org/pemp/contents/part1/ports-and-container-shipping/maritime-deviation/>].

⁴ Source: Maersk [<https://www.maersk.com/local-information/shipping-from-asia-pacific-to-europe/ae11-westbound>].

⁵ Notteboom T., Pallis A., & Rodrigue J-P. (2022), op. cit. [<https://porteconomicsmanagement.org/pemp/contents/part1/ports-and-container-shipping/deviation-main-shipping-route-mediterranean-container-ports/>].

2. A concise overview of the EU-ETS mechanism

Main regulatory references:

- Directive 2003/87/EC amended by Directive (EU) 2018/410 and by Directive (EU) 2023/959;
- Legislative Decree 9th June 2020, n.47;
- EU Regulation 2015/757.

Each authorised installation/company must annually offset its emissions with allowances (European Union Allowances - EUAs, equivalent to 1 tonne of CO₂eq), which can be bought and sold by individual operators. Installations can buy allowances at European public auctions or receive them free of charge, subject to certain conditions. Alternatively, they can procure them on the market. This system aims to set a maximum emission limit, and to enable market-based emissions trading.

2.1 The rally of EUA prices

Market quotations for EU emissions (so-called EUAs, an acronym for European Allowances) rose from €33 (January 2021) to €62 (September 2021), to €84 in June 2022 and are currently around €60 (March 2024)⁶. The highest peak to date occurred in 2023, in the aftermath of news on the extension to the maritime sector, and reached €101.6 (double the forecast for 2023, which stood at €50).

⁶ European Energy Exchange [<https://www.eex.com/en/market-data/environmental-markets/spot-market#%7B%22snippetpicker%22%3A%22EEX%20EUA%20Spot%22%7D>].

FIT-FOR-55 MEASURES: potential impact on the regional logistic system

FIT FOR 55 is a comprehensive package of measures under consideration by the EU Commission to achieve the goal of reducing greenhouse gas emissions by at least 55 per cent in 2030, compared to 1990 levels. The measures under consideration address the issue with a comprehensive approach, involving climate, energy, transport and taxation regulations all in one. Here are the main regulatory initiatives:

- FUEL-EU** regulation facilitating planning and long-term investment for the use of renewable and low-carbon fuels in maritime transport.
- EU-ETS** Directive amending the system for greenhouse gas emission allowance trading. The extension to maritime transport was decided through Directive (EU) 2023/959
- Directive (2003/96/EC) - commonly known as the **ETD** – on Energy Taxation, removing exemptions for oil fuels used in maritime transport.
- AFID** regulation (Alternative Fuels Infrastructure Development) on the implementation of infrastructure for alternative fuels.
- Proposal for a directive supporting renewable energies.
- The **EU MRV** Regulation 2015/757 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport.

2.2 The extension of the EU-ETS mechanism to European maritime transport

Pursuant to the first paragraph of the new Art. 3ga of the ETS Directive (2003/87), as amended by the EU Directive 2023/959, EU-ETS taxation is applied as follows:

- The mechanism applies to the operator of the ship if it is over 5,000 gross tons. The flag of the ship or the nationality of the owner or operator is not relevant.
- The mechanism operates according to the emission tables per ship type, identified by applying the EU-MRV calculation system developed by EMSA⁷. Indeed, the mileage is multiplied by both the emission factor of that ship and the market quotation of the EUA.

The mechanism applies to:

- 100% of emissions from ships performing voyages between ports within the EU-EEA area;
- 50% of emissions when only one of the two ports is within the EU-EEA area;
- 0% of emissions when none of the ports are included in the EU-EEA area.

The Directive also envisages a gradual application of the mechanism according to the following timeline:

- 2025: 40% of emissions reported for 2024;
- 2026: 70% of emissions reported for 2025;
- 2027 and beyond: 100% of reported emissions.

Application of the EU-ETS mechanism and timetable for its entry into force

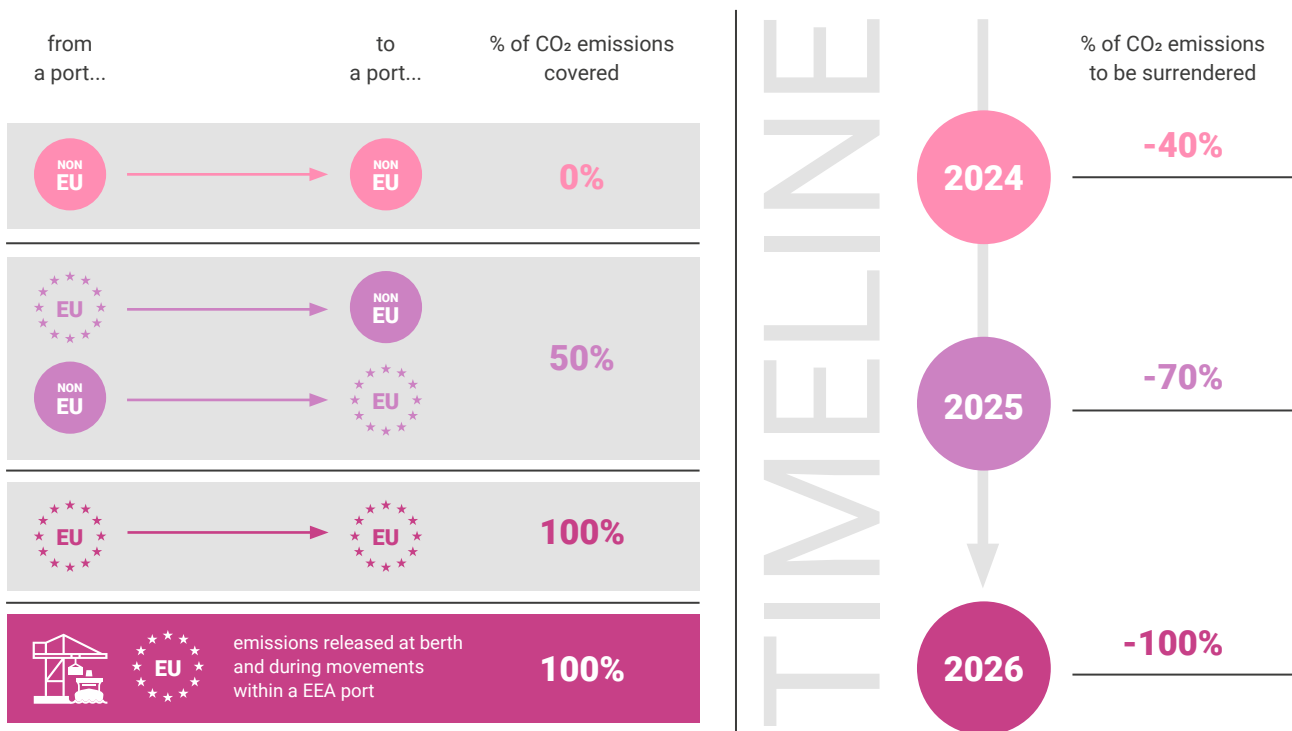


Figure 4 | Source: SRM on author's elaboration

⁷ European Maritime Safety Agency.

2.3 Evasion strategy options of the EU-ETS system

Industry literature and the EU Commission itself have identified 4 main evasion practices of the EU-ETS, applicable to the maritime sector as a whole:

1. Adding a non-EU port-of-call;
2. Changing the order of ports in the current schedules so that the non-EU-EEA regional port is the first port of call in the area;
3. Removing all EU-EEA ports from the planning and outsourcing the supply of European ports from non-EU-EEA ports;
4. Like the previous one but removing some of the EU-EEA ports.

2.4 Commonly proposed measures addressing the risk of relocation

- Encouraging all states in the European and Mediterranean region (including non-EU-EEA ones) to voluntarily join EU-ETS model implementation systems.
- Change the thresholds within which a port of call is considered as such, for example, by incorporating minimum quantities of cargo or passengers to be loaded/unloaded. This adjustment aims to prevent fictitious stopovers shortly before landing in the EU-EEA area.
- Applying an additional tax per cargo or passenger unit, depending on the previous port of call, to discourage relocation policies.

Nonetheless, these measures present the following operational difficulties:

- Involving a multiplicity of states, especially in the short term, to adopt a regulatory scheme similar to the European one.
- There is a risk that the penalizing scheme for ports considered as ports of call may inadvertently include genuine cases, not motivated by an evasion strategy of the EU-ETS mechanism. Furthermore, the EU-MRV mechanism would require amendment to encompass non-EU-EEA ports, which are currently excluded.
- The imposition of additional taxation per unit of cargo/passenger, even if intended to deter evasion of the EU-ETS, could potentially violate WTO agreements on free trade.

2.5 The new anti-evasion article. The definition of 'port of call'

In the ETS Directive (Dir. 2003/87), Art. 3 contains the definitions necessary for the rule to operate. With the recent amendment, in addition to defining the 'operator of the ship', a subject obliged to surrender the allowances equivalent to the emissions produced by the ship, Directive 2023/959 also had to define when the stop in a port is to be defined as a port of call, a prerequisite for acquiring the distance data to multiply the polluting factor of the type of ship – the EU MRV system mentioned above. The legislator decided to integrate the concept of 'port of call' in an attempt to protect the market of European container terminals, especially those with a transshipment function. Pursuant to the new letter z) of article 3, 'stops for the sole purposes of refuelling, obtaining supplies, relieving the crew of a ship [...], making repairs to the ship, stops in port because the ship is in need of assistance or in distress,[...] stops for the sole purpose of taking shelter from adverse weather [...], and stops of container ships in a neighbouring container transshipment port listed in the implementing act adopted pursuant to Article 3ga(2) are excluded'.

This is subject to the following conditions:

- Port location less than **300 nautical miles** from a port under the jurisdiction of a Member State.
- Ports with **transshipment exceeding 65%** of total annual container traffic.

Example of application of the anti-evasion measure

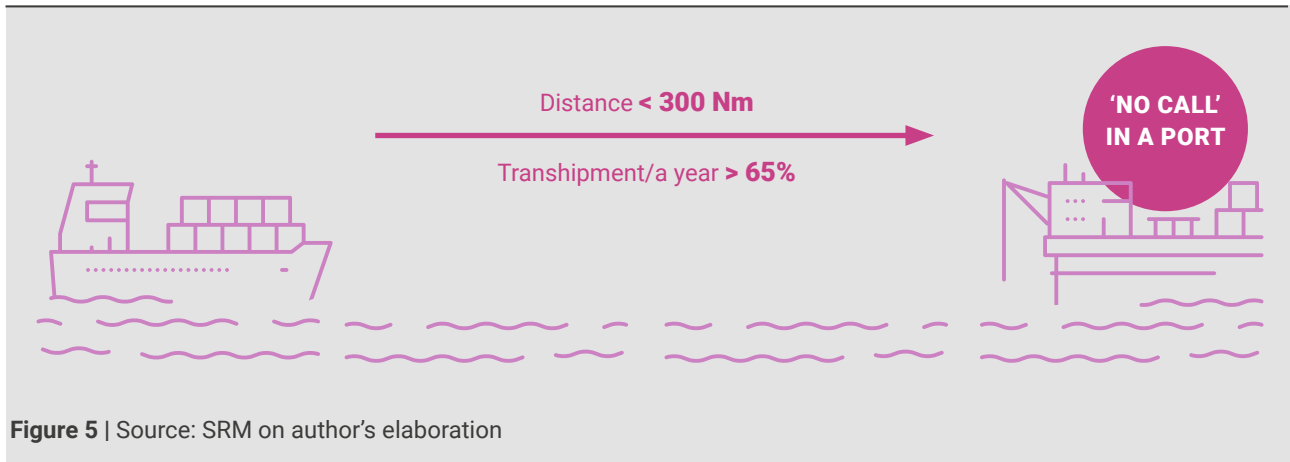


Figure 5 | Source: SRM on author's elaboration

These neighbouring transshipment ports were identified by a Commission implementing act by 31 December 2023, to be updated every two years thereafter.

In view of the first deadline of 31 December 2023, the Commission launched a public consultation to receive feedback on the 'neighbouring' ports to be listed, with East Port Said and Tanger Med already included in the list. To date, 36 opinions have been received⁸.

3. The case of Gioia Tauro with respect to the overall organization of seaborne container transport and to the proposed measures

Gioia Tauro, thanks both to national and European infrastructural decisions (core TEN-T port) and to terminal operators' investments, has established itself and consolidated, not without difficulty, as the hub of container (and car) interchange in the central Mediterranean macro-area. On this subject, please refer to sections 1.2 and 1.3 above.

The visuals below clearly show a cost burden for European ports and a competitive advantage reserved for non-EU-EEA ports. However, paragraphs 3.1 and 3.2 below will attempt to explain how, paradoxically, the anti-evasion rule makes the picture even worse. In fact, the Commission, in showing zealous attention to carbon leakage, not only fails to consider the economic and strategic losses but proposes to watch over possible relocation policies in order, if necessary, to intervene with regulatory changes after these have happened. However, a container terminal is made of technical nautical and port operators, docks, yards, railway gateway, etc. and if the terminal operator decides to dismantle the cranes in order to relocate, there is a real risk of rapid and irreversible decline, as demonstrated in Italy by the other two transshipment hubs that were established in the past in other southern/insular regions, namely Cagliari and Taranto.

⁸ Feedback received can be consulted here: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13867-EU-Emissions-Trading-System-ETS-neighbouring-container-transshipment-ports_en.

Therefore, in our opinion, the Commission fails to consider that the relocation process, should it happen, will not be reversible.

Visualisations of current impact of Directive (EU) 2023/959

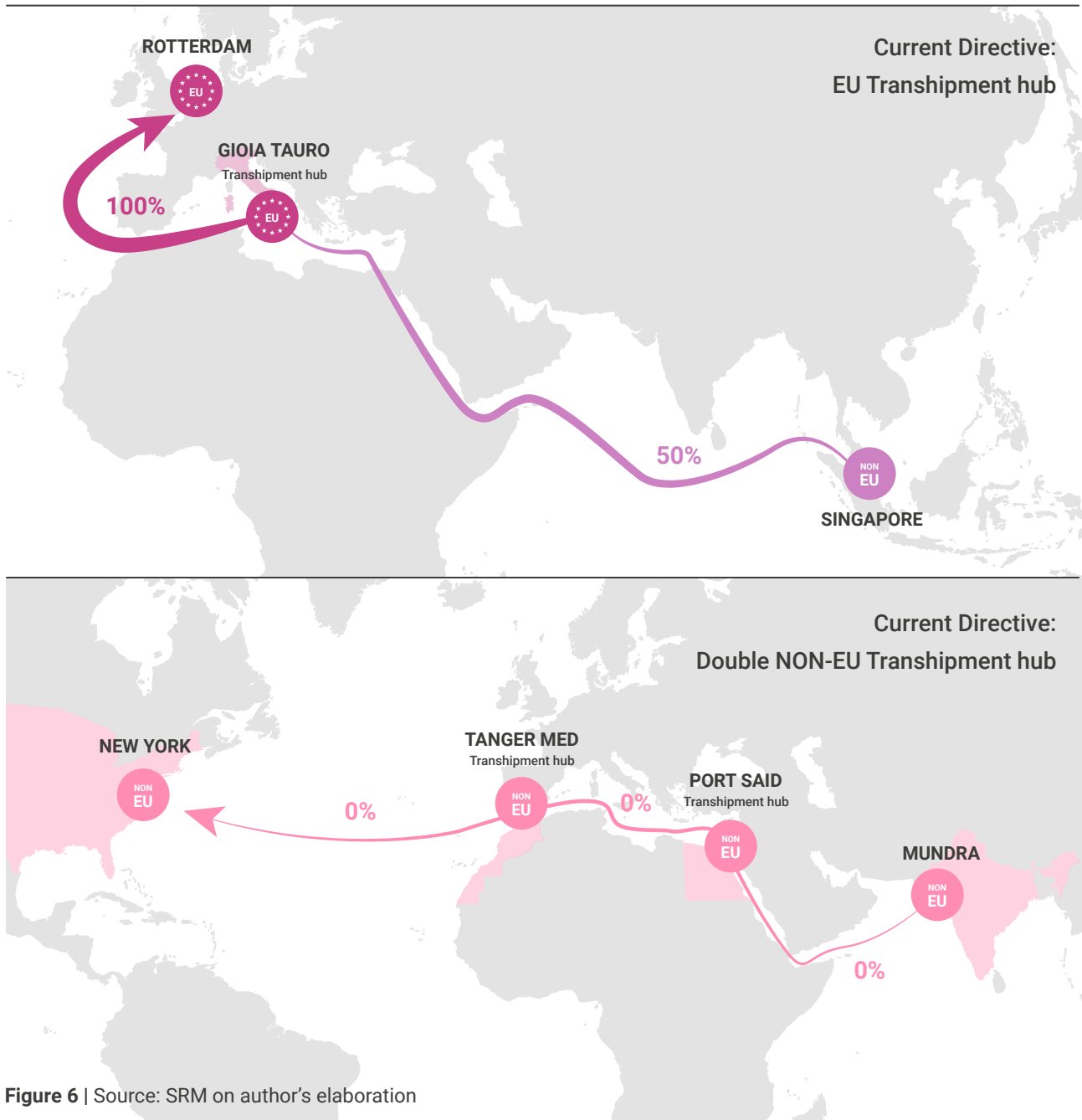


Figure 6 | Source: SRM on author's elaboration

3.1 The importance of investment in equipment by the terminal operator

The following is a series of data which can demonstrate how the container port market is characterised by a high capital investment component. For ease of discussion, we will limit ourselves to highlighting the supply dynamics of the main piece of equipment, i.e. the 'Ship to shore container cranes' type. Currently, 22 of these cranes operate in the yards of the port of Gioia Tauro. They are characterised by a high level of specialisation, determined by the buyer at the time of the order.

At Gioia Tauro, in summary, four macro-types of these cranes can be identified, each of which is suitable for operating a certain size category of ship.

The latest state-of-the-art equipment purchased by the terminal operator is composed of 3 *Ship-to-shore container gantry cranes* delivered in May 2023. They have an approximate cost of €12 million each. The delivery time from the order of these cranes is approximately 24 months. Therefore, the terminal operator's decision to invest in the crane lot described above was taken, given the market survey and order placement phases, 30 months in advance.

The cost of relocating one of these cranes, for a 500/1000 nm section (relocation to another hub in the Mediterranean region), can be estimated at approximately €1 million per crane.

It is clear that any decision to relocate will not be taken without a prior in-depth analysis. On the other hand, it is equally evident that such a decision, given the capital invested and the costs of transferring equipment corresponding to at least 10% of the cost of new equipment, as well as the time required to implement it, is unlikely to be reversible, even if the ETS rule were subsequently modified. The next paragraph will highlight, from the analysis of a consolidated line, how **the rule, especially with the 'anti-evasion' variant, disadvantages the liners that have invested in Gioia Tauro.**

3.2 Case Study: analysis of increased cost for a ship calling at Gioia Tauro as first/last EU-EEA port, performed on a real and consolidated liner service.

Pre and post anti-evasion rule

In the documents supporting the legislative proposal, which led to the adoption of Directive 2023/959, it is clearly stated that the anti-evasion rule will have to avert both the relocation of transshipment ports outside the EU and the implementation of evasive port calls that limit the length of the route on which the ETS contribution is calculated.

The two pictures below show a liner service that exists and has been plied on a weekly basis by a 2M alliance vessel for **more than 6 years**.

Next, the amount of emission allowances due, for the call at Gioia Tauro within the line, will be calculated according to the rule. Although this line had been consolidated for more than 6 years and can therefore be considered genuine, authentic, not evasive, it will be shown how the Directive subjects the ship operator that calls at Gioia Tauro to increasingly worsening conditions, which would put our⁹ transshipment container hub potentially 'out of business'. This situation will be examined by going through the pejorative breakdown of the regulatory and market adjustments that, inexplicably, seem to have gathered on the economy of our port, including:

- the regulation itself;
- the explosion of the market cost of emission allowances on the figures expected for 2023: the average value of an EUA for 2023 is €86 with an all-time high of €101.6¹⁰ (the forecast for 2023 was €50);
- the anti-evasion rule that, by 'cancelling' Port Said, 'lengthens' the first-entry route to Singapore (increasing the amount due by at least three times).

⁹ The port is described as 'ours' not only because it is Italian but also because it is a core hub of the TEN-T network on the Scandinavian-Mediterranean corridor.

¹⁰ GSE (2023), Rapporto Aste CO₂ – II Trimestre 2023. Monitoraggio del mercato del carbonio.

Timetable of the 2M-Jade/AE11 Westbound line

Port call	Transit time	Arrives	Departs
Qingdao	-	-	Day 1 (Tuesday)
Busan	3 days	Day 4 (Saturday)	Day 4 (Monday)
Ningbo	8 days	Day 9 (Friday)	Day 9 (Sunday)
Shanghai	11 days	Day 12 (Monday)	Day 12 (Tuesday)
Xiamen	15 days	Day 16 (Friday)	Day 16 (Friday)
Nansha New Port	16 days	Day 17 (Saturday)	Day 17 (Sunday)
Yantian	17 days	Day 18 (Sunday)	Day 18 (Monday)
Singapore	22 days	Day 23 (Friday)	Day 23 (Sunday)
Port Said East	37 days	Day 38 (Saturday)	Day 38 (Sunday)
Gioia Tauro	41 days	Day 42 (Wednesday)	Day 42 (Friday)
Barcelona	45 days	Day 46 (Sunday)	Day 46 (Wednesday)
Valencia	49 days	Day 50 (Thursday)	Day 50 (Saturday)

Table 1 | Source: Maersk (updated April 2024)

The 24,000 TEU vessels used in the liner services [AM2 of the 2M-Jade/AE11 Westbound line] with the Far East regularly call at the ports shown in Table 1. In the Mediterranean they call at Gioia Tauro, Barcelona, Valencia and, again, Gioia Tauro.

In May 2022 the ship MSC Nela unloaded 3,267 containers and loaded 917 containers during its first call at GT [arrival 21/05/2022 at 19:00, departure 24/05/2022 at 02:00]. Interestingly, as proof of GT's strategic importance, the MSC Nela called at GT twice, both as the first port of call in the EU-ETS area and as the last in the Mediterranean region before heading directly for the Far East again.

For the purpose of calculating the impact of the EU-ETS, only the first call at GT will be taken into account. For the second, the final results can be assumed to be similar, as the difference in distance between Barcelona or Valencia and GT is not significant.

Gioia Tauro is the first European port of entry after Port Said [1800 km - 960 Nm].

The next port is Barcelona [1255Km - 677 Nm].

The arrival route is 960 nautical miles; the ship, sailing at an average of 12 knots, takes 3 and a half days to arrive at GT with an estimated fuel consumption of 120 tonnes per day. The total fuel consumed can be estimated at 420 tonnes equal to 1,344 tonnes of CO₂ emitted into the atmosphere. By purchasing 50% of the emissions allowances at €86 per ton CO₂¹¹, the additional EU-ETS cost of the trip would reach €57,788.

¹¹ Average EUA price for 2023.

Therefore, the journey to GT will incur an extra cost of €57,788, not applicable in the case of replacing GT with a non-EU-EEA port. Furthermore, by choosing GT, the journey to Barcelona will be 100% incorporated, with costs estimated at €81,505. This cost would be half, or €40,752, should a non-EU-EEA port be used instead of GT.

Therefore, the total cost impact can be quantified at approximately €139,293.

On the other hand, the potential savings by replacing GT with a non-EU-EEA port can be estimated at €98,540 due to the elimination of the first entry route to GT (-€57,788) and the reduction to 50% of the arrival route to Barcelona (-€40,752).

Dividing the potential saving of €98,541 by 4,184 TEUs handled, the cost increase per TEU for a liner that decides to operate in the EU-ETS area is about €24. However, in this calculation the EUA value has been assumed to be €86 t CO₂, the average price in 2023; having to make a forecast estimate, it cannot be disregarded that the highest recorded EUA value in 2023 was €101.6, in the aftermath of the inclusion of the maritime sector in the ETS. Therefore, it is believed that much higher values will be reached than the €86 figure included in the calculation when there are more players involved in the market, such as the many shipping companies that will have to purchase allowances in the short term, starting in January 2025.

In conclusion, in order to provide a reliable, albeit optimistic estimate, it is considered necessary to adopt the €100 price per EUA in the simulation, with an increase in costs that can be summarised as follows:

- €161,969 of new costs per ship voyage continuing to use GT;
- Only €47,386 of new costs by avoiding GT and using a non-EU port (resulting in a saving of €114,583, per ship voyage);
- €27 per TEU in the case of the NELA ship in the call of 21 May 2022. This value may increase/decrease as the volumes handled vary. However, we will see in the next paragraph how this value will be pushed up to €76 per TEU by the anti-evasion rule.

At this stage, to highlight its illogicality, we will apply the effect of the anti-evasion rule, designed to defend European container transshipment ports, such as Gioia Tauro.


3.2.1 The impact of the anti-evasion or anti-relocation rule. Distorted effects

Port Said, a port preceding Gioia Tauro on the AE11 Westbound line, **will no longer be considered a port of call and will not interrupt the route** prior to the ship's first call in the EU area, which, therefore, will be considered as coming from Singapore. In miles terms this means more than 5,000 nm compared to 900 from Port Said. Therefore, the total costs per route as listed above, will be increased up to 5 times for the distance of first entry into the EU. It seems clear that this anti-evasion measure forces liners to change their calls and that, while nominally appearing precautionary, in practice it is more than penalising for ports such as Gioia Tauro, Malta, Cyprus, Algeciras, Sines, Las Palmas, etc., in favour of ports in North Africa, Israel or the Middle East.

The total additional cost due to the effect of the anti-evasion rule can be estimated, for the outward voyage of the NELA ship alone, keeping Gioia Tauro instead of another hub, at **€319,451**, since for the calculation one has to go all the way back to the port before Port Said, which is Singapore. All this, including the return voyage and multiplied by 52 weeks/year, results in annual extra charges on this route of around €33 million.

Calculating impacts on the distance multiplier

Vessel MSC NELA, call to Gioia Tauro on 21-24 May 2022

Distance in nautical miles 	Singapore-Port Said 4,113 Nm	Port Said-Gioia Tauro 960 Nm	Gioia Tauro-Barcelona 670 Nm

	Distance towards Gioia Tauro (1 st EU port)	1 st voyage between EU ports	Nautical miles under ETS
Applying the ETS on actual distances	960	670	1,150
	50% 480	100% 670	
Applying the anti-evasion rule	5,073	670	3,207
	-50% 2,536	100% 670	

Tabella 2 | Source: SRM on author's elaboration

Impact on a specific vessel: the MSC Nela on the AE11 Westbound

Transport cost per TEU

EUA costs considered	€50 Base price	€86 Average price 2023	€100 Max. price 2023
[A] Nuovi oneri mantenendo GT	€80,985	€139,293	€161,969
[R] Risparmio evitando GT	€57,291	€98,540	€114,583
Dividing [R] by 4,184 TEUs handled			
[C] Additional cost per TEU	€14	€24	€27

Application of the 'anti-evasion' rule   

Livelli di costo EUA	€50 Base price	€86 Average price 2023	€100 Max. price 2023
[A] New costs with GT	€225,786	€388,349	€451,567
[R] Savings without GT	€159,727	€274,730	€319,451
Dividing [R] by 4,184 TEUs handled			
[C] Additional cost per TEU	€38	€66	€76

Table 3 | Source: SRM on author's elaboration

Furthermore, it should be underscored that the vessels used on this route, after Barcelona and Valencia, call at Gioia Tauro again before heading back to the Far East. To avoid an overload in the discussion, and to keep it focused on Gioia Tauro, the subsequent routes, Barcelona –Valencia and Valencia – Gioia Tauro, which total an additional 1,000 miles at a 100% EUA rate, have been excluded, as they are intra-EU. Therefore, it would not have been fair to account for them as an increase in costs to call at Gioia Tauro. However, to a good approximation, these additional 1,000 miles (at 100% EUA) result in additional costs of about one third of the total indicated above.

4. Proposals for amendments to the regulation to safeguard transshipment traffic

The ETS regulation represents a single element of the complex regulatory framework commonly referred to as 'FIT FOR 55'. Therefore, the regulation can only be understood and evaluated within this framework and taking into account that a strict surrender of emission allowances is linked to an ambitious re-investment plan for isolated resources.

4.1 Stop the clock

As with the aviation ETS in 2012, the most sensible course of action is a temporary suspension, which would allow the scheme to be adjusted in advance and prevent relocations. Indeed, the threat of relocation hangs over the whole issue. The relocation of a terminal operator is a difficult process to reverse and revising the regulation after two years seems to be the wrong strategy. Therefore, it is considered appropriate to adopt a 'stop the clock' measure for international voyages to/from Europe, applying the ETS regime only to intra-European voyages from 2024 onwards, while waiting for the adoption of international rules within the IMO that will apply the ETS to all ships on a global scale (as well as those related to lower emission fuels). It is considered reasonable to wait for such rules, which, due to their general scope, could better address the issues of a sector that by its nature is cross-border and international. Alternatively, bilateral agreements could be concluded with Mediterranean countries to achieve an even, fair and shared application of the ETS.

Should the timetable for the adoption of the ETS within the IMO be deemed inadequate, EU-ETS should be adopted on the international entry/exit routes, not without first taking one of the following measures.

4.1.1 Excluding well-established routes involving the ports listed in the anti-evasion rule

It is considered that the anti-evasion rule cannot impose additional charges on pre-existing and established routes. As the case study in section 3.2 shows, a deep-sea vessel from the Far East has been calling at Gioia Tauro as the first European port after Port Said every 7 days for years. It is clear that the call at Port Said is genuine and not driven by evasive practices. Therefore, the application of a 3 to 5 times surcharge imposed by the anti-evasion rule is certainly to be avoided. In short, if the historical data show that a particular port has always been part of an established pattern of ports of call for the line concerned, the ports in question should be considered as 'ports of call' and set to zero in the calculation of the distance multiplier.

4.1.2 Reducing the percentages from 50% to 20% for inbound/outbound and from 100% to 70% in the first/last intra-EU-EEA voyage

A regulatory strategy capable of keeping the rule intact is to reduce the allowance percentages on the first entry/exit route and on those immediately following or preceding intra-EU-EEA routes. Such a decision, as well as being justified by the logical assumption that in a hypothetical Singapore-Gioia Tauro route, only 20% of emissions take place in the Mediterranean, would make it possible to eliminate any other anti-evasion or conservative correction by means of free allowances.

4.1.3 Level playing field. Same rules between ports in the homogeneous transshipment business, both for EU or non-EU ports

In order to avert market distortions, capable of highlighting the inconvenience of future or past investment in the infrastructure of transshipment terminals located in European territory, it is considered that the regime applied to Port Said and Tanger Med should simply be extended, identically, to Gioia Tauro and other similar European ports (Malta, Sines, etc.).

In this paragraph we will explain both the logic of the proposal in practical terms by means of examples, and its compatibility with certain regulatory provisions already present in EU Directive 2023/959, to be amended.

In Figure 7, it can be seen how the proposed amendment ensures a level playing field for transshipment ports operating in the Mediterranean.

Proposal for amendment to the ETS mechanism

The Directive defines a 'port of call' as follows:

z) 'port of call' means the port where a ship stops to load or unload cargo or to embark or disembark passengers, or the port where an offshore ship stops to relieve the crew; stops for the sole purposes of refuelling, obtaining supplies, relieving the crew of a ship other than an offshore ship, going into dry-dock or making repairs to the ship, its equipment, or both, stops in port because the ship is in need of assistance or in distress, ship-to-ship transfers carried out outside ports, stops for the sole purpose of taking shelter from adverse weather or rendered necessary by search and rescue activities, and stops of containerhips in a neighbouring container transshipment port listed in the implementing act adopted pursuant to Article 3ga(2) are excluded.

It is recommended that the words 'European or' are added before 'neighbouring'. The amended text would thus read as follows: '*... stops of containerhips in a European or neighbouring container transshipment port listed in the implementing act adopted pursuant to Article 3ga(2) are excluded*'.

Within the framework of the implementing act, this would allow Gioia Tauro to be included in the same list as Tanger Med and Port Said, applying the same requirement of a transshipment share > 65% of total containers handled.

4.1.4 Allocation of free ETS allowances to transshipment hubs

Incorporating a dedicated provision for container transshipment ports to accommodate EU-ETS allowances pursuant to Article 10a(6) of the ETS Directive is essential. This provision is designed to safeguard against the risk of relocation by offering protection mechanisms through the allocation of free allowances to sectors vulnerable to such risks.

Examples of proposed amendments to the EU Directive 2023/959

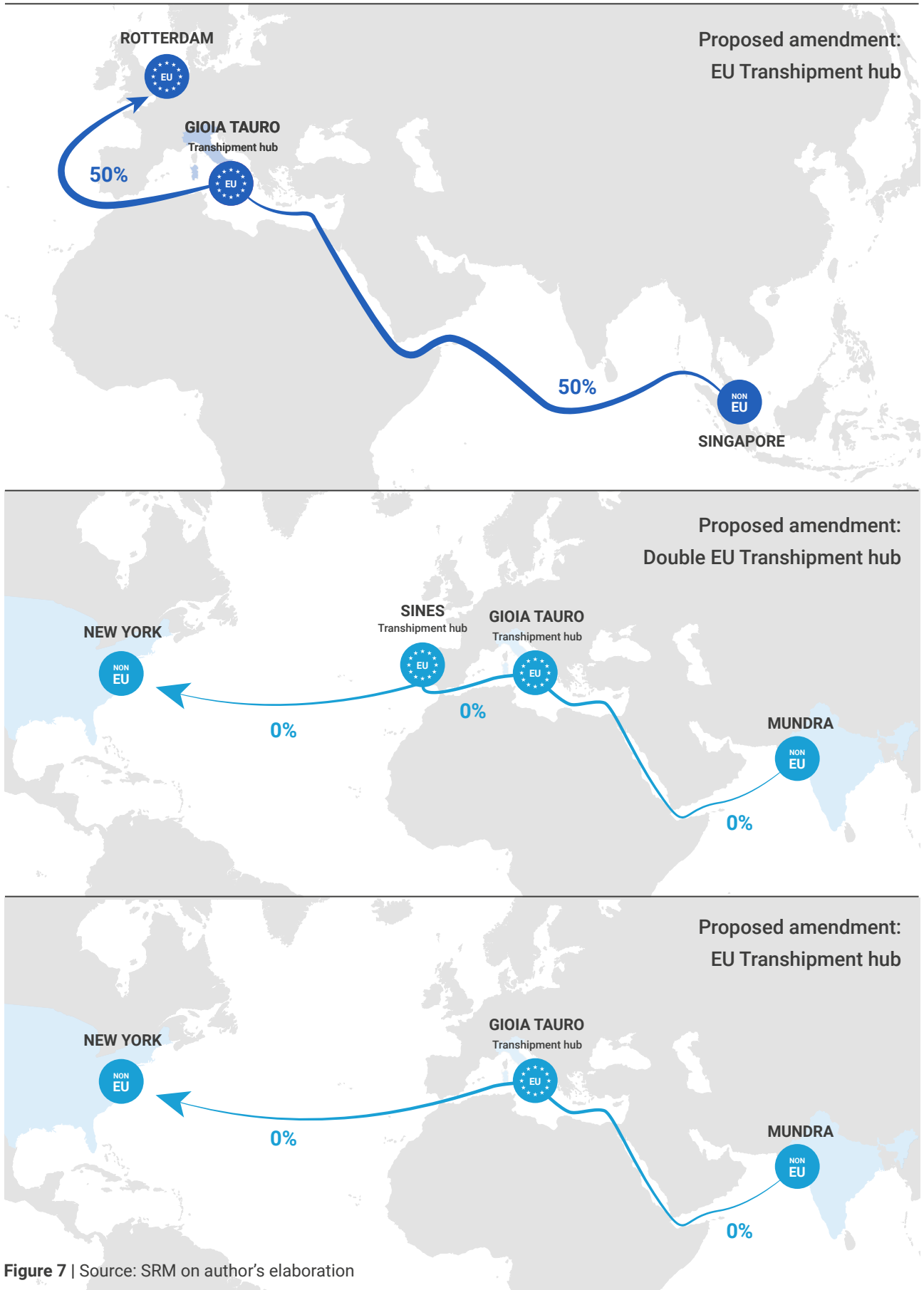


Figure 7 | Source: SRM on author's elaboration

However, due to their intricate nature and constraints regarding duration and allocation percentages, these provisions are regarded as secondary considerations compared to the proposals outlined in preceding paragraphs.

4.1.5 Balancing the competitive disadvantage of transshipment hubs through the targeted use of resources generated by the sale of ETS allowances

The provisions of art.10, letter f) of the ETS Directive 2003/87 indicating *'measures to decarbonise the maritime sector, including the improvement of the energy efficiency of ships, ports, innovative technologies and infrastructure, and sustainable alternative fuels, such as hydrogen and ammonia that are produced from renewables, and zero- emission propulsion technologies'*, alongside the provisions of FUEL-EU and AFID regulations, need to guarantee adequate funding to liners that keep operating in European transshipment hubs. In this regard, support is deemed necessary for initiatives aimed at institutionalising green corridors, which can be defined as a maritime route between major port hubs (container hubs) on which the technological, economic and regulatory feasibility of deploying low-emission ships through public and private action is decided. Green corridors would provide sufficient 'scale' and volume to ensure impact leverage, as they would be 'large' enough to include all actors in the value chain, including fuel producers, ship operators, cargo owners and regulators.

5. Conclusions: losing Gioia Tauro is not an option

The year 2022/2023 represented a historic watershed period for the port of Gioia Tauro. With the creation of the last and penultimate mile infrastructures built by the AdSP, the port of GT is also facing the gateway market with ambition. Although the process of increasing the capacity of the rail network between the port and the freight villages has yet to be completed, there are already 80 trains a week departing from the port.

This fact, together with the terminal operators' decisive investment campaign, is believed to be a strong element of the port's economic fundamentals. Added to this are the strategic and ambitious choices made by the AdSP in aiming for a high level of infrastructure, including logistical support for the ships themselves. An example is the creation of the dry dock capable of receiving, for maintenance, the ships discussed at length in this chapter.

For these reasons of active policy (gateway, infrastructure, investment, dry dock), together with the economic evidence shown regarding the selection that the market has already made in singling out and picking GT among various competitors, it is believed that GT has solid economic fundamentals that allow it to look to the future with confidence, unless the ETS rule is so illogical as to produce distorting effects such as the one shown in paragraph 3.2 especially due to the anti-evasion rule. This correction, should it remain as is, will fail to serve its purpose of protecting a port like Gioia Tauro.

However, it was considered appropriate to contribute to the discussion by making the proposals listed in the previous paragraph. Everyone agrees that the worst-case scenario in connection with the entry into force of the new measures, in particular the EU-ETS, is the relocation of transshipment ports outside the EU. Moreover, this would take place while maintaining the same emissions at a regional level or possibly increasing them as non-EU ports do not even apply the rules related to fuels with lower emissions, the so-called FUEL EU. The EU institutions themselves, in the analytical documents supporting the bill, report

that this risk is real and cannot be ruled out. Therefore, despite the certainty on the soundness of GT's complex infrastructural hub, it is reasonable to reconsider the suitability of an instrument capable of introducing market-distorting elements, with the risk of failing to reduce emissions and of losing control over the economic leverage to reinvest according to the FIT FOR 55 logic.

To use expressions from the preparatory documents of the directive, in addition to the so-called Carbon leakage, we will also witness a strategic leakage, an economic leakage, and a tax revenue leakage, capable of undermining the reinvestment mechanism in the energy transition of the FIT FOR 55 strategy. A strategic leakage would occur because the North African or Middle Eastern states, which are certainly less stable than the European ones, will host the logistical nodes downstream of which the logistics of the European production system will be located. Regarding the economic loss, however, some data related to Gioia Tauro can be summarised as follows:

Direct employment	1,600 dock workers
Indirect employment	4,000 jobs
Public contracts in the last 20 years	€179,000,000
Terminal operators' investment in the last 10 years	€230,000,000

Part Two

The vision of
international
observers

Chapter 5 | **The Belgian maritime innovation ecosystem**

The maritime industry plays a significant role in the economic development of nations, serving as a crucial driver of global trade and fostering innovation in various sectors. Belgium, as a country with a rich history of maritime activities, located in the heart of Europe with access to the North Sea, has long been recognized for its maritime heritage and its strategic position as a gateway to international markets. Over the years, Belgium has developed a robust maritime landscape that encompasses diverse sectors such as shipping, ports, logistics, offshore energy, and marine technology. The country's ports have been striving to become first movers in the circular economy transition, aiming to develop as circular hotspots (Van *et al.*, 2020). In recent times, the importance of fostering innovation within the maritime sector has gained considerable attention worldwide. Innovation has become a key driver for sustainable growth, competitiveness, and resilience in an increasingly globalized and technologically advanced environment. In this context, understanding the dynamics of Belgium's maritime innovation ecosystem becomes crucial to identify its strengths, challenges, and potential areas for improvement.

The purpose of this chapter is to provide an in-depth exploration and analysis of the Belgian maritime landscape and its associated innovation ecosystem. By examining the key actors, institutions, policies, and initiatives, this research aims to shed light on the factors that contribute to the successful development and implementation of maritime innovations in Belgium. Furthermore, it seeks to identify the map of the involved local maritime stakeholders. The chapter adopts a multidisciplinary approach, drawing upon concepts and frameworks from fields such as innovation studies and maritime stakeholders. By integrating qualitative and quantitative methods, including literature reviews, interviews, and data analysis, a comprehensive understanding of the Belgium maritime innovation ecosystem will be developed. The findings of this research are expected to contribute to the existing body of knowledge on maritime innovation, while also providing practical insights for policymakers, industry stakeholders, and researchers. Understanding the specific characteristics of the Belgian maritime landscape and innovation ecosystem will enable policymakers to design effective strategies to foster innovation, enhance competitiveness, and promote sustainable development within the sector.

Overall, this chapter aims to provide a comprehensive overview of the Belgian maritime landscape and its innovation ecosystem. By delving into the various facets of the sector, the study seeks to uncover the map, drivers, challenges, and opportunities that shape the innovation dynamics in Belgium's maritime industry. Through this analysis, valuable insights can be gained, contributing to the further development and advancement of the country's maritime sector in the face of a rapidly evolving global economy.

1. Literature review

The maritime industry has been crucial to the global economy, facilitating the transport of goods and people across the world. Maritime clusters, which consist of interconnected firms, institutions, and other organizations, have been shown to foster innovation within these industries. Maritime innovation ecosystems have been the subject of recent research, with scholars defining them as evolving sets of actors, activities, and institutions that are important for innovative performance (Gifford *et al.*, 2021). These ecosystems consist of organizations and connections between them, generating creativity and output on a sustainable basis (Granstrand *et al.*, 2020). However, despite the importance of innovation in the maritime industry, only 11% of analyzed papers focused on innovations in the industry as a whole (Koukaki, 2020).

1.1 Approach

This literature review draws upon a total of 34 relevant papers found using a systematic search of databases and forward and backward snowballing. After a pre-review, 17 papers were selected for further analysis, which included 14 journal papers, 2 webpages, and 4 book sections. This review presents an analysis of the main perspectives and views on various topics related to maritime clusters. The research topics identified in the reviewed literature include maritime cluster composition, functions, and governance; maritime cluster effects and contributions; and maritime cluster competitiveness, evolution, policies and innovation. The purpose of this literature review is to highlight the latest research, omissions, and limitations of current research and identify new research directions.

1.2 Defining clusters based on the evolutionary cluster theory

Maritime clusters represent a specific type of industry cluster, and to establish the necessary context for this literature review, it is important to understand the concept of industry clusters. Marshall's concept of the localized industry and industrial districts were the earliest conceptualizations of industry clusters in the literature. The concept of industry clusters has evolved over time; evolutionary cluster theory, which is the most dominant approach to cluster research, characterizes clusters as "geographically bound networks of firms, related economic agents, and institutions in a particular industry sector and/or geographical area" (Boschma and Frenken, 2006). Clusters are frequently studied due to the benefits they provide to economic growth and innovation through knowledge spillovers and economies of agglomeration (Feldman and Audretsch, 1999) (see also Figure 1).

1.3 Maritime cluster composition

Many studies have assessed the influence of port and shipping clusters on economic growth and productivity. Moreover, several scholars have provided definitions of maritime clusters as distinct from other industry cluster types. De Langer's (2002) framework is one such example, which focuses on structure, governance, performance, and external influence. Another study by Pardali *et al.* (2016) highlights specific research themes in maritime clusters, including content, context, measurement, leading firm behavior, knowledge sharing, policy and competitiveness. Recent studies have investigated the role of digital innovation in shaping maritime clusters (Chen, 2019). Shi *et al.* (2020) present a layered sector composition of maritime clusters (Figure 2) and show a cluster structure making a division among logistics-based and service-based sub-clusters (Figure 3).

Evolutionary policy making in the context of innovation ecosystems

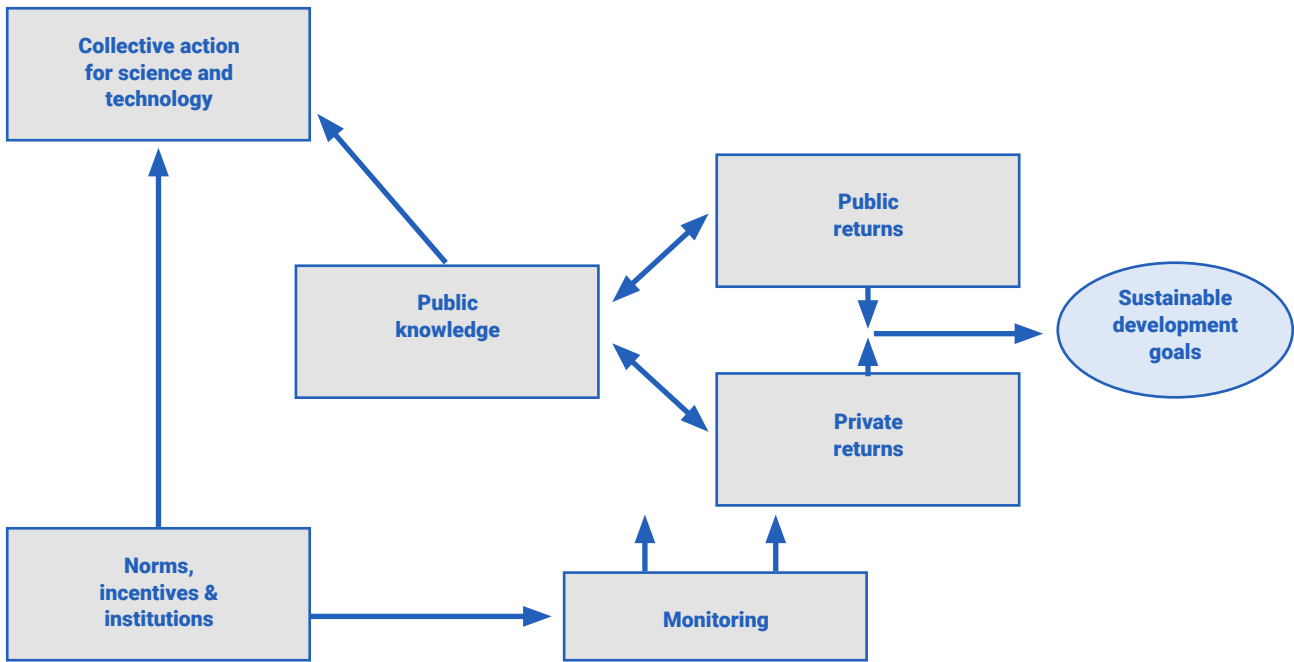


Figure 1 | Source: McKelvey, Zaring, and Szucs (2019), and Gifford and McKelvey (2019)

Diverse composition of maritime clusters under an alternative classification

Broad sectors	
	Fishing & aquaculture
	Marine recreation & tourism
	Cables & submarine telecom
Extended sectors	
	Marine equipment: Scrapping naval construction
	Shipbuilding & Repair: Dredging & marine works
	Maritime intermediate services: Marine insurers; Legal advisers; Bankers; Accountants; Technical consultants & surveyors
	Maritime support services: Media & publishers; Maritime education; Manning agencies; Research & consulting services
	Maritime regulators: Classifications societies; Maritime industry associations
Traditional sectors	
Port Operation: Cargo loading & unloading; Cargo storage & distribution; Cargo value added processing	
Maritime transportation: Freight transportation; Passenger transportation	
Inland transportation: Road, rail & barge transportation	
Auxiliary service: Pilotage & towing service; Forwarding service	

Figure 2 | Source: SRM on Shi et al. (2020)

Two basic maritime cluster types

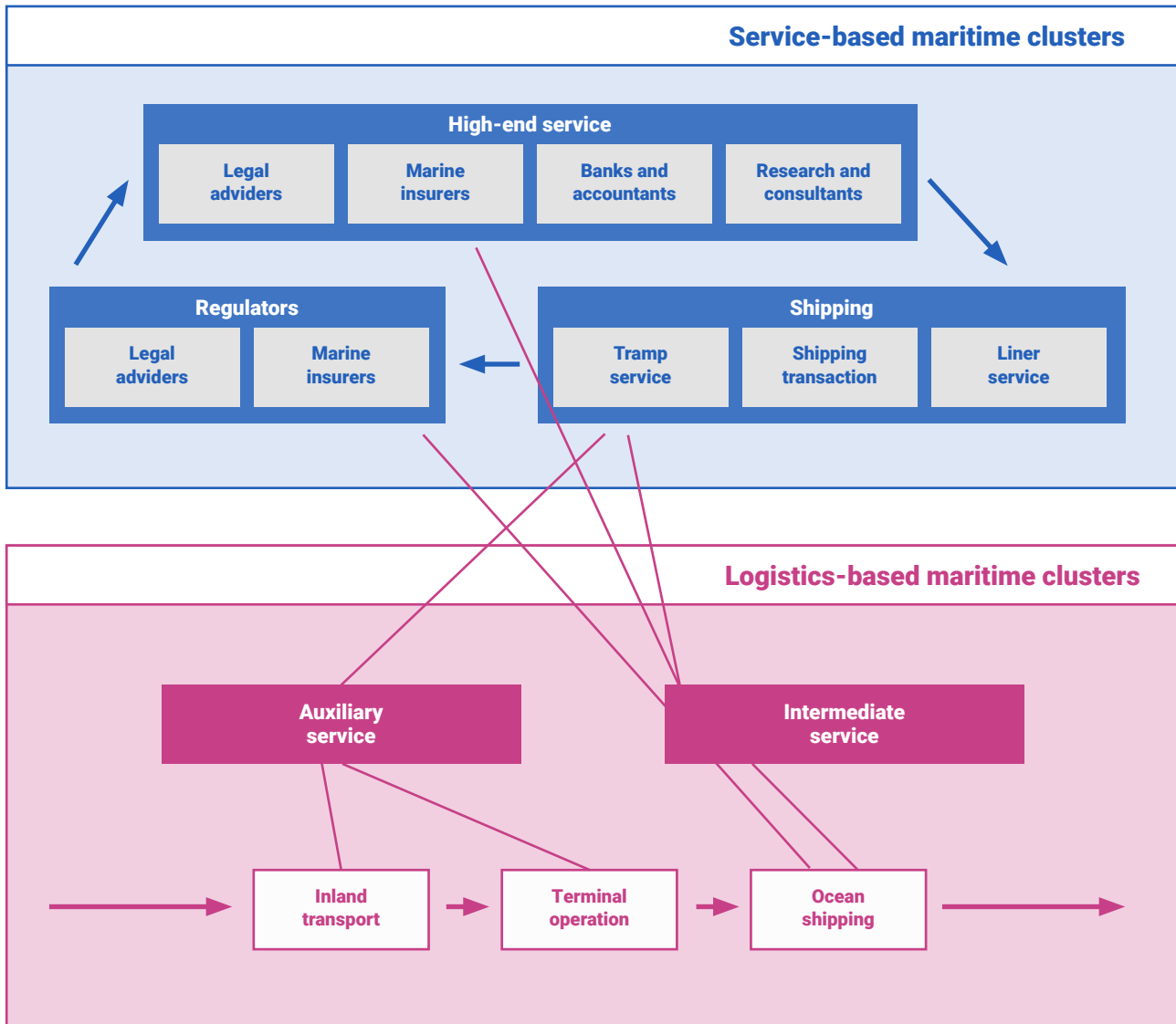


Figure 3 | Source: SRM on Shi *et al.* (2020)

1.4 Maritime cluster effects and contributions

Many studies also investigated the effects and contributions of maritime clusters. De Langen *et al.* (2012) found that firms in maritime clusters tend to have a stronger competitive position than those outside of the cluster. Maritime clusters have been identified as a driving force of innovation, with research suggesting that firms in maritime clusters are more innovative than non-clustered firms (Sampson and Woolaston, 2004). Gertler and Levitte (2005) emphasize the importance of institutions in facilitating innovation in maritime clusters, highlighting that effective governance is key to promoting innovation collaboration among players in the cluster.

1.5 Maritime cluster competitiveness, evolution, policies and innovation

The competitiveness of maritime clusters is critical to their success, and policymakers play a significant role in supporting cluster growth. Several studies have investigated the relation between maritime cluster competitiveness, evolution, policies and innovation. Research by Makkonen *et al.* (2020) offers a firm-level perspective on innovation in a Finnish maritime cluster, highlighting the importance of skilled Labour and firm competencies in enhancing competitiveness. There is also a growing interest in the role of maritime clusters in facilitating international trade and the competitiveness of shipping firms. Moreover, several studies have examined the role of public policy in the development of maritime clusters and the promotion of innovation. The evolution of maritime clusters has also been studied. Koliouisis *et al.* (2019) proposed a three-tiered framework for maritime cluster generation and provided implications for management, governance and policy.

1.6 Areas of innovation in the maritime industry

One area of innovation in the maritime industry is remote pilotage, which has been slow to develop due to the unpredictable nature of innovation (Brooks *et al.*, 2016). An innovation ecosystem perspective provides a more complete assessment of why the maritime industry has been slow to move on remote pilotage (Koukaki, 2020).

Autonomous shipping is another area of innovation in the maritime industry, with potential cost reductions and operational efficiencies (Wallengren *et al.*, 2022). An ecosystem approach to autonomous shipping can create value by integrating various stakeholders, such as shipbuilders, technology providers, and regulators (Tsvetkova *et al.*, 2022).

In addition, Generative design, an AI-driven technology, is discussed as a new approach to asset design that could revolutionize the design process for maritime assets. Several new advanced technologies poised to revolutionize the maritime industry, such as visualization technology, augmented reality, artificial intelligence, digital twins, autonomous functions, additive manufacturing, as well as the areas of clean energy transition like alternative fuels and green ecosystems as critical driving forces behind the energy transition in the maritime industry. It is worth mentioning that the blue economy is presented as a key enabler for a global paradigm shift for maritime industries beyond decarbonization and the energy transition (American Bureau of Shipping, 2022).

1.7 The performance record of maritime innovation ecosystems

There are few examples of successful maritime innovation ecosystems in the literature. One example is the co-innovation ecosystem between Orange Business and the Port of Antwerp, which brought together sector leaders of a similar mindset and reaped significant rewards for all (Wallengren, 2021). However, the literature suggests that the scattered discussion arena in the maritime industry is sometimes incapable of developing solutions for the whole industry (Koukaki *et al.*, 2020). Therefore, more research is needed to identify successful maritime innovation ecosystems and understand the factors that contribute to their success.

1.8 Maritime cluster research gaps

Based on the literature review, there are several research and literature gaps that need to be addressed to enhance the understanding and development of maritime clusters.

One of the key research gaps is the lack of focus on the differences between various maritime clusters. While the literature on maritime clusters acknowledges that the composition and structure of each cluster may differ from others, there is limited research on the specificities of each cluster and how they impact on the innovation process. This hinders the development of tailored policies and strategies for each maritime cluster, resulting in ineffective innovation processes.

Another research gap is the lack of empirical studies related to the impact of policies and strategies for innovation management in maritime clusters. Though several studies have examined the impact of such policies and strategies on firm competitiveness and innovation, there is limited empirical evidence to support these claims. Therefore, more studies need to focus on empirical validation of existing frameworks and models (De Langen *et al.*, 2012).

Furthermore, there is a lack of research on how emerging technologies, such as blockchain, artificial intelligence, and the Internet of Things, can positively impact on innovation processes in maritime clusters. With digital transformation at the forefront of many sectors, there is a need to examine how these emerging technologies can be leveraged in the maritime clusters to improve innovation processes and create competitive advantages (Chen, 2019).

Next, there is a need for greater collaboration among researchers and policymakers to bridge the gap between academic research and practical application. Most of the research carried out in the field is either academic or policymaker-driven, leaving a significant gap between theory-building and the practical application of such theories (Notteboom *et al.*, 2013). There may even be a conflict between academic rigor and practical relevance. Scholars often focus on academic research, while policymakers demand practicality. This can lead to issues where academics may not fully understand the actual problems, while policymakers may not comprehend academic topics. A related issue relates to the merging of theory with practice in maritime cluster studies, allowing them to stray away from fundamental research (theory building) (Notteboom *et al.*, 2013). Porter's argument has been deemed excessive, indicating that too much academic analysis can lead to policy paralysis (Martin *et al.*, 2003).

Lastly, the key players and stakeholders involved in successful maritime innovation ecosystems include sector leaders, startups, scaleups, and other entities that can bring together resources and expertise to address real challenges within the industry (Wallengren, 2021). The delays and challenges inherent in the innovation environment or ecosystem also require explicit consideration (Brooks *et al.*, 2016). The maritime ecosystem includes people, intangible assets, corporate cultures, standards for interaction, social networks, and a great willingness to cooperate (Buitendijk, 2019). Cities such as Rotterdam are explicitly profiling themselves as global maritime capitals and striving to develop into flourishing innovation ecosystems (Buitendijk, 2019). The management of complex innovations is a key strategic issue, and an innovation ecosystem perspective provides a more complete assessment of why the maritime industry has been slow to move on certain issues (Brooks *et al.*, 2016). However, more research is needed to identify the specific key players and stakeholders involved in successful maritime innovation ecosystems and understand how they can be orchestrated to unlock shared value for businesses, communities, and the industry as a whole (Buitendijk, 2019).

All in all, the evolution of emerging maritime clusters presents a significant research challenge. Emerging countries face the challenge of breaking through the stable global hierarchy of maritime clusters and developing into dominated maritime clusters. With the introduction of the global supply chain and digital transformation, new types of business models and interorganizational relationships should be substantiated in future research.

1.9 Conclusion on literature

Maritime clusters have been shown to foster innovation and contribute significantly to the growth of the maritime industry. This literature review has examined the various research topics pertaining to maritime clusters, including maritime cluster composition, functions, and governance; maritime cluster effects and contributions; and maritime cluster competitiveness, evolution, policies and innovation. The identified challenges in maritime cluster research include the need to strike a balance between academic rigor and practicality and the merging of theory with practice. The directions for future research include the examination of new forms of interorganizational relationships, the development of new business models in the era of digital transformation and innovation, and the study of emerging maritime clusters. This chapter contributes to answering these questions for the Belgian case.

2. Research approach

The research leading to this chapter was composed of three steps:

- Identifying and mapping maritime cluster stakeholders in Belgium based on literature.
- Interviewing a selection of stakeholders.
- Collecting answers to an online survey among stakeholders.

2.1 Identifying and mapping cluster stakeholders

This step is focused on the exploration of stakeholders' involvement in innovation, with particular emphasis on mapping and defining stakeholders. It endeavors to comprehend the stakeholders' groups, through literature and the expertise of authors as they are experienced professionals in the maritime industry. The purpose of the study in this section is to map stakeholders and define the pertinent stakeholder.

Stakeholder is a term used to denote "any group or individual who is affected by or can affect the achievement of an organization's objectives" (Freeman, 1984). According to (Wellard, 1997), it is likely that the most fundamental distinction between stakeholders lies between those who influence a decision or action, and those who are influenced by this decision or action (whether in a positive or negative manner); these two groups can be referred to as active and passive stakeholders, respectively. Therefore, it is essential to have a thorough comprehension of the concept of "stakeholder" in order to undertake a successful stakeholder analysis.

The stakeholder mapping is based upon ascertaining the anticipated potential profile of each stakeholder, which will then be utilized to identify potential stakeholder groups in order to create a list of primary and secondary stakeholders.

2.2 Interviewing cluster stakeholders

In order to establish the relationships among Belgium's maritime cluster stakeholders, we employ a qualitative approach by conducting interviews with stakeholders. These interviews provide us with a unique opportunity to delve deeper into the perspectives and insights of stakeholders within the Belgian maritime innovation ecosystem.

By engaging in face-to-face discussions, we uncover hidden opinions, gain a nuanced understanding of stakeholders' viewpoints, and explore the underlying motivations and challenges they face. Through this qualitative analysis, we capture rich and context-specific information that cannot be easily obtained through other methods. The interviews serve as a valuable tool in augmenting our understanding of the intricate dynamics and intricacies within the maritime innovation ecosystem, enabling us to make informed decisions and recommendations based on a holistic comprehension of the stakeholders' perspectives.

2.3 Conducting an online survey among cluster stakeholders

Our research approach is complemented with an online survey to collect quantitative data from stakeholders within the Belgian maritime innovation ecosystem. By adopting a quantitative approach, the study aims to systematically analyze the collected data to identify the needs and pains experienced by stakeholders, as well as to uncover the challenges and opportunities present within the ecosystem. The online survey is designed to gather specific information related to stakeholder experiences, opinions, perceptions, and expectations in order to provide a comprehensive understanding of the current state of the maritime innovation landscape in Belgium.

The data obtained from the survey are then subject to statistical analysis, enabling us to draw meaningful conclusions and make evidence-based recommendations for future interventions and improvements within the ecosystem. This methodology ensures an efficient and objective exploration of stakeholder perspectives, contributing to a holistic assessment of the Belgian maritime innovation ecosystem.

3. The Belgian maritime cluster

The process of mapping Belgian maritime cluster stakeholders was undertaken in accordance with the following steps:

- An initial list of pertinent stakeholders was compiled.
- Through desk research and internal dialogue between professionals in the maritime industry, the stakeholders' groups were evaluated and reorganized.
- Subsequent sets of stakeholders' groups were then formulated.

3.1 The initial list of pertinent cluster stakeholders

After conducting a review of existing maritime ecosystems worldwide, a pertinent roster of stakeholders within the maritime industry was compiled, as depicted in Table 1.

The initial list of pertinent stakeholders

Business bodies

Shipowners, Ship operators, Ship management companies, Ship brokers, Charterers, Cargo owners, Cargo handling companies

Regulatory bodies

Flag (BE)/EU/IMO, Classification societies, Port state/ Local authorities, Recognized organizations, Legal institutions, Policy, Regulators & compliance, Legal advisors

Financial bodies

Financial institutions, Finance & commercial, Insurance companies and P&I clubs, Shareholders

Human relations

Seafarers, Office personnel, Next of kin, Labour unions and seafarer organizations, Media, Non-governmental organizations, Environmentalists / Professional societies / International organizations, and Society

Crewing and education

Manning agents, Training institutions, Maritime academies

Engineering & Maintenance

Service companies, Makers & OEMs, Fuel and lubricant manufacturers, Shipbuilders, Shipyards & ship designers, Site teams, Supporting services & Engineering, Software providers, technical advisors, Ship design consultants

Logistics chain

Freight forwarders and Logistic partners, Transport providers, Local agents, Warehouses, Suppliers, End customers

Research and development

Research institutions / Academic institutions, Knowledge providers, Startups, Maritime accelerators

Table 1 | Source: authors' elaboration

3.2 The organised list of pertinent cluster stakeholders

In order to identify major stakeholders that have power and influence within the maritime ecosystem, authors have categorized stakeholders into 3 major groups: primary, secondary and tertiary stakeholders' group. These three groups shape the maritime innovation ecosystem are illustrated in Figure 4.

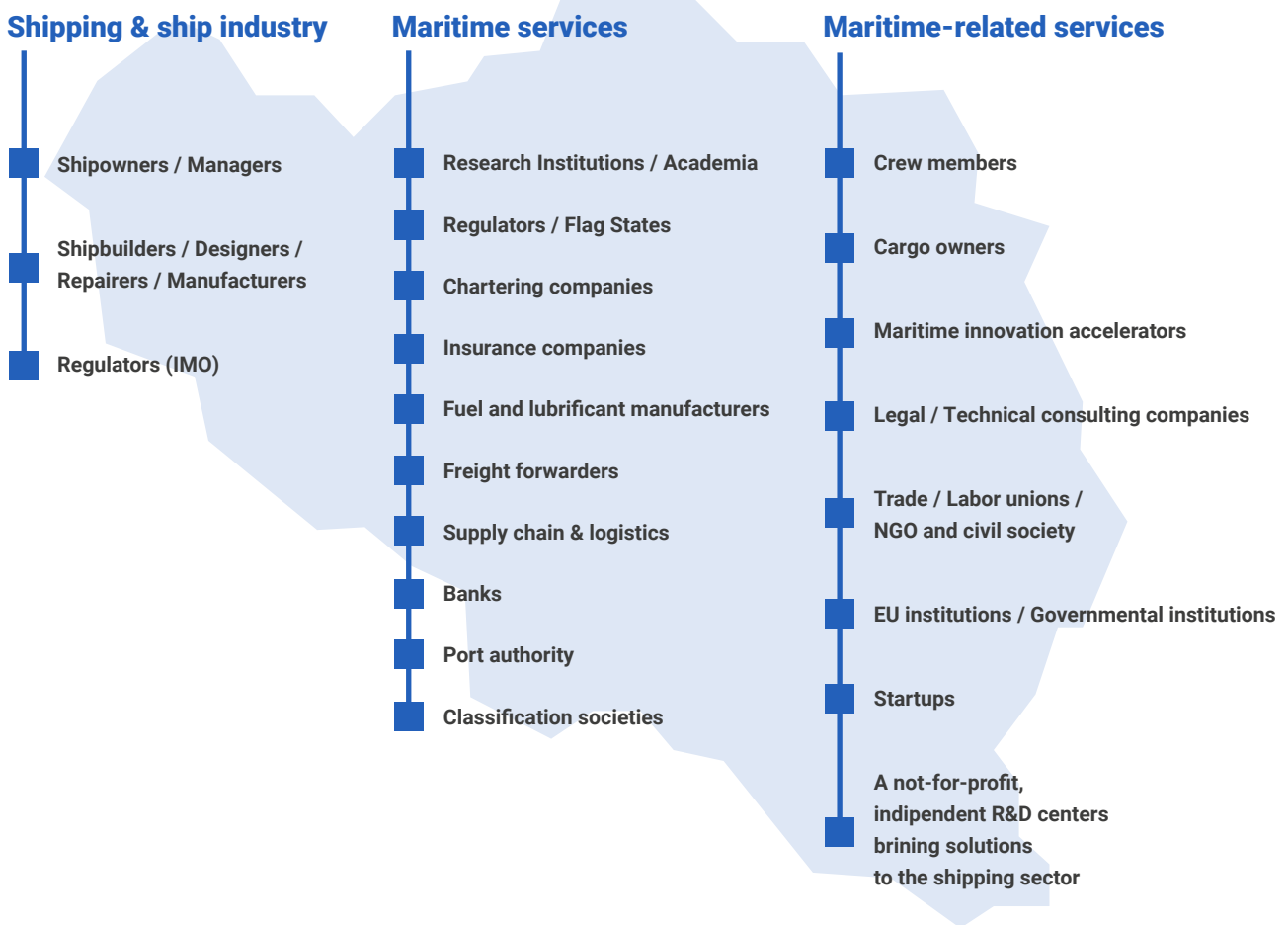


Figure 4 | Source: SRM on authors' elaboration

4. The cluster stakeholders' relationships and strategies

Interviews were conducted as a primary data collection method to acquire detailed and comprehensive insights from Belgian maritime cluster stakeholders on their relationships and strategies. Unlike standard surveys or rating scales, these interviews focused on exploring the interviewees' experiences and perspectives, uncovering intricate details about innovation in the maritime sector. The effectiveness and flexibility of the interview approach allowed for in-depth exploration of nuanced information beyond what could be captured through other data collection techniques.

A key factor contributing to the success of the interviews was the establishment of a strong rapport with the stakeholders, facilitated by our shared maritime professional background. This rapport enabled a profound understanding of their viewpoints and fostered a conversational exchange during the interview process, making it a highly valuable approach for data gathering. The interviews followed a flexible framework that allowed for interactive discussions, generating substantial and contextually relevant material. One notable advantage of our interview method was the freedom given to stakeholders to express their thoughts openly and candidly. This approach contrasted with the limitations of rating scales or questionnaires, which often restrict the depth and richness of input.

Additionally, the ordering of questions in our interviews was tailored to each specific situation, deviating from the standardized and pre-determined sequence of closed-ended questions commonly found in other data collection methodologies. The interviews conducted for this qualitative analysis were characterized by a high level of openness and cooperation from the majority of participants, with only a few instances of interviewees declining to answer certain questions. While acknowledging the potential for bias in qualitative research, the inclusion of multiple interviews with diverse stakeholders helped minimize bias and enhance the validity of the interview findings.

The first step in the research process was the careful selection and identification of key stakeholders within the Belgian maritime ecosystem who play significant roles, as shown in table 2. These individuals were considered major actors who could provide valuable insights into the subject under investigation. Efforts were made to secure appointments with the selected participants, taking into account their busy schedules. It was observed that some participants did not respond promptly to our initial invitations, necessitating multiple reminders. However, there were also instances where certain participants promptly replied to our interview invitations.

List of selected key stakeholders for interviews

Shipping companies	Euronav / Anglo Eastern / Bocimar / DEME
Classification societies	Lloyd's Register/ Bureau Veritas / DNV / RINA
Port authorities/ Terminals	Port of Antwerp / PSA / MPET / DP world
Shipyards	EDR Antwerp Shipyard / Antwerp Marine Technics / GARDEC VJ N.V / FLANDERS SHIP REPAIR
Engine manufacturers 2019	Man Energy Solutions/ Anglo Belgian Corporation
Technology providers	Alphatron Marine Belgium / Radio Holland Belgium
Standby list	Navitec Marine Services NV, ETM, maritime information systems

Table 2 | Source: authors' elaboration

At the commencement of each interview, we initiated the conversation by providing an introduction about our academic studies and professional background. This served to establish credibility and foster a friendly and trusting environment conducive to open dialogue. To ease into the interview process and establish rapport with the interviewees, we began with general questions that allowed them to express their thoughts more freely. This approach aimed to create a comfortable atmosphere, encouraging the interviewees to share their perspectives openly.

Throughout the interview, we employed a technique of drawing questions from the respondents' answers. By actively listening and analyzing their responses, we tailored subsequent inquiries to delve deeper into the topics they raised. This method ensured a focused and relevant line of questioning, enabling us to obtain comprehensive insights.

As the interview progressed, we transitioned to asking more direct questions, aiming to uncover the underlying motives and details behind the interviewees' initial responses. By employing a targeted approach, we sought to gain a deeper understanding of their perspectives and experiences.

In addition to verbal communication, we closely observed the interviewees' facial expressions, gestures, and body language during the interview. These non-verbal cues provided valuable insights and helped us interpret their responses beyond their spoken words.

To ensure a systematic approach to data collection, a questionnaire consisting of closed-ended questions was initially developed. However, during the actual interviews, we adopted a more open-ended approach. This shift occurred based on the interviewees' responses to the initial set of closed-ended questions. By tailoring subsequent inquiries to their specific answers, we were able to delve further into their perspectives and experiences, unearthing nuanced and detailed insights.

Following the completion of the interviews, we transcribed each interview meticulously, ensuring accurate records of the interviewees' responses. This step provided a written account of the interview data for further analysis. To facilitate the analysis process, we initially organized the data based on the structure of our interview questions. This provided a preliminary understanding of the interviewees' perspectives. However, as we delved deeper into the transcripts, a thematic analysis approach emerged.

Themes naturally surfaced during the interviews, prompting us to restructure the data around these emerging themes. The qualitative analysis approach employed focused on interpreting the rich and nuanced qualitative data gathered during the interviews. Rather than seeking quantitative metrics, our goal was to gain a deep understanding of the participants' experiences, perspectives, and insights. The analysis involved several steps. We began by immersing ourselves in the interview data, reading and re-reading the transcripts to familiarize ourselves with the content. Next, we engaged in a systematic coding framework. Throughout the analysis, we maintained a reflexive approach, critically reflecting on our biases and assumptions to ensure an objective interpretation.

The thematic analysis of the interviews with stakeholders led to the below summarized findings.

4.1 Findings Dubai Ports (DP) World Antwerp

The interview with DP World provides valuable insights into the company's current state, ongoing transformation, and its approach to innovation in the logistics industry. DP World, a port operator specializing in vessel loading and discharging, is in the process of transitioning into a global integrated supply chain logistics player. While the transformation is still underway, the company's commitment to innovation and efficiency is evident through the implementation of various innovative practices such as technology automation and the use of straddle carriers and automatic stacking cranes.

The interview also sheds light on DP World's labor management system, which utilizes a pool of dockers categorized as fixed, semi-fixed, and loose labor. While this system offers flexibility, it may present challenges in ensuring sufficient labor availability during peak workloads.

Overall, DP World's interview underscores its determination to adapt to the changing logistics landscape and become a comprehensive supply chain logistics provider. By embracing innovation, the company aims to enhance operational efficiency and deliver value to its customers. The findings emphasize the significance of ongoing transformation, collaborative efforts, and safety-conscious innovation in driving the success of DP World and the wider logistics industry.

4.2 Findings Excelerate Technical Management (ETM) Antwerp

The thematic analysis provides insights into ETM's role in the Belgian maritime ecosystem and its involvement in innovation. ETM Antwerp's limited role in innovation is evident, with innovation primarily driven by the headquarters in the United States. The Antwerp focus lies predominantly on commercial aspects, given the importance of Europe in terms of commercial opportunities. There is a distinction between the technical and commercial perspectives of innovation, with ETM's technical departments and engineering based outside the Belgian network.

The implementation of innovations in Belgium would impact ETM's customers, emphasizing the need for open collaboration and engagement with stakeholders, including competitors, to ensure practical and effective implementation. Cooperation among stakeholders is highlighted as essential for achieving broad and purpose-driven innovation. Collective thinking within a group sharing similar interests and ideas increases the likelihood of successful innovation.

Open collaboration is preferred over closed innovation, as it allows for information sharing, learning, and the identification of opportunities. The relationship with terminal operators is emphasized as crucial for ETM's operations, and their acceptance and interest play a significant role in successful innovation implementation. However, a lack of collaboration between terminal operators and shipping lines is identified as a barrier to achieving broad innovation.

In conclusion, the thematic analysis reveals ETM's limited involvement in innovation within the Belgian maritime ecosystem, with a focus on commercial aspects. The impact of implementing innovations, the importance of cooperation, and the relationship with terminal operators are emphasized as key factors influencing ETM's operations and innovation practices. ETM believes collaboration among stakeholders, including competitors, is essential for achieving broader and purpose-driven innovation in the maritime industry.

4.3 Findings Companie Maritime Belge (CMB)

CMB is committed to collaboration and sharing its innovation with other stakeholders. They have strong networking relationships with industry partners and have actively engaged with stakeholders such as the port authority and terminals. The market demand for their innovation is evident, and the feedback from stakeholders has been positive, with interest and enthusiasm expressed.

They recognize the crucial role of the supply chain in making innovation feasible and ensuring the availability and reliability of alternative fuels. While there may be differing opinions among stakeholders regarding the use of hydrogen and ammonia as alternative fuels, they have found partners who share their vision and are actively exploring these options. Together, they aim to make a positive impact on reducing emissions and advancing sustainable solutions in the industry.

4.4 Findings Det Norske Veritas (DNV) Antwerp

Based on the interview with DNV, it is evident that the organization prioritizes understanding and addressing the needs of its customers in the maritime industry. They employ various methods such as regular interactions, data analysis, and proactive engagement to gather insights and tailor their solutions accordingly. This customer-centric approach allows them to develop innovative solutions that streamline operations and enhance efficiency.

DNV also emphasizes the importance of collaboration with stakeholders in Belgium. They actively engage with regulatory bodies, maritime companies, and industry associations to understand their requirements and provide tailored solutions.

In terms of innovation, DNV has implemented several notable solutions in the maritime industry. Remote surveys and digitalization efforts have significantly improved efficiency and reduced costs for stakeholders. The positive initial response from stakeholders demonstrates the practicality and value of these innovations. Clear guidelines, experienced surveyors, and ongoing evaluation ensure the effectiveness and accuracy of remote surveys, enabling stakeholders to optimize their operations while minimizing disruptions.

Overall, the interview highlights DNV's proactive approach to understanding customer needs, collaborating with stakeholders, and driving innovation in the maritime ecosystem. By prioritizing customer satisfaction, embracing new technologies, and actively engaging with industry stakeholders, DNV positions itself as a key player in shaping the innovation landscape in the maritime industry.

4.5 Findings Registro Italiano Navale (RINA) Antwerp

The interview highlights RINA's active involvement in innovation as a classification society. RINA develops and deploys innovative solutions, with a particular focus on technological advancements and data collection through sensors. The collected data is used to create an energy governance system that calculates fuel consumption based on various parameters.

RINA aims to engage stakeholders, such as shipping lines and terminals, in adopting these innovations. The impact of RINA's innovations on stakeholders in the ecosystem varies. Some stakeholders may accept the innovations and benefit from their implementation, while others may reject or remain neutral towards them. The acceptance or rejection of innovations depends on factors such as stakeholder priorities, readiness for change, and perceived benefits.

The interview also reveals the existence of other ecosystem initiatives in Europe, such as those pursued by universities in Gothenburg, Genoa, Napoli, and Milan. This indicates opportunities for collaboration between RINA and these initiatives, potentially contributing to the mapping of the ecosystem.

In conclusion, RINA's active engagement in innovation, potential collaboration with other ecosystem initiatives, and the impact on stakeholders underscore its commitment to driving positive change in the Belgian maritime ecosystem.

4.6 Findings Lloyd's Register (LR) Antwerp

The thematic analysis reveals the evolving role of classification societies in the maritime industry, particularly in relation to innovation. They have expanded their focus beyond traditional classification services and are actively involved in advisory services and investment in innovation. The development of new rules, tests, and survey requirements is a key aspect of classification societies' involvement in innovation. These requirements are essential for accommodating emerging technologies and fuels, and classification societies bear the costs associated with their development.

Classification societies are recognized as significant contributors in shaping the future of the maritime industry. They have the potential to lead in creating new regulations, particularly at the local or national level, to address the challenges and opportunities posed by emerging technologies. Collaboration with authorities and governments is crucial for the successful implementation of new regulations and initiatives.

The support of local authorities provides a starting point and paves the way for larger-scale projects, allowing for the observation of developments and ensuring practicality. Progress is being made in the development of autonomous systems and AI, primarily in low-risk scenarios with minimal traffic and non-hazardous cargo. However, concerns regarding responsibilities and conflicts in autonomous systems remain, highlighting the complexity of determining liability and applicable laws.

Finally, among the various innovations, the transition to alternative fuels is emphasized as the most important and needed development for the maritime sector. The adoption of alternative fuels is vital for achieving sustainability goals and reducing the environmental impact of the industry.

4.7 Findings Dredging, Environmental and Marine Engineering (DEME)

The interview with DEME provides a comprehensive overview of the maritime innovation landscape and ecosystem. DEME's approach to driving innovation in the maritime sector is centered around collaboration, digitalization, sustainability, research and development, and leveraging a supportive ecosystem. Their emphasis on tailoring solutions to clients' needs and delivering comprehensive packages showcases their customer-centric approach.

DEME acknowledges the transformative potential of digital technologies and their commitment to sustainability, aiming to reduce emissions and explore renewable energy sources. Their investment in research and development highlights their dedication to staying at the forefront of market needs and pushing the boundaries of innovation in the maritime industry.

Furthermore, DEME's business diversification demonstrates their adaptability and willingness to explore new ventures, leveraging their existing expertise and understanding of local conditions. They recognize the importance of the maritime ecosystem, collaborating with various stakeholders, including academic institutions, universities, and scientific organizations, to foster innovation.

Overall, DEME's insights shed light on the evolving landscape and the key factors driving innovation in the maritime industry. Their comprehensive approach and emphasis on collaboration, digitalization, sustainability, research and development, and a supportive ecosystem position them as a prominent player in the maritime innovation landscape.

4.8 Findings Antwerp-Bruges Port Authority

The thematic analysis of interview highlights the Antwerp - Bruges port authority's commitment to digitalization, innovation, and collaboration within the port ecosystem. The creation of the Chief Digital Innovation Officer role in 2017 underscores the organization's recognition of the importance of incorporating technology and fostering innovation for the port's future. The goal of transforming the port into a smart port, as defined by the foundational pillars of a smart port, emphasizes the use of digitization and data sharing to enhance efficiency, integration, and collaboration among stakeholders.

However, the port faces challenges in terms of integration, collaboration, and data sharing within the ecosystem. These challenges include limited communication, coordination, and trust among companies, as well as concerns over data privacy and cybersecurity. The port authority addresses these challenges by actively engaging companies, establishing platforms, promoting an innovation culture, and fostering an environment of trust and cooperation.

The port authority's innovation strategy, based on proof-of-value initiatives, an innovation culture, the port as an innovation platform, and outside-in innovation, guides their approach to fostering innovation and collaboration.

They also invest in digital talent and ecosystems, collaborate with external organizations, and focus on the strategic pillars of digitalization, circular economy, and energy transition to drive the port's development. Efforts have been made to overcome roadblocks in data sharing, including legislative changes to enable customs to share data and the use of data sharing platforms like Nxtport. By addressing concerns, fostering open-minded discussions, and educating stakeholders about the benefits of data sharing and innovation, the port authority aims to create a collaborative and innovative ecosystem.

Overall, the Antwerp port authority's initiatives and strategies demonstrate their commitment to transforming the port into a smart, sustainable, and innovative hub. By embracing technology, fostering collaboration, and investing in digital talent and ecosystems, the port authority aims to position Antwerp as a leading port in terms of innovation, efficiency, and integration within the global maritime industry.

4.9 Findings MSC PSA European Terminal (MPET)

Based on the qualitative analysis, several key findings emerged regarding innovation, approval processes, decision-making, risk aversion, collaboration, infrastructure, bureaucracy, and data sharing within the Belgian maritime ecosystem.

Firstly, MPET reported having sufficient sources for innovation, including in-house expertise and the support of the coalition with PSA. However, they also acknowledged the challenges associated with lengthy approval processes, which can take up to a year due to the need for consensus and reassessments of project viability.

The decision-making process was reported to start locally and progress to the board level. However, for significant projects, approval from both group CEOs is necessary, indicating a hierarchical decision-making structure. This process involves re-evaluation and assessment of the project's value by regional committees at different levels, which further contributes to the time required for decision-making.

While there is a cautious approach towards implementing new ideas, it was highlighted that the level of caution is determined by the strength of the business case. Projects demonstrating past success or positioning the company as early adopters with risk mitigation measures increase the chances of gaining approval. However, profitability and its importance for future investments are crucial factors.

Collaboration with stakeholders, particularly in terms of infrastructure, funding, regulations, and rules, was emphasized as essential for mutual benefit. The Port of Antwerp was seen as a facilitator in collaboration, but certain limitations were identified, such as EU regulations and limited financial resources impacting the port's direct action in projects like shore power.

Bureaucracy was seen as a hindrance to innovation, slowing down the pace of progress. It was mentioned that wasteful spending occurs on redundant studies or initiatives whose conclusions were already known, highlighting the impact of indecisiveness and systemic issues.

MPET Connect was identified as the most significant innovation implemented by MPET, focusing on optimizing container planning and logistics. Its importance lies in engaging the trucking and barging communities, which often feel excluded from the process.

Sharing data with multiple stakeholders was acknowledged as a challenging industry-wide issue. The extent of data sharing would depend on the evolution of stakeholders' mindsets, especially considering the reservations of older generations and the push from younger professionals. The regulatory landscape, including regulations set by PSA International and the broader industry, would also influence the extent of data sharing.

4.10 Findings Euronav

Euronav recognizes the significance and growth potential of the ecosystem and emphasizes the need for collaboration and interaction among stakeholders. They actively contribute to innovation through vessel-related advancements, IT projects, and initiatives focused on crew well-being, safety, and performance. Euronav is open to sharing their platform and exploring external collaborations, as long as they align with their operational requirements and policies.

Challenges in sharing ship data, such as ownership, storage, security, and compliance, are acknowledged, but Euronav expresses a willingness to explore controlled and mutually beneficial data sharing initiatives. Collaboration and workgroups are facilitated through the Plug and Play platform, with Euronav serving as a founding partner. They recognize the need for continuous improvement, learning, and the involvement of organizations like MCA in connecting stakeholders. Euronav faces challenges in pursuing innovation but remains committed to collaboration, finding innovative solutions, and becoming an innovation-driven global hub for maritime innovation. The collaboration with Toqua represents a positive step in their ongoing efforts to collaborate with partners within the ecosystem.

4.11 Findings Remant

Based on the interview with Remant Transport Logistic, several key points emerge. The company recognizes the need for more action and less talk in the maritime ecosystem regarding innovation. They prioritize building their own software in-house, which contributes to client value, productivity, and efficiency.

Feedback from employees and customers is crucial for continuous improvement. They actively gather feedback through surveys, meetings, and open communication channels. Collaboration with stakeholders, such as shippers, suppliers, and shipping lines, is essential to their operations. They also seek collaborations with startups and technology providers to enhance their offerings.

Data integration and sharing are important, and they strive for seamless exchange by establishing robust connections with standardized formats and protocols. While challenges exist, they work closely with stakeholders to find pragmatic solutions.

Remant Transport Logistic acts as a mediator, connecting various stakeholders and facilitating the flow of information. Areas needing improvement include the speed of implementation and the fostering of agility and innovation.

Important trends in the maritime sector include automation for operational optimization and the transition to cleaner fuels to address environmental concerns.

In conclusion, Remant Transport Logistic demonstrates a commitment to innovation, collaboration, and addressing industry challenges. They acknowledge the potential for Belgium to be called an ecosystem, but further efforts are required to fully realize this potential and improve collaboration in the maritime industry. Their emphasis on customer collaboration and the need for innovative solutions highlights their focus on customer-centricity and market competitiveness.

4.12 Findings Anglo-Eastern

Based on the qualitative analysis, the ship management company recognizes the need for stronger support and funding for innovation projects in the maritime industry. While they have faced challenges in securing government funding and subsidies, they have found alternative sources of funding through

their ship owner clients. However, they emphasize the importance of increased support, especially for new projects and technologies, and express hope that future initiatives like the European Green Deal and carbon taxation system will allocate funds for innovation.

The ship management company actively collaborates with stakeholders in the maritime industry, including classification societies, engine makers, and regulatory bodies, to ensure compliance, develop codes and requirements, and shape the future of ship management practices. They are also involved in the ongoing efforts to develop regulations for ship management systems (SMS), working closely with classification societies and the International Maritime Organization (IMO).

The company is engaged in various projects related to sustainable shipping, exploring technologies such as ammonia, methanol, and molten salt nuclear energy. They manage a fleet operating on greener fuels and oversee the construction of new ships that will utilize alternative fuels. To enhance innovation in the maritime ecosystem, particularly in decarbonization efforts, the company suggests a “time to wake” approach, focusing on regulating emissions during ship operation and assigning responsibility for greener fuel production to a separate body.

They propose penalizing fuel producers for their environmental impact to incentivize the transition to more sustainable fuels. By implementing these suggestions, the ship management company believes that the industry can facilitate a smoother adoption of sustainable technologies and further advance decarbonization efforts.

4.13 Findings Port of Singapore Authority (PSA) Antwerp

The interview highlights PSA’s commitment to collaboration, innovation, and sustainability within the maritime ecosystem. The company places a strong emphasis on collaborating with stakeholders, including competitors, to drive innovation and create win-win situations. They are open to partnerships and recognize the need for specialized expertise outside their organization.

PSA has dedicated departments for sustainability and innovation, indicating the significance of these areas. They actively pursue innovative techniques and tools, prioritizing sustainability, safety, and security. The company participates in innovation awards and continuously seeks ways to improve their operations.

The collaboration with MPET, a joint venture, and CMB is positive, reflecting the company’s cooperative approach. PSA follows an approval process for significant innovation projects, ensuring thorough impact analysis and strong business cases. Data exchange occurs with shipping lines through EDI, although strict confidentiality protocols are in place to protect sensitive information. PSA prioritizes data security and confidentiality, ensuring that confidential data from one shipping line is not shared with another.

Overall, PSA demonstrates a commitment to sustainability, collaboration, and innovation, while prioritizing safety, security, and data protection.

4.14 Findings Engine, Deck, Repair Antwerp Shipyard (EDR)

Firstly, EDR primarily adopts a reactive approach to innovation, focusing on responding to innovation rather than driving it. However, they do have proactive environmental specialists who actively seek out innovative solutions to improve processes and environmental sustainability. The regular meetings held by EDR lead to concrete outcomes and follow-up actions, demonstrating their commitment to implementing discussed ideas and tracking progress effectively.

Collaboration and innovation within the maritime sector face challenges such as complex administration and regulations, resistance to change from some stakeholders, and a lack of motivation to participate in innovation initiatives. While collaboration with the Port Authority is generally positive, compliance with existing laws and regulations, as well as financial constraints, pose challenges. Despite these obstacles, the Port Authority shows enthusiasm for collaborating with other stakeholders to drive innovation.

Furthermore, EDR collaborates with external engineering companies and technology providers for research and development, focusing primarily on executing jobs but engaging in collaboration to ensure smooth implementation of retrofits and specific applications. EDR foresees changes in the future that could lead to a more active role in innovation. Factors such as the implementation of regulations and the growing need for sustainability expertise may create opportunities for EDR to play a larger role in driving innovation. Collaboration with shipping companies and innovation hubs primarily revolves around executing retrofits and specific applications.

EDR engages in discussions and cooperation to ensure the successful implementation of innovative solutions. In the Belgium innovation ecosystem, political factors influence shipbuilding innovation. While some support exists from the government and positive trends are observed, greater support and collaboration from all European countries would be beneficial.

EDR expresses a willingness to contribute to the Belgium maritime innovation ecosystem. EDR's current focus in innovation is on minimizing air and water pollution in open-air environments. They aim to develop technology that eliminates pollution within a specific radius of the ship, contributing to environmental sustainability. While EDR maintains relationships with engine manufacturers and suppliers, their collaboration is primarily focused on specific applications and retrofits. Direct innovation initiatives with engine manufacturers are typically driven by shipping companies and owners.

In summary, EDR demonstrates a commitment to innovation and collaboration within the maritime sector, despite facing challenges. Their proactive environmental specialists and regular meetings indicate a drive for improvement. With changes on the horizon and a focus on sustainability, EDR has the potential to play a more active role in driving innovation in the future.

5. The cluster's characteristics

An online questionnaire was also employed as a quantitative approach to obtain valuable data from the same stakeholders who were previously engaged in a meeting. The utilization of an online survey complements the insights gathered during the meeting by providing an opportunity to gather a more comprehensive understanding of cluster characteristics. By employing the online questionnaire, participants are given a structured platform to express their opinions and experiences, ensuring standardized data collection across all stakeholders. This approach offers several advantages, including increased convenience and flexibility for stakeholders to respond to the survey at their own pace and convenience.

Based on the data collected through the online questionnaire sent to the stakeholders, the outcomes for each of the cluster's characteristics are given below.

5.1 Approach to innovation

The majority of organizations (85.7%) have a proactive approach to innovation, actively seeking new opportunities and improvements for their business (Table 3). A smaller percentage (14.3%) adopts a reactive approach, responding to changes in the industry or market. This indicates a strong willingness to seek out and pursue new opportunities for improvement, and suggests a dynamic and forward-thinking mindset among stakeholders.

Approach to innovation

Proactive Innovation	85.7%
Reactive Innovation	14.3%
Passive Innovation	0.0%

Table 3 | Source: authors' elaboration

5.2 Method to foster innovation

The most common method used by organizations to foster innovation is collaborating with external partners and stakeholders (42.9%, see Table 4). This emphasizes the importance of networking and knowledge exchange within the ecosystem. Allocating resources for research and development and embracing new technologies and innovative approaches are also prevalent strategies. However, there is relatively less emphasis on encouraging creativity, learning, and diversity within the organizations surveyed.

Method to foster innovation

Collaborating with external partners and stakeholders	42.9%
Allocating resources for research and development	14.3%
Embracing new technologies and innovative approaches	14.3%
Encouraging creativity and experimentation among employees	7.1%
Creating a culture of learning and development	7.1%
Nurturing diverse and inclusive teams and perspectives	0.0%
Encouraging risk-taking and overcoming failure	0.0%
Incorporating feedback and insights from customers and users	0.0%
Building a supportive and inspiring physical and virtual work environment	0.0%

Table 4 | Source: authors' elaboration

5.3 Exchange of knowledge or resources with other actors in the maritime ecosystem

The most common knowledge and resource exchange method among stakeholders in the maritime ecosystem is networking and partnering with other companies, startups, and organizations (35.7%, see Table 5). Sharing research and insights with customers, users, and stakeholders is also a prevalent approach. However, there is a relatively lower involvement in collaboration with academic institutions and research centers for joint projects and publications. The latter could be an untapped opportunity for further innovation.

Exchange of knowledge or resources with other actors in the maritime ecosystem

Networking and partnering with other companies, startups, and organizations	35.7%
Sharing research and insights with customers, users, and stakeholders	35.7%
Joining innovation and incubation programs and hubs	7.1%
Joining open-source projects and communities for knowledge sharing and co-creation	7.1%
Collaborating with academic institutions and research centers for joint projects and publications	0.0%
Forming consortia or alliances with other companies for pre-competitive collaboration	0.0%
Engaging with public entities and regulators for policy advocacy and dialogue	0.0%
No	0.0%

Table 5 | Source: authors' elaboration

5.4 Evaluation of knowledge, funding, and resource flow in the Belgian maritime ecosystem

According to the responses, the evaluation of the flow of knowledge, funding, and resources within the Belgian maritime ecosystem varies (Table 6). While a significant portion considers it to be good (42.9%), there is also a considerable proportion that rates it as fair (28.6%) or poor (21.4%). This indicates the need for further improvement in facilitating the exchange of resources and fostering a supportive environment for innovation.

5.5 Major challenges facing the maritime innovation ecosystem in Belgium

In the opinion of the respondents, the major challenges facing the maritime innovation ecosystem in Belgium include a shortage of skilled talent and expertise, regulatory complexity and uncertainty, and insufficient collaboration and networking opportunities between stakeholders (Table 7). Limited access to funding and capital and resistance to change are also identified as significant challenges. Addressing these challenges would be crucial to unlocking the full potential of innovation in the ecosystem.

Evaluation of knowledge, funding, and resource flow in the Belgian maritime ecosystem

Excellent	0.0%
Good	42.9%
Fair	28.6%
Poor	21.4%
Don't know	

Table 6 | Source: authors' elaboration

Major challenges facing the maritime innovation ecosystem in Belgium

Insufficient collaboration and networking opportunities between stakeholders	28.6%
Shortage of skilled talent and expertise	21.4%
Regulatory complexity and uncertainty	21.4%
Resistance to change	14.3%
Limited access to funding and capital	7.1%
Lack of diversity and inclusivity in the startup and innovation community	0.0%

Table 7 | Source: authors' elaboration

5.6 Strengths of the maritime innovation ecosystem in Belgium

The strengths of the maritime innovation ecosystem in Belgium, as perceived by the respondents, include a vibrant community of entrepreneurs and innovators, a strong network between stakeholders, and the availability of cutting-edge technologies and infrastructure (Table 8). Leveraging these strengths can further enhance the ecosystem's innovation capabilities. Access to funding, a skilled talent pool, and a supportive regulatory environment were identified as relatively weaker strengths.

5.7 Areas of the maritime industry that could benefit the most from increased innovation

Based on the responses, the area of the maritime industry that could benefit the most from increased innovation is efficiency and sustainability (Table 9). This aligns with the growing emphasis on sustainability and optimization in the sector. Customer experience and value-added services were also identified as potential areas for innovation. Other areas, such as shipbuilding and design, logistics and supply chain management, and digitalization and automation, were identified as less prioritized for innovation.

Strengths of the maritime innovation ecosystem in Belgium

Vibrant community of entrepreneurs and innovators	42.9%
Strong network between stakeholders	21.4%
Skilled talent pool	7.1%
Supportive regulatory environment	7.1%
Availability of cutting-edge technologies and infrastructure	7.1%
Access to funding	0.0%

Table 8 | Source: authors' elaboration

Areas of the maritime industry that could benefit the most from increased innovation

Shipbuilding and design	7.1%
Operations and safety	0.0%
Efficiency and sustainability	64.3%
Logistics and supply chain management	0.0%
Port operations and infrastructure	7.1%
Digitalization and automation	0.0%
Workforce and training	0.0%
Customer experience and value-added services	14.3%
Regulatory compliance and market access	0.0%

Table 9 | Source: authors' elaboration

5.8 New business models or collaborations to promote innovation in the maritime industry in Belgium

According to the responses, collaboration between stakeholders (ports, shipping lines, logistics providers) for end-to-end visibility and efficiency is seen as a significant opportunity to promote innovation in the maritime industry in Belgium (Table 10). Public-private partnerships for building sustainable and resilient maritime infrastructure were also identified as valuable. Data-sharing and analytics partnerships and collaboration with technology startups and accelerators were mentioned as potential avenues for innovation as well.

New business models or collaborations to promote innovation in the maritime industry in Belgium

Collaboration between stakeholders (ports, shipping lines, logistics providers) for end-to-end visibility and efficiency	42.9%
Public-private partnerships for building sustainable and resilient maritime infrastructure	21.4%
Data-sharing and analytics partnerships for better decision-making and optimization	14.3%
Collaboration with technology startups and accelerators for rapid prototyping and scaling	14.3%
Shared economy and platform-based models for sources sharing and pooling	0.0%
Integration of blockchain technology for secure and transparent transactions and documentation	0.0%
Crowdsourcing and open innovation for tapping into diverse and novel ideas and solutions	0.0%
New financing models for encouraging innovation and risk-taking (venture capital, impact investing)	0.0%
Collaboration with academic institutions and research centers for knowledge dissemination and applied research	0.0%

Table 10 | Source: authors' elaboration

5.9 Conclusion on cluster characteristics

In conclusion, the stakeholders in the Belgian maritime innovation ecosystem demonstrate a proactive approach to innovation and recognize the importance of collaboration and knowledge exchange. However, challenges such as talent shortage, regulatory complexity, and limited collaboration opportunities need to be addressed. By leveraging their strengths, fostering a supportive environment, and focusing on key areas for innovation, stakeholders can further enhance the ecosystem's innovation capabilities and drive sustainable growth in the maritime industry.

6. SWOT

A comprehensive SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted to evaluate Belgium's maritime innovation ecosystem. This analysis was based on the interviews conducted with 14 key stakeholders and feedback received through the online questionnaire. The findings reveal several significant aspects that shape the current state of Belgium's maritime innovation landscape.

6.1 Strengths

- Vibrant community of entrepreneurs and innovators:** Belgium has a strong and active community of entrepreneurs and innovators in the maritime sector, which fosters a culture of innovation and idea generation.
- Strong network between stakeholders:** The ecosystem benefits from a robust network and collaboration among stakeholders, promoting knowledge sharing, partnerships, and joint initiatives.

3. **Commercial Opportunities:** The Belgium maritime innovation ecosystem benefits from Europe's importance in terms of commercial opportunities. This indicates a potentially robust market for innovative solutions.
4. **Commitment to Sustainability:** The emphasis on reducing emissions and advancing sustainable solutions in the industry highlights a strength in addressing environmental challenges and aligning with global sustainability goals.
5. **In-House Technology Development:** The focus on building their own solutions in-house, as highlighted by some stakeholders, showcases a strength in technological capabilities and the ability to develop tailored solutions for clients.

6.2 Weaknesses

1. **Shortage of skilled talent and expertise:** There is a recognized shortage of skilled professionals and expertise in the maritime industry, which can hinder the pace of innovation.
2. **Regulatory complexity and uncertainty:** The complex and uncertain regulatory environment poses challenges for stakeholders, potentially slowing down the implementation of innovative solutions.
3. **Limited Involvement of some stakeholders:** Some international organizations have a limited role in innovation within the Belgian maritime ecosystem. This could indicate a weakness in terms of active participation and contribution to innovation initiatives.
4. **Lack of Stakeholder Engagement:** Some stakeholders fail to actively engage and collaborate, which is a threat of missed opportunities and limited progress in terms of innovation within the ecosystem.
5. **Differing Opinions on Alternative Fuels:** The differing opinions among stakeholders regarding the use of hydrogen, ammonia, methanol, batteries, as alternative fuels is seen as a potential weakness in achieving consensus and alignment on specific innovation initiatives.
6. **Competing Priorities and Interests:** The existence of differing opinions among stakeholders can pose a threat to consensus-building and hinder progress on specific innovation initiatives, particularly if competing priorities and interests arise.
7. **Stakeholder Readiness and Priorities:** Stakeholder acceptance of innovations depends on their priorities, readiness for change, and perceived benefits. Differing priorities and readiness levels among stakeholders could pose challenges to widespread implementation and adoption of innovative solutions.
8. **Challenges in Integration and Data Sharing:** Challenges related to integration, collaboration, and data sharing within the ecosystem. These weaknesses can hinder the seamless flow of information and hinder innovation efforts.
9. **Lengthy Approval Processes and Bureaucracy:** The challenges associated with lengthy approval processes and bureaucracy, pose a weakness in terms of slowing down the pace of progress and hindering innovation within the ecosystem.
10. **Limited Financial Resources:** The limitations in financial resources, as highlighted by the limitations faced by some stakeholders, present a weakness in terms of direct action and investment in projects.
11. **Need for More Action:** The recognition of the need for more action and less talk in the maritime ecosystem regarding innovation suggests a weakness in terms of implementation and agility within the ecosystem.

12. **Speed of Implementation:** The mention of areas needing improvement in the speed of implementation indicates a weakness in terms of the pace of innovation and adaptation within the ecosystem.
13. **Complex Administration and Regulations:** The complexity of administration and regulations in the maritime sector presents a challenge that may hinder the speed and efficiency of innovation initiatives.
14. **Resistance to change:** Resistance to adopting new technologies and processes may hinder the pace of innovation and impede the ecosystem's progress.

6.3 Opportunities

1. **Collaboration with Other Initiatives:** Other ecosystem initiatives in Europe presents an opportunity for collaboration and knowledge sharing. This collaboration can contribute to a broader mapping of the ecosystem and foster collective innovation efforts.
2. **Potential for Improved Collaboration:** CMB, MCA, and the port authority's initiatives to address challenges and foster an environment of trust and cooperation present opportunities for improved collaboration among stakeholders in the maritime innovation ecosystem.
3. **Public-private partnerships for sustainable infrastructure:** By forming partnerships between public and private entities, there is an opportunity to develop sustainable and resilient maritime infrastructure, driving innovation and environmental sustainability.
4. **Data-sharing and analytics partnerships for decision-making:** Collaboration in data-sharing and analytics can enable better decision-making, optimization, and innovation within the maritime ecosystem.
5. **European Green Deal and Carbon Taxation System:** The future initiatives like the European Green Deal and carbon taxation system provides opportunities for increased support and funding for innovation projects, particularly those related to sustainable shipping and decarbonization.

6.4 Threats

1. **Limited access to funding and capital:** The limited availability of funding and capital can pose a significant challenge for innovative projects and startups in the maritime sector.
2. **Limited Innovation Scope:** Innovation within the Belgian maritime ecosystem is predominantly driven by headquarters outside Belgium. This represents a potential threat to the ecosystem's autonomy and influence over innovation initiatives.
3. **Regulatory and Technological Challenges:** The adoption of alternative fuels and sustainable solutions may face regulatory and technological challenges that could impede progress and pose a threat to the ecosystem's ability to achieve its sustainability goals.
4. **Competitive pressure from other maritime innovation ecosystems:** The presence of competitive maritime innovation ecosystems in other countries may pose a threat to Belgium's position and attractiveness as an innovation hub.
5. **Data Privacy and Cybersecurity Concerns:** Concerns over data privacy and cybersecurity. These threats pose challenges to data sharing and innovation efforts and require robust security measures and privacy protocols to be in place.

7. Conclusion and recommendations

7.1 Conclusion

Upon analyzing the thematic analyses of various interviews conducted with key players in the Belgian maritime ecosystem, several common themes and trends emerge. These include the importance of collaboration, innovation, digitalization, sustainability, customer-centricity, and the role of regulatory bodies.

Overall, the interviews highlight the growing recognition of the importance of innovation in the maritime sector. Companies such as DP World, ETM, CMB, DNV, RINA, LR, DEME, MPET, Euronav, Remant, and others are actively engaging in innovation to enhance operational efficiency, meet sustainability goals, and address emerging challenges.

Collaboration is consistently emphasized as a crucial factor in driving innovation and success within the maritime industry. Stakeholders recognize the need to work together, not only within their own organizations but also with competitors, industry associations, academic institutions, and regulatory bodies, to foster broad and purpose-driven innovation and leverage collective expertise, resources, and networks. Nevertheless, some stakeholders have highlighted a certain level of heterogeneity in terms of collaboration within the ecosystem. This disparity can be attributed to factors such as competition among companies, the desire to maintain a competitive advantage, protect intellectual property, and concerns about the potential leakage of sensitive data.

The role of regulatory bodies and authorities is recognized as critical in shaping the maritime industry's future. Companies actively engage with regulatory bodies, collaborate with governments, and participate in industry associations to ensure that regulations and initiatives support innovation, sustainability, and operational excellence. Collaboration with authorities and governments is crucial for the successful implementation of new regulations and the advancement of emerging technologies.

Innovation is a central focus for all the companies analyzed. Each organization has its own approach to innovation, with varying degrees of involvement and emphasis. However, it is clear that innovation is seen as a key driver of competitiveness, efficiency, and sustainability in the maritime sector.

Digitalization is another prominent theme across the interviews. Companies are embracing digital technologies, data analytics, and automation to optimize operations, enhance efficiency, and improve customer experiences. The integration and sharing of data are identified as crucial for achieving seamless collaboration and realizing the full potential of digitalization within the maritime ecosystem.

Sustainability and environmental concerns are top priorities for many companies operating in the maritime industry. The transition to alternative fuels, reduction of emissions, and adoption of sustainable practices are seen as vital for achieving long-term viability and addressing global sustainability goals. Stakeholders are actively exploring and investing in technologies and solutions that minimize the environmental impact of maritime operations.

The transition to sustainable practices and the adoption of alternative fuels emerges as key drivers of innovation in the maritime industry. Companies such as CMB, DNV, RINA, and Euronav are actively exploring alternative fuels, such as hydrogen and ammonia, to reduce emissions and advance sustainability. The interviews highlight the significance of the supply chain in making innovation feasible and ensuring the availability and reliability of alternative fuels.

Customer-centricity is a shared focus among the companies analyzed. Understanding customer needs, tailoring solutions, and providing exceptional service are seen as essential for maintaining competitive

advantage and driving customer satisfaction. By prioritizing customer-centric approaches, companies aim to enhance operational efficiency, optimize supply chain logistics, and deliver value to their customers. The interviews also shed light on the challenges faced by companies in the Belgian maritime ecosystem. Lengthy approval processes, hierarchical decision-making structures, risk aversion, bureaucratic hurdles, and concerns over data sharing and cybersecurity are identified as obstacles to innovation. Companies acknowledge the need to address these challenges and foster an innovation culture that encourages agile decision-making, open-minded discussions, and the sharing of data and resources

In conclusion, the thematic analysis reveals a shared commitment among stakeholders in the Belgian maritime ecosystem to embrace innovation, collaboration, and sustainability. While each company has its unique perspectives and approaches, there is a collective understanding of the need to adapt to changing market dynamics, leverage new technologies, foster collaboration, and address environmental concerns. The interviews underscore the importance of ongoing transformation, customer-centricity, and safety-conscious innovation in driving the success of companies and shaping the future of the maritime industry in Belgium

7.2 Recommendations

Based on the findings from the thematic analysis of the interviews conducted with stakeholders in the Belgium maritime ecosystem, several recommendations can be made to foster innovation, collaboration, and sustainability in the industry.

1. **Foster a culture of innovation:** Companies should actively promote a culture that encourages innovation and rewards creative thinking. This includes fostering an environment where employees are empowered to propose and implement innovative ideas, promoting cross-functional collaboration, and establishing mechanisms to recognize and incentivize innovative initiatives.
2. **Streamline approval processes:** Lengthy approval processes can hinder innovation and slow down the implementation of new ideas. It is recommended to work with regulatory bodies and government agencies to streamline approval processes, reduce bureaucratic hurdles, and establish clear guidelines for innovation projects. This will enable companies to bring their innovative solutions to market more quickly.
3. **Embrace collaboration:** Collaboration among stakeholders is crucial for driving innovation in the maritime ecosystem. Companies should actively seek partnerships and collaborations with other industry players, academic institutions, regulatory bodies, and port authorities. Joint innovation initiatives, knowledge sharing platforms, and collaborative research projects can foster the exchange of ideas, resources, and expertise, leading to more effective and impactful innovations.
4. **Address data sharing and cybersecurity concerns:** Companies should develop robust data sharing frameworks and protocols that ensure the security and privacy of sensitive information. Collaborative platforms should be designed with strong cybersecurity measures to protect against potential threats. Clear guidelines and standards for data sharing can facilitate collaboration while maintaining data integrity and security.
5. **Invest in research and development:** To drive innovation, companies should allocate resources for research and development (R&D) activities. Investing in R&D will enable the exploration of new technologies, alternative fuels, and sustainable practices. Collaboration with academic institutions and research centers can provide access to cutting-edge research and expertise, facilitating the development of innovative solutions.

6. **Promote sustainability:** Given the industry's environmental impact, companies should prioritize sustainability in their innovation efforts. This includes exploring and investing in alternative fuels, such as hydrogen, ammonia, and biofuels, to reduce emissions. Additionally, implementing energy-efficient technologies, optimizing logistics and transportation processes, and adopting eco-friendly practices can contribute to sustainability goals.
7. **Embrace digitalization and automation:** The integration of digital technologies and automation can enhance operational efficiency, optimize resource utilization, and enable data-driven decision-making. Companies should explore opportunities to digitalize processes, implement smart technologies, and leverage artificial intelligence and machine learning to drive innovation and improve overall performance.
8. **Encourage continuous learning and upskilling:** To foster innovation, companies should invest in training and development programs to enhance employees' skill sets. This includes providing opportunities for continuous learning, organizing workshops and seminars on emerging technologies, and supporting employees' participation in industry conferences and events. A skilled and knowledgeable workforce will be better equipped to drive innovation within the organization.
9. **Seek Funding and Investment Opportunities:** Explore avenues for increased funding and capital by engaging with investors, venture capitalists, and government agencies. Promote the unique strengths and commercial opportunities within the Belgium maritime innovation ecosystem to attract investments for innovative projects and startups.
10. **Promote a Culture of Agility and Implementation:** Encourage a culture of action and implementation within the ecosystem by setting clear goals, timelines, and accountability mechanisms. Foster an environment that values experimentation, learning from failures, and quick adaptation to drive innovation forward.

By implementing these recommendations, companies in the Belgian maritime ecosystem can create an environment that nurtures innovation, fosters collaboration, and promotes sustainability. This will position them at the forefront of industry advancements, ensuring their long-term competitiveness and contributing to the overall growth and development of the maritime sector in Belgium.

Chapter 6 | Maritime flows of general cargo in Western Mediterranean: understanding regional flows into global trends

The chapter aims to provide an analysis of maritime general cargo flows, taking into account containerised and non-containerised cargo, between the two shores of the Western Mediterranean¹. Mainly, the analysis intends to be a regional insight of containerised cargo. This regional perspective aims to contribute to a better understanding of the organisation and functions of general cargo flows in the Western Mediterranean. At the present time, the global patterns of operation and organisation of container flows have been quite extensively explained. However, less attention has been paid to smaller or less important spaces when explaining global container flows. It is considered that such a regional approach, as the one proposed here, would provide a better understanding of how regional and global flows and functions are mutually shaped and how containerised cargo relates to other types of flows, namely, non containerised general cargo.

This contribution aims to show how general cargo flows in the Western Mediterranean, and in particular the relationship between Europe and the Maghreb, far from being a closed system, are configured as complex relationships. Regional flows are closely related to global container flows, while being conditioned by local needs and constraints. At the same time, containerised flows are not a closed system per se either, and are embedded in competitive or complementary relationships with non-containerised general cargo flows.

In order to demonstrate these ideas, three basic statistical databases are used. The first source is Eurostat, which provides information on tonnage volumes of the different types of cargo, as well as the number of TEUs per European port and country of destination/origin. The second database is that of Puertos del Estado from Spain, which provides detailed information on transshipment operations of Spanish ports. Finally, data provided by UNCTAD on average port dwell times of container vessels by country, as well as by maximum and average size have been used. The combination of these three sources undoubtedly helps to illustrate the ideas guiding the article. But they also illustrate the difficulties in obtaining reliable and continuous information over time on flows in the Western Mediterranean.

¹ The northern or European shore includes Portugal, Spain, France, Italy and Malta. The southern or Maghreb shore includes Mauritania, Morocco, Algeria, Tunisia and Libya. These ten countries make up the Group of Transport Ministers of the Western Mediterranean (GTMO 5+5).

The chapter is organised into five sections. The first part gives a contextual, especially quantitative, overview of general cargo flows between the two shores of the Western Mediterranean. The second focuses more specifically on container flows. It describes their integration into global container flows and also their regional distribution. Following part aims to highlight the importance of non-containerised cargo flows and how they relate to container traffic. The next one aims to be an exposition of relationships between different types of flows. Finally, and before the conclusion, some considerations on the challenges and perspectives of general cargo flows in the Western Mediterranean are presented. It is worth noting that the presented analysis is much more focused on describing the general patterns of flows than on explaining year by year changes and responses to disruptive events that have occurred in recent years.

1. The flows of general cargo between the two shores of Western Mediterranean. An overview

Maritime flows of goods between the northern and southern shores of the Western Mediterranean are the main means by which trade between these shores is channelled. The contextualisation of the evolution of general merchandise flows in recent years within the maritime flows as a whole provides an initial overview of their relative importance and structure (Figure 1). Considering all goods, the first characteristic to note is the imbalance in volume between the two directions of flows in favour of flows coming from the Maghreb. While flows from the European countries of the Western Mediterranean to the Maghreb, between 2017 and 2022, have moved in a range between 30.9 and 40.1 million tonnes, in the opposite direction these figures are between 63 and 40.8 million tonnes. This imbalance is due to the importance of bulk cargoes, especially liquids related to energy products, in flows originating in the Maghreb countries. However, excluding the volume of bulk cargo, and therefore considering only general cargo, the relationship between the two directions of flows is reversed. For example, taking 2022 as a reference, the 15 million tonnes of general cargo loaded in the ports of the European shore towards the Maghreb are reduced to a little more than half (8.6 million) when considering the reverse direction. This distribution by type of goods and by direction is a reflection of the economic structures of the Western Mediterranean countries. The Maghreb, taken as a whole, is an exporter of raw materials and energy products, which are large-volume goods. In turn, the European countries on the northern shore are exporters of processed products of higher added value and lower volume, which are preferably moved as general merchandise.

The breakdown of general cargo according to whether it is containerised or non-containerised cargo (Table 1 and Table 2) allows us to understand how this balance is produced in favour of European countries. In 2022, containerised flows to the Maghreb from the European countries of the Western Mediterranean will represent 10 million tonnes compared with 3.7 million tonnes in the opposite direction. On the other hand, the flows of non-containerised goods are balanced, with the two directions of flow representing volumes of around 5 million tonnes. Therefore, the imbalance in general cargo flows noted above between the two directions is attributable to containerised goods.

Maritime flows of bulks, containerised cargo / Ro-Ro and other general cargo between the two shores of Western Mediterranean. 2017-2022. Loads and Unloads

Thousands tons

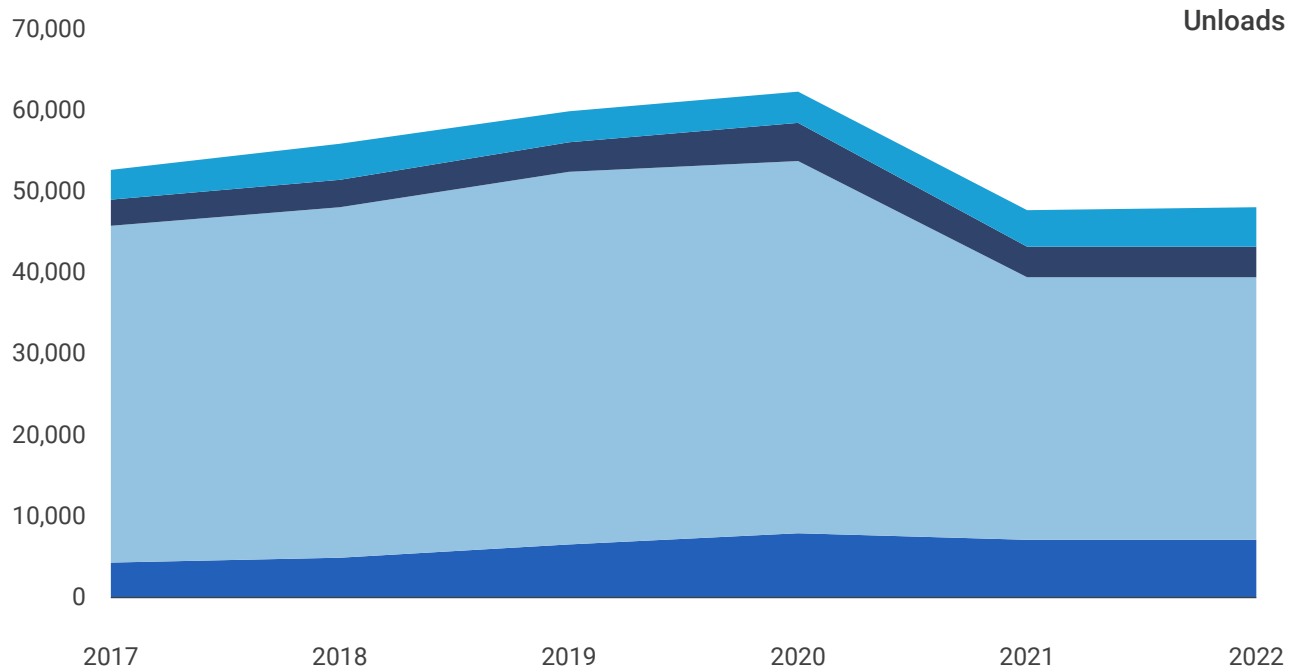
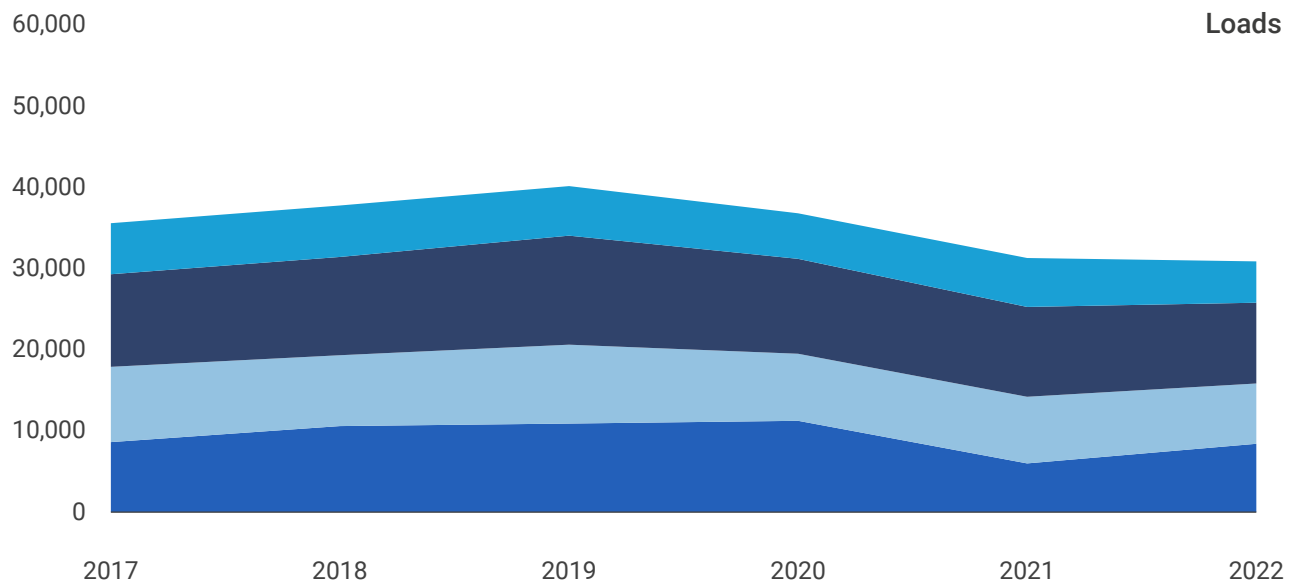


Figure 1 | Source: Eurostat

■ Dry Bulk ■ Liquid bulk ■ Containerised ■ Non-Containerised

Matrix origin-destination of general cargo of containerised flows in Western Mediterranean. 2022

Thousands tons

	Algeria	Libya	Morocco	Mauritania	Tunisia	Total
Spain	3,264	211	2,750	606	332	7,163
France	136	4	424	7	23	594
Italy	237	412	576	1	413	1,639
Malta	2	57	1	-	-	60
Portugal	101	6	388	4	9	508
Total	3,740	690	4,139	618	777	9,964

	Spain	France	Italy	Malta	Portugal	Total
Algeria	298	44	41	-	3	386
Libya	2	-	16	-	-	18
Morocco	1,493	269	491	15	268	2,536
Mauritania	287	-	-	-	-	287
Tunisia	234	20	285	5	-	544
Total	2,314	333	833	20	271	3,771

Table 1 | Source: Eurostat

If up to this point the two shores of the Western Mediterranean have been considered as a whole, an analysis of relations between countries provides a greater understanding of the establishment of maritime relations in the space studied. It can be seen that most container flows are established from Spanish ports, which, with 7.2 million tonnes in 2022, account for 71.9% of total north-south flows. These flows are mainly destined for two countries, Morocco (2.8 million tonnes) and Algeria (3.3 million tonnes). In terms of volume, this is followed by flows from Italy, with 1.6 million, which has a more balanced distribution of its flows to the different Maghreb countries. On the other hand, flows from the ports of Morocco stand out, especially those to Spain. In fact, the latter relation, with 2.5 million tonnes, represents 39.6% of the total containerised cargo from the Maghreb to the European countries of the Western Mediterranean. In comparison, the second most important, that from Morocco to Italy, represents only 13%.

Matrix origin-destination of general cargo non-containerised flows in Western Mediterranean. 2022

Thousands tons

	Algeria	Libya	Morocco	Mauritania	Tunisia	Total
Spain	98	26	3,128	9	87	3,348
France	77	2	39	1	169	288
Italy	20	10	128	-	1,141	1,299
Malta	2	2	-	-	3	7
Portugal	33	-	83	1	10	127
Total	230	40	3,378	11	1,410	5,069

	Spain	France	Italy	Malta	Portugal	Total
Algeria	102	20	37	-	11	170
Libya	33	-	97	-	-	130
Morocco	3,205	76	104	-	37	3,422
Mauritania	-	1	-	-	-	1
Tunisia	41	133	940	2	7	1,123
Total	3,381	230	1,178	2	55	4,846

Table 2 | Source: Eurostat

When considering non-containerised goods, the relationship between Spain and Morocco stands out in both directions. With figures of around 3.2 million tonnes in each direction, flows between Spain and Morocco account for 61.7% of the non-containerised north-south flows in the Western Mediterranean and 66.1% of the south-north flow. In second place, the relationship between Italy and Tunisia stands out, with flows of around one million tonnes in each direction.

From the exposed above, it is clear that the maritime flows of general cargo between the two shores of the Western Mediterranean are heterogeneous in terms of the types of merchandise, the balance between the directions of the flows and the relations between countries. Most of the flows correspond to containerised goods, with an imbalance between the two directions in favour of flows from European countries to the Maghreb. In these flows, the importance of Spain stands out, either as the origin of flows to Morocco and Algeria or as the destination of flows from Morocco. Although the volumes of non-containerised goods are smaller, there is a balance between the two directions of the flows. The flows between Spain and Morocco and, to a lesser extent, between Italy and Tunisia are particularly noteworthy.

2. The flows of containerised cargo between the two shores of Western Mediterranean

As indicated above, most of the general cargo flows between the two shores of the Western Mediterranean are channelled through the use of containers. In fact, in recent decades, containers have become the preferred means of global trade, especially for manufactured goods. Therefore, in order to gain a deeper understanding of the structuring of container flows between the countries of the two shores of the Western Mediterranean, it is necessary to understand how container flows are established at the global level and how intra-Mediterranean flows are inserted into them.

2.1 The global flows of containers

The importance of container in global trade exchanges 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 2). They are the transpacific route, that link Asia and the West Coast of North America, the route between Asia and Europe, and the transatlantic route between Europe and the East Coast of North America. Specifically, in 2022, these routes handled 28.2, 24.2 and 8,5 million TEU, respectively². Besides these transoceanic routes, North-South flows and regional flows covering destinations closer to each other are also important.

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 containers in import-export movements through a denser network of ports. This is the 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 characterised by their capacity to handle large vessels and large quantities of containers, and their tendency to have few links with their hinterland. Gateway ports are focused on serving their hinterland. In many cases, not all, these gateway ports have limited infrastructure and container handling capacity and therefore lack the conditions required to perform hub functions 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 minimise 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.

² UNCTAD (2023), Review of Maritime Transport 2023, New York, United Nations Conference on Trade and Development.

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.

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. Some figures help to illustrate these changes³. 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. Between the same dates, scheduled services offered by alliance member operators increased from 29.8% to 62.6%.

Containerised cargo by main routes and percentage of East-West routes (two directions) over the total 2016-2022

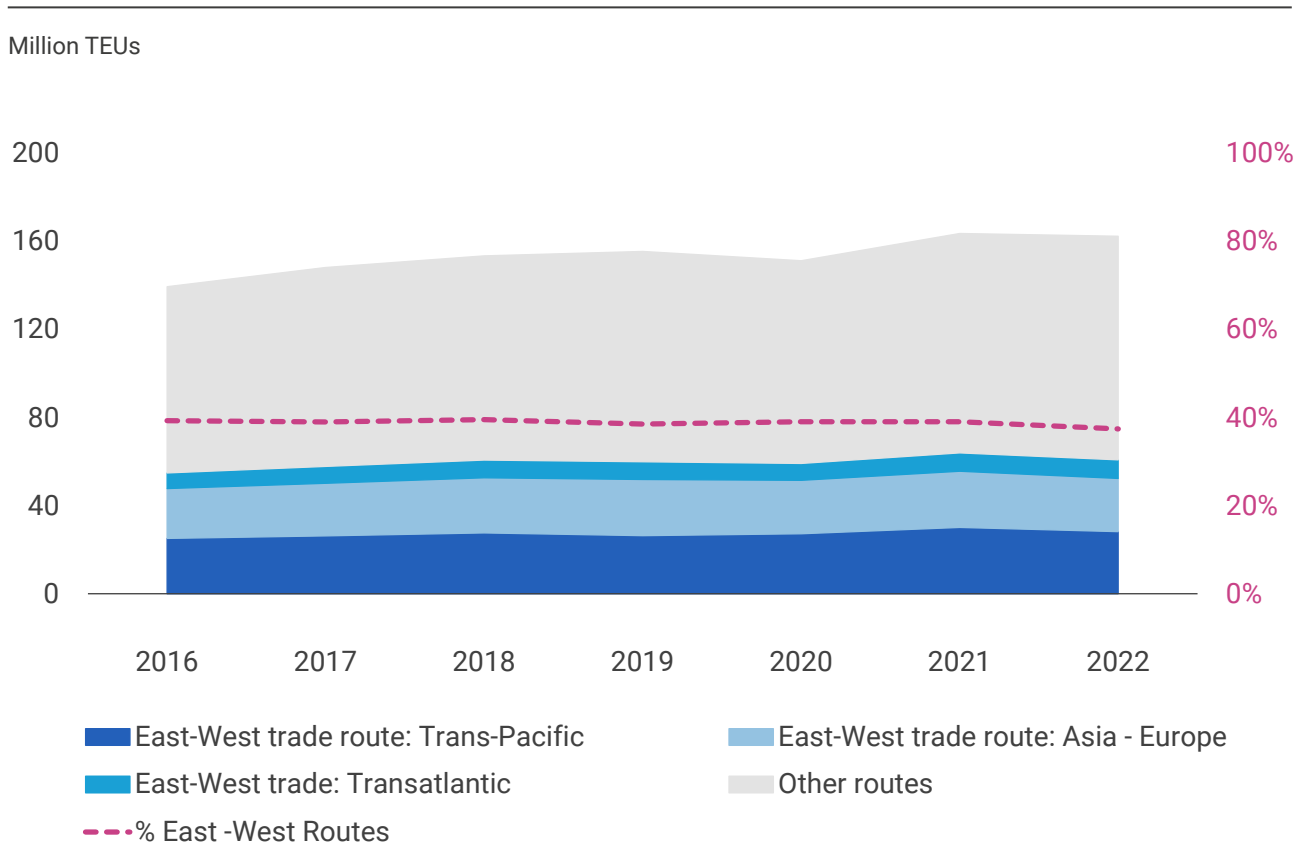


Figure 2 | Source: UNCTAD

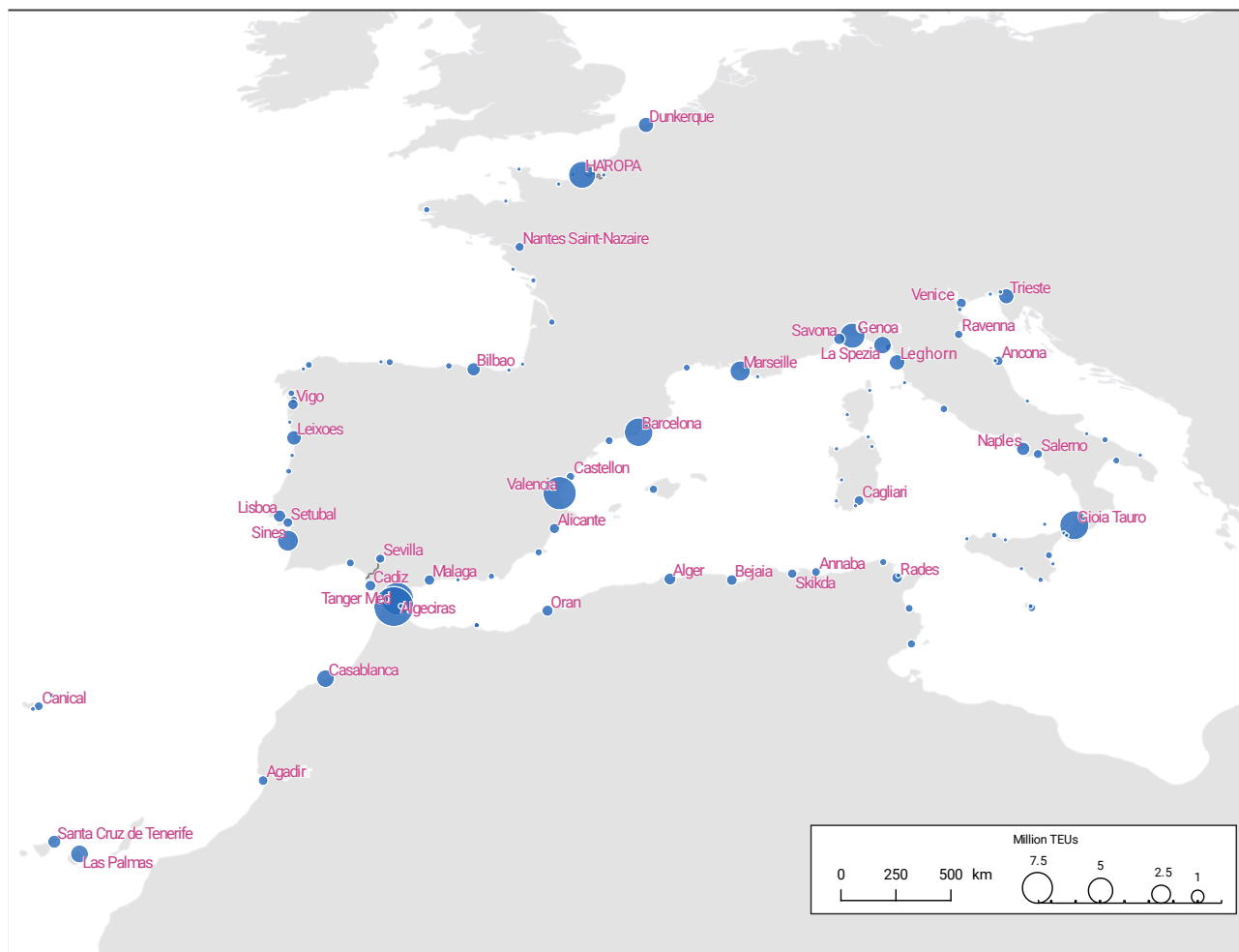
³ UNCTAD (2019), Review of Maritime Transport 2019, New York, United Nations Conference on Trade and Development.

When considering the major east-west trade routes, the percentage of TEU moved by the three existing major alliances stands at 86.6% on the transpacific route, 91.5% on the transatlantic route and 98.9% on the Asia-Europe route. 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.

2.2 The insertion of European ports of Western Mediterranean in global and regional flows

The ports of the Western Mediterranean countries as a whole handled 44.7 million TEUs in 2022 (Figure 3). The distribution of this volume among the ports of the Western Mediterranean allows us to understand how the global system of container flows described above takes shape in this space. Firstly, and as a sign of the concentration process described above, it should be noted that 75.1% of the TEUs indicated are handled in the 11 ports out of the 96 considered. These 11 ports are always above 1 million TEUs and their volumes range from 1 million TEUs in La Spezia to 7.6 million TEUs in Tanger Med.

Ports of Western Mediterranean by containers (TEU) 2022*



* Data of Algeria from 2020.

Figure 3 | Source: authors' elaboration on Eurostat, ANP, OMMP, Tanger Med and Algerian ports

These ports are Tanger Med, Valencia, Algeciras, Gioia Tauro, Barcelona, Genoa, Sines, Marseille, Las Palmas, Casablanca and La Spezia. If we consider the first five, all of them with more than 3 million TEUs they account for more than 50%. Their distribution would obey two logics: on the one hand, their location in the vicinity of the major transoceanic routes such as Tanger Med, Algeciras and Gioia Tauro or Las Palmas. The rest would combine this proximity, albeit attenuated, with powerful hinterlands. It should also be noted that, with the exception of Tanger Med and Casablanca, the above-mentioned ports are concentrated on the European side. The next most important port in the Maghreb, Alger, remains below 400,000 TEUs.

Eurostat data, although excluding the ports of the Maghreb (Figure 4), offer the possibility of knowing the origin or destination of TEU flows in the different European ports of the Western Mediterranean. This allows a better understanding of how these ports are inserted in global flows and the role played by regional flows, the latter being those established with the Maghreb, Europe and the rest of the Mediterranean.

TEUs in European ports of Western Mediterranean by transoceanic, regional and Maghreb flows. 2022

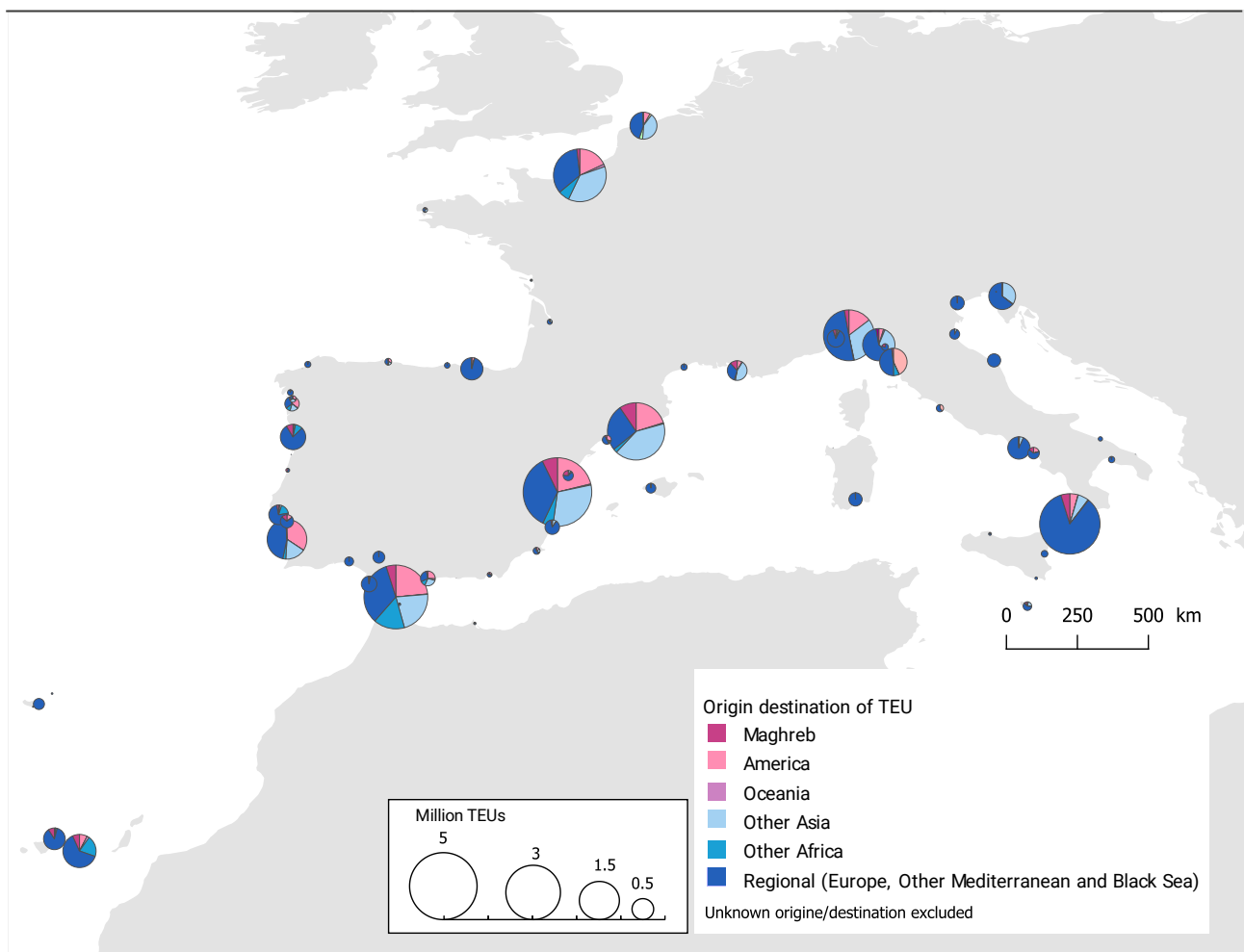


Figure 4 | Source: authors' elaboration on Eurostat

Firstly, it is worth noting the weight of Maghreb relations in the container flows of European ports in the Western Mediterranean countries. Of the total TEUs moved in the European ports of the Western Mediterranean, those with origin or destination in the Maghreb account for 4.8%⁴. If we consider the three ports with the highest volume of TEUs with the Maghreb, Valencia, Algeciras and Barcelona, their volumes are between 0.34 million and 0.19 million. As a percentage of total TEUs, they are respectively 7.2%, 4.9% and 9.4%. Among the major ports, only Marseilles, with 0.16 million TEUs, reaches a percentage of TEUs moved with the Maghreb of more than 10%. Therefore, considering the total TEU flows, the flows with the Maghreb of the ports of the European countries of the Western Mediterranean occupy a minor position. A different situation can be noted for the other flows that we have considered as regional, those established with other European ports or with ports in other Mediterranean countries. Notably, these are the ones which account for the largest volume, 17.9 million TEUs out of the total of 34 million, i.e. 52.2%. These figures represent a volume equivalent to more than double that of the next most important region, the Rest of Asia. In terms of both volume and importance in regional flows, the port of Gioia Tauro stands out, its 3.1 million TEU handled under this category representing 84.5% of the total flows of this port. This port could be considered as an enclave highly specialised in European and Mediterranean flows, although with a limited participation of the Maghreb. Given its geographical position, its low participation in transoceanic flows is striking. Other ports of note, with more than one million TEUs classified as regional are Valencia, Algeciras and Genoa, with percentages of their respective totals of 35.8%, 33.6% and 50.1% respectively.

When considering inter-oceanic flows, those linking European Mediterranean ports with global markets and spaces, two areas stand out: Asia and America. Flows with Asia represent 22.1% of the total TEU flows of the Mediterranean ports, while those with the American continent represent 15%. In the flows with Asia, the ports of Valencia and Barcelona stand out, as well as Le Havre, a port located on the Atlantic coast of France and which, due to its characteristics, could be assimilated to the ports of the Rhine Delta. Other ports of importance are Genoa, Marseilles and Algeciras. In the flows with Asia, and within the Mediterranean context, the position of proximity to the major transoceanic routes seems to have less influence than the possibility of access to economically relevant hinterlands. In the case of America, the main ports would be Valencia and Algeciras, each with more than one million TEU, although Barcelona, Sines, Le Havre and Genoa have values of more than half a million TEU. In this case, in which ports on the Atlantic coast of Portugal and France are considered, in addition to Algeciras, it does seem that the geographical position with respect to the transoceanic routes plays a greater role in the concentration of TEU flows from the American continent.

The African continent, excluding the Mediterranean countries, is the origin or destination of 5.4% of the total TEUs moved in the ports of the European countries of the Western Mediterranean. Algeciras is positioned as the main port for flows of this geographical origin. Its volume stands at 0.65 million TEU, representing 15.8% of the TEU of this port.

In short, TEU flows in the ports of the Western Mediterranean countries show a high degree of concentration in a limited number of ports. This pattern would fit in with the trend towards concentration noted when describing the general trends in the organisation of container flows. When considering the origin or destination of the flows handled, the importance of regional flows with Europe and the rest of the Mediterranean stands out in the first place, accounting for more than half of the total number of TEU moved.

⁴ The following figures excludes TEU with unknown origin/destination.

To these regional flows should be added those with the Maghreb, although these account for a much smaller share of the volumes. All these regional flows are combined in each port with flows which could be classified as transoceanic and which link each port to global supply chains. Asia and America are the main transoceanic origins or destinations. The importance of these areas is not unrelated to the description above of the main transoceanic routes, two of which link Europe with Asia and North America.

2.3 The flow with Maghreb in ports of European countries of Western Mediterranean

The distribution of TEU flows with the Maghreb at port level in 2022 shows (Figure 5), once again, the strong concentration of existing flows: the four main ports account for 65.4% of flows. These ports are Barcelona, Valencia, Algeciras and Gioia Tauro. In the case of Valencia and Barcelona, their flows are focused almost exclusively on Morocco and Algeria. It is worth noting that the sum of these two ports accounts for 71.3% of flows with Algeria.

TEU in European ports of Western Mediterranean by Maghreb country. Total. 2022

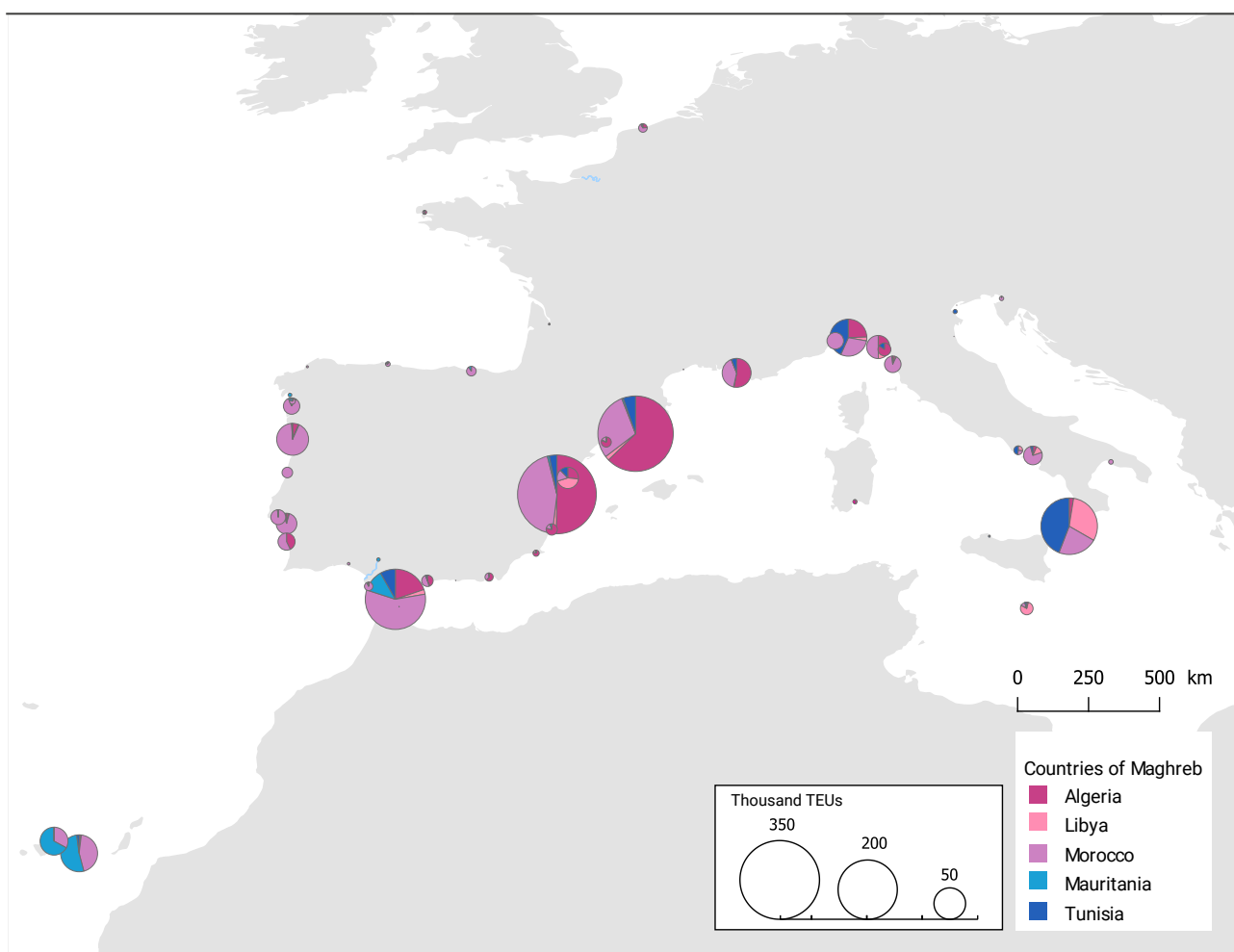


Figure 5 | Source: authors' elaboration on Eurostat

Moreover, in both Valencia and Barcelona, flows with Algeria are the most important in quantitative terms, representing 50.4% and 62.8% respectively of the total flows established in these ports with the Maghreb. Algeciras, with smaller volumes of TEU to or from the Maghreb, nevertheless presents a more diversified

geographical pattern. In this case, if flows with Morocco account for more than 50% of flows with the Maghreb, Mauritania, Algeria and Tunisia are also present. The case of Gioia Tauro is similar to that of Algeciras. In its flows with the Maghreb, those with Tunisia stand out with 44.1%, although those with Libya and to a lesser extent with Morocco are also present. In addition to these four ports, which together handle more than one million TEUs, there are a large number of ports with volumes of less than 100,000 TEUs. In addition to the four main ports already mentioned, the rest of the ports can be classified into three main groups. Firstly, the ports of the Canary Islands, which specialise in flows with Mauritania and, to a lesser extent, with Morocco. Secondly, we can point out the Portuguese façade, which is mainly oriented towards Morocco. In these two cases, geographical proximity seems to be the main factor explaining the distribution of flows with the Maghreb by country. Finally, another set of ports would include Marseilles and the ports of the Ligurian coast, among which Genoa stands out, with a distribution of their flows centred on the countries of the central Maghreb, Morocco, Algeria and Tunisia. Therefore, the ports of Barcelona and Valencia stand out as the main channellers of TEU flows with the Maghreb from the ports of the European countries of the Western Mediterranean. The flows from these two ports are focused on trade with Morocco and especially with Algeria. Two other ports, Algeciras and Gioia Tauro, are also positioned as ports of importance in relations with the Maghreb.

Empty and full unloaded TEU in European ports of Western Mediterranean from Maghreb. 2022

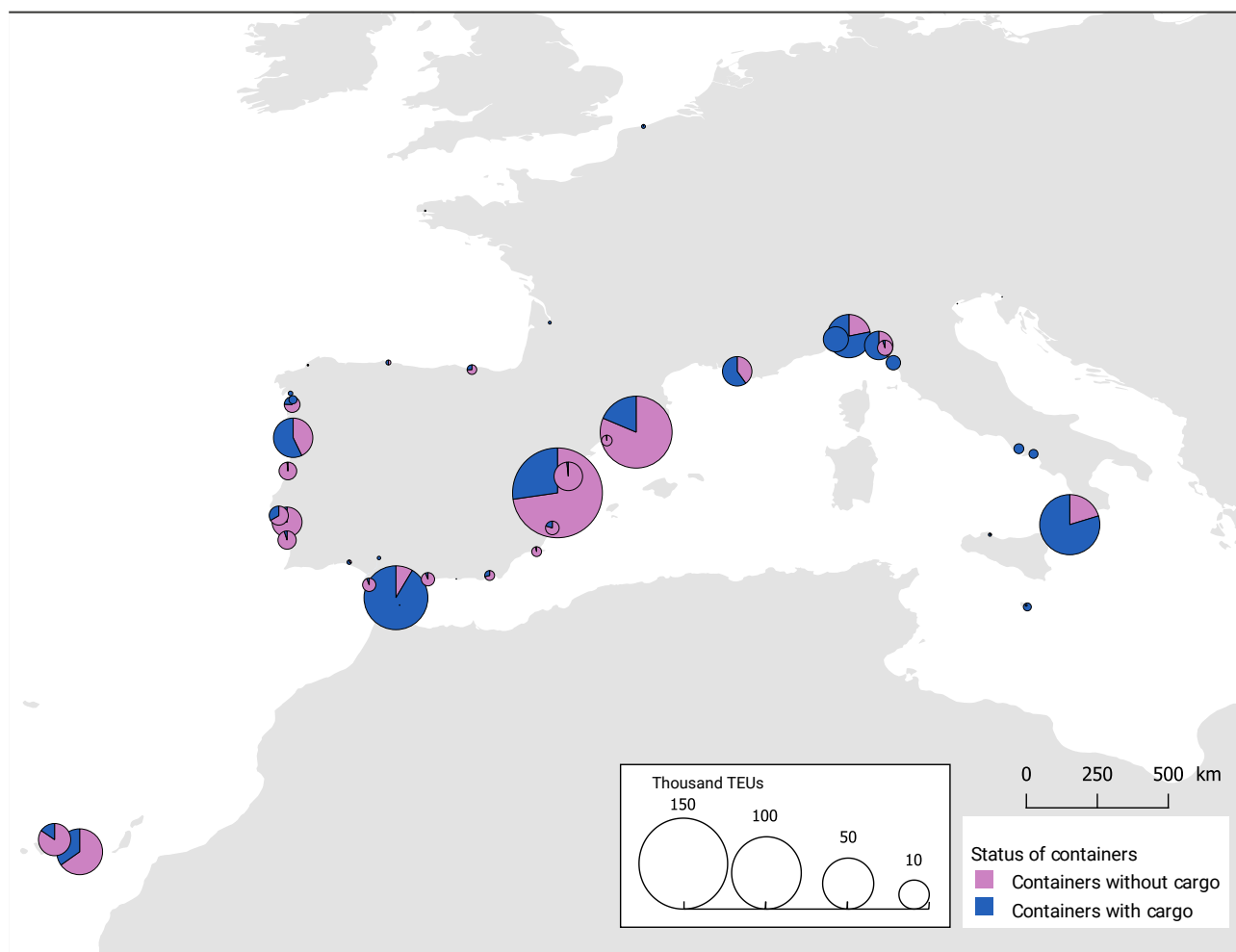


Figure 6 | Source: authors' elaboration on Eurostat

On a third level, there is a large group of ports, with volumes significantly below the most important ports, whose relations are marked by their geographical proximity to the Maghreb countries.

Statistical data from Eurostat provide another type of information, namely on the utilisation of TEU, distinguishing those containing cargo from those transported empty, without cargo. Consideration of this characteristic according to the direction of flow in European ports in the Western Mediterranean clearly shows two distinct patterns. While practically all the containers loaded in the European ports are full containers, on the return journey, in the South-North direction, a significant proportion of the containers make the journey without cargo. In the ports as a whole, 54.1% of the TEU unloaded from the Maghreb correspond to empty containers, reaching figures of 72.7% and 81.4% in the ports of Valencia and Barcelona respectively. On the other hand, in the north-south flows, 94.7% are full containers and in the ports of Valencia and Barcelona this figure is above 98% in both cases.

It is therefore worth noting how the flows of empty containers from the Maghreb make up an important part of the TEU flows in the Western Mediterranean. At the same time, it should be noted that these empty containers are mainly channelled through two ports, Valencia and Barcelona, which are the ones that concentrate the greatest number of TEU in the flows of European ports with the Maghreb. This imbalance is a reflection of the difference in tonnes moved in containers mentioned above and is a reference to

Empty and full loaded TEU in European ports of Western Mediterranean from Maghreb. 2022

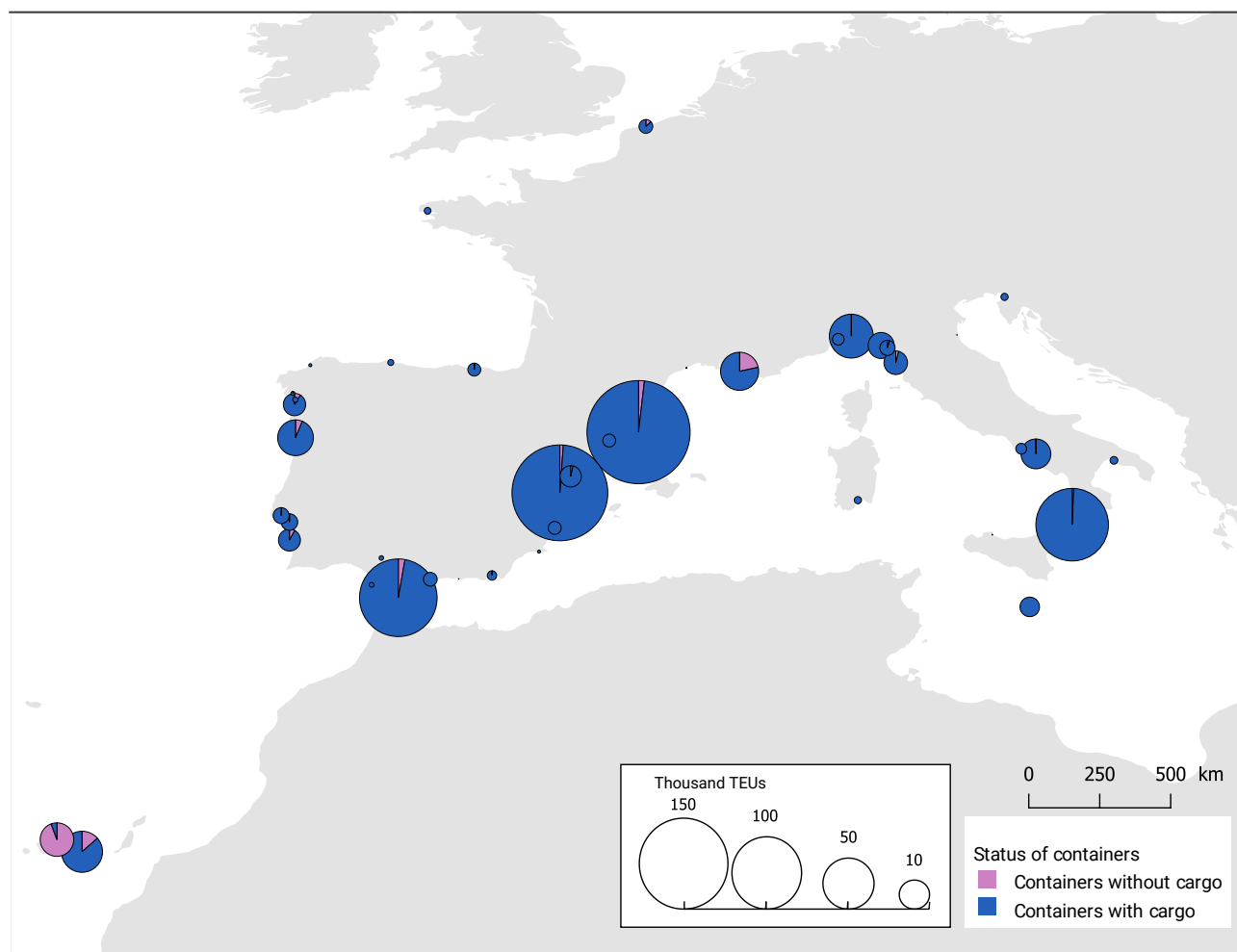


Figure 7 | Source: authors' elaboration on Eurostat

the greater export capacity of the European countries compared to the Maghreb countries. However, as indicated when explaining the functioning of global container flows, the volumes of containers in ports do not only respond to the characteristics of the hinterland, but the flows of containers in transshipment must also be considered.

2.4 The function of transshipment: the example of Spanish ports

At present, there is no detailed information on the transit function for all Western Mediterranean ports. Some ports publish an overall figure for the total volume of transit without detailing origins and destinations. Only Puertos del Estado provides detailed data on transit flows in Spanish ports. This information on transit operations in Spanish ports should serve as an example to try to explain the influence of transshipment on container flow patterns in the Western Mediterranean.

The information provided by Puertos del Estado makes it possible to disaggregate the TEU flows between Spanish ports and the Maghreb according to whether or not they are transit movements between vessels by direction of flow (Figure 8).

Considering the total TEU moved in Spanish ports with origin or destination the Maghreb, it is worth noting the majority presence of TEU in transit operations both in loading and unloading. The unloading of containers in transit accounts for 21.4% of the total containers moved in the Spanish port system as a whole and the loading of this same category of containers accounts for 43.3%. In other words, the greatest proportion of TEU moving between Spain and the Maghreb countries corresponds to movements of TEU to the Maghreb that have carried out a transit operation in a Spanish port.

When considering the ports individually, the ports of Algeciras (89.9%) and Las Palmas (82%) stand out for their high proportion of transit operations in flows with the Maghreb. With smaller proportions, but with larger volumes, are Valencia and Barcelona, the former with 69.8% of TEU with the Maghreb corresponding to transit movements and the latter with 51.1%. Moreover, as was the case when considering the Spanish ports as a whole, container shipping operations in transit to the Maghreb account for the largest share of total operations: 50.4% in the case of Valencia and 38.4% in the case of Barcelona.

This reaffirms the idea that a large part of the flows between the major ports of Spain and the Maghreb are made up of TEUs coming from other geographical areas and which undergo a transshipment movement before reaching their final destination in one of the Maghreb countries. The same is true in the opposite direction: Spanish ports are constituted as transshipment infrastructures for TEUs loaded in the ports of the Maghreb countries and destined for other geographical areas. Therefore, it can be affirmed that Spanish ports act as platforms from which the Maghreb countries access the global container flow chains.

This function of the Spanish ports with respect to the Maghreb, that of allowing the insertion of Maghrebi containerised goods into the global TEU routes, would be determined by the limited capacity of the port system of the countries on the southern shore of the Western Mediterranean to receive and treat the vessels that operate these global routes. As indicated above, the major interoceanic routes are operated by large vessels in terms of both TEU carrying capacity and draught. They therefore need infrastructures that allow both their berthing and efficiency in the loading and unloading processes of large volumes of TEUs. At present, the ports of the Maghreb, with the clear exception of the Port of Tangier Med, do not offer sufficient technical characteristics to accommodate large container ships, making transshipment operations in other ports necessary to join the global routes.

TEUs from/to Maghreb by operation (transshipment/hinterland) in Spanish ports. 2021

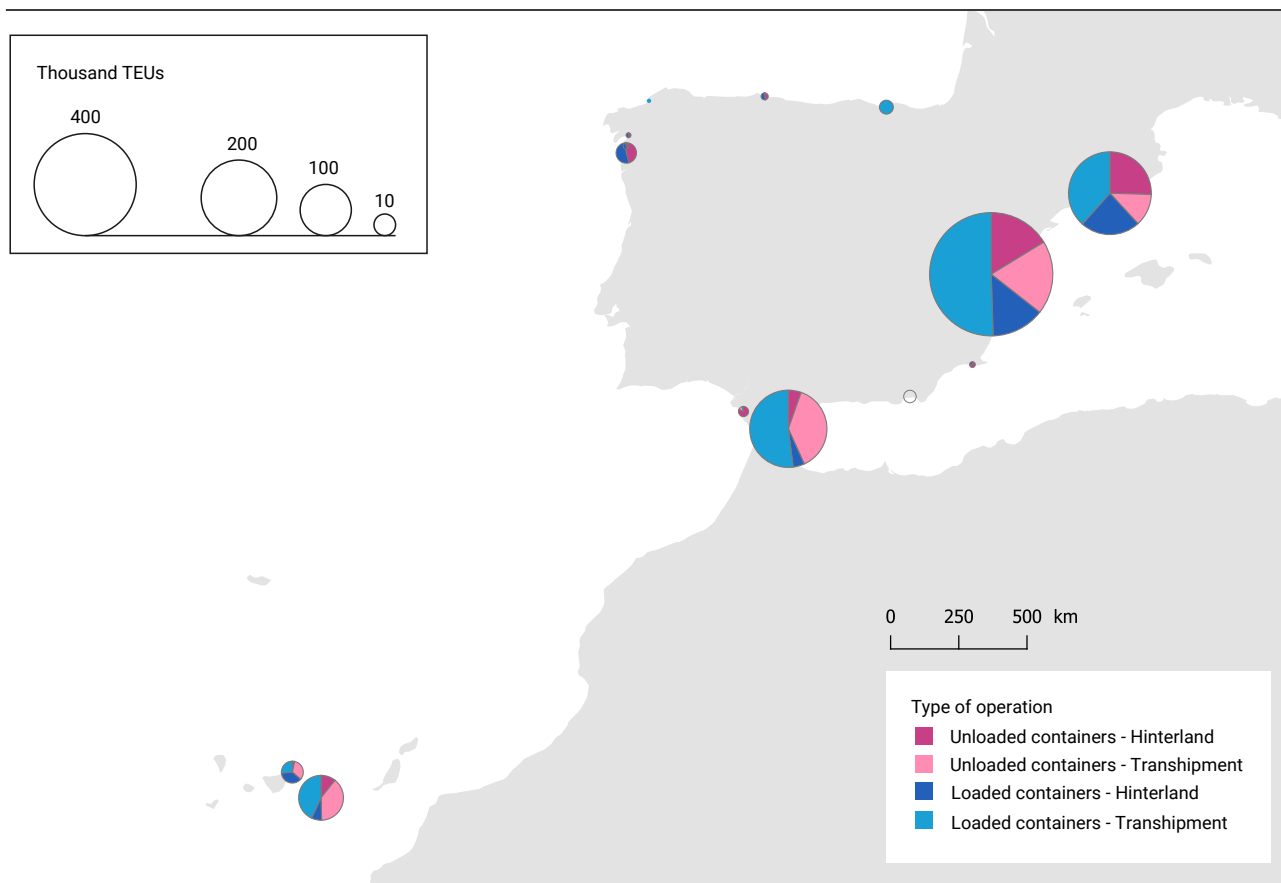


Figure 8 | Source: authors' elaboration on Puertos del Estado

The infrastructural limitations of the Maghreb ports can be seen in the statistics provided by UNCTAD on the port performance of the countries. Three variables make it possible to understand the differences between the port systems of the countries on the Northern shore of the Mediterranean and those on the Southern shore, in relation to the capacity to handle container ships: the maximum size of the ship handled in one of the ports of each country, measured in TEU, the average size, also measured in TEU, and the average time spent in port by container ships, measured in days. If the first two indicators could be related to the physical capacities of the ports, the third would refer to the handling capacity of container vessels measured in time. These three indicators mark a clear difference between the European countries of the Western Mediterranean and those of the Maghreb, with the exception of Morocco.

Figure 9 shows the differences in relation to the capacity of the different countries. The maximum size of container ship handled by each country shows that the five European countries, together with Morocco, have the capacity in their ports for large ships of more than 20,000 TEU to call at their ports. In contrast, in Algeria or Tunisia, for example, the maximum capacity of ships handled in their facilities is 2,260 and 1,350 TEU respectively. A similar situation is found when considering the average size of container ships. While European countries range from 2,257 TEU in Portugal to 5,025 TEU in France, in the Maghreb they range from 845 TEU in Tunisia to 1,480 TEU in Mauritania, with the exception of Morocco, which again has values within the range of European countries.

When considering the average length of stay in port, the picture obtained is similar to that of the consideration of vessel sizes. The European countries and Morocco are below one day of average stay,

with the exception of Malta, which slightly exceeds this limit. On the other hand, on the Southern shore, values of 1.72 days are found in Libya, 2.43 in Algeria, 2.72 in Mauritania and 3.28 in Tunisia.

Maximum and average size of container ship by Western Mediterranean countries. 2021

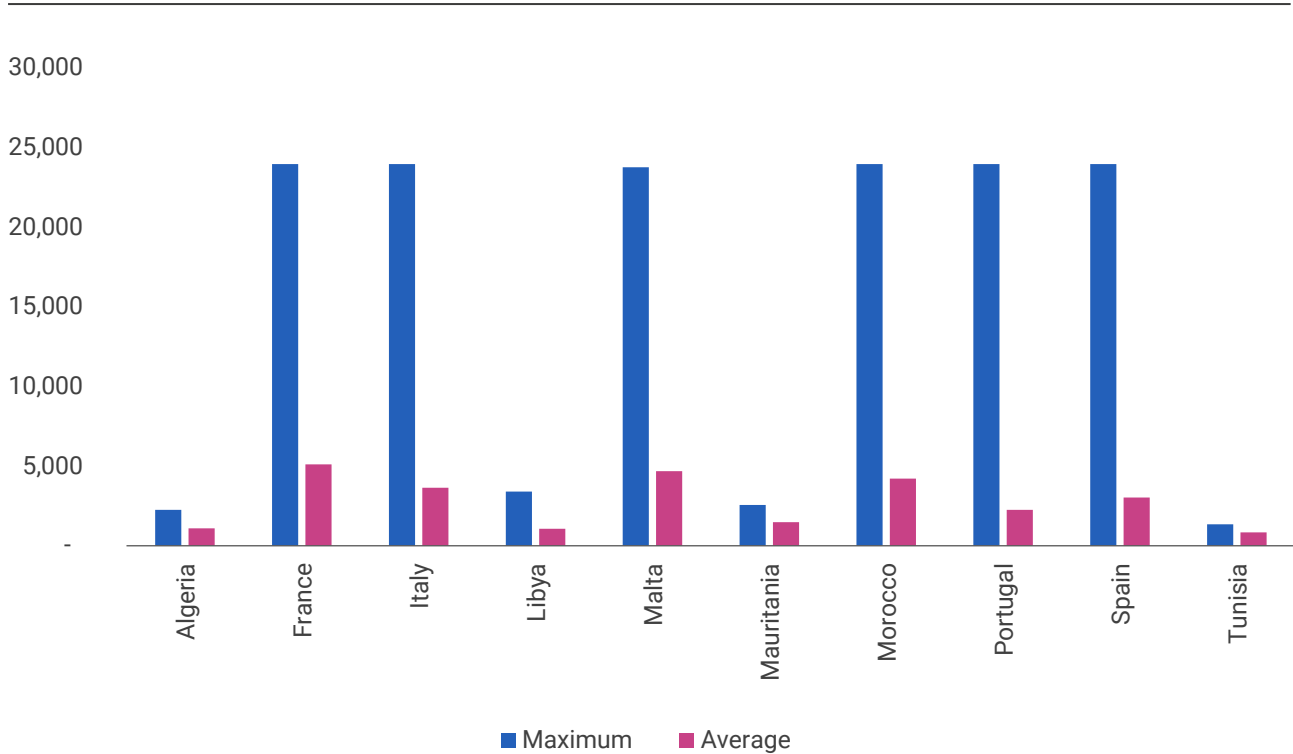


Figure 9 | Source: UNCTAD

Average dwell time of container ship by Western Mediterranean countries 2021 (DAYS)

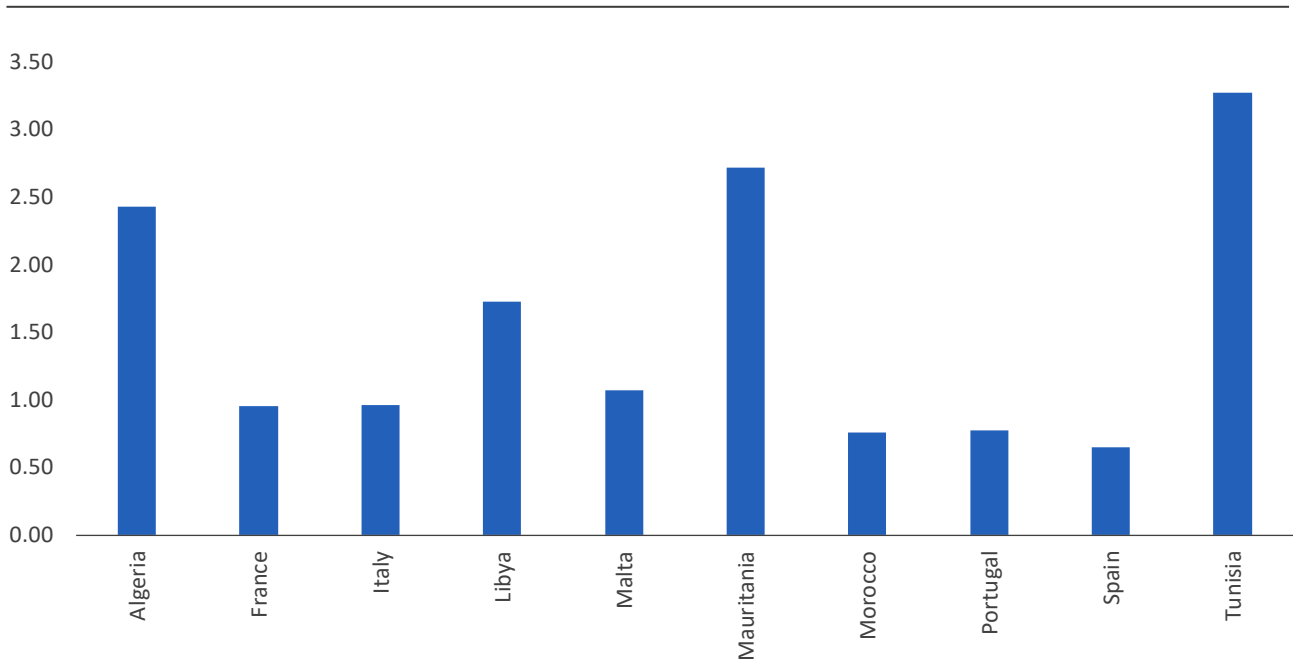


Figure 10 | Source: UNCTAD

Based on the data from Spanish ports, it can be seen how the transit function conditions a large part of the container flows between Spain and the Maghreb countries. This transit function would result from the need to insert container flows to and from the Maghreb into global container routes. The exception of Morocco, and its port of Tanger Med, should not go unmentioned. The constraints of the vessels operating on these routes and the infrastructural and performance limitations of the Maghreb ports would make it necessary to carry out transit operations in order to access transoceanic routes, thus linking up with more remote economic areas. The concentration, in the Spanish case, of both transit and hinterland flows in a very limited number of ports would also be a reflection of the trends already noted in the global container transport system.

3. The flows of non-containerised cargo between the two shores of Western Mediterranean

As pointed out in the first part of the article, non-containerised cargo accounts for a non-negligible part of the maritime flows of general cargo in the Western Mediterranean, specifically 42.9%. This type of cargo is made up of different types of goods and different ways of handling them. While it mainly refers to the loading and unloading of road vehicles dedicated to the transport of goods, it also includes new vehicles or other special types of goods. The distinction between the various types of cargo is not homogeneous between the different statistical systems, which sometimes makes detailed analysis or comparison between statistical sources difficult. Regardless of the problems that may arise in the accounting or conceptualisation of non-containerised general cargo, the fact remains that it is an essential channel in the routing of goods between the two shores of the Western Mediterranean.

When the first tables in this article presented the overall figures for general cargo between the two shores of the Western Mediterranean, in contrast to a decompensation by direction of flow in the case of containers, non-containerised general cargo showed a balance in both directions of flow. The importance of the relationship between Spain and Morocco was also highlighted.

Figure 11 shows how the relationship between Spain and Morocco is based above all on flows through the Strait of Gibraltar, specifically the flows linking the port of Algeciras and Tanger Med. This flow reached 5.4 million tonnes in 2022, which represents 54.4% of the total flows between the two shores of the Western Mediterranean. This flow in the Strait of Gibraltar is mainly made up of Ro-Ro cargo units, i.e. lorries, trailers or semi-trailers. The second most important port on the European shore is Genoa and is far from the volumes of Algeciras. Its relations are mainly established with Tunisia, in particular with the port of Radés. Apart from the flows from Algeciras and Genoa, the volumes of non-containerised general cargo from the European ports of the Western Mediterranean are much more limited.

It should be noted that trade in general cargo between Spain and Morocco, as well as trade between Italy and Tunisia, is mainly in the form of non-containerised cargo flows. In the case of Spain, the importance of non-containerised goods accounts for 59.9 percent of the total general cargo between the two countries. This fact can be explained by the short distance of the crossing of the Strait of Gibraltar, which would favour the use of road in the routing of goods and their loading as Ro-Ro units in the maritime section. In the case of the relationship between Italy and Tunisia, the importance of non-containerised goods is even greater, reaching 74.9%. In this case, it is not only the geographical proximity that determines the type of flow between the two countries.

On the contrary, the explanation should be sought in the type of products and in the organisation of logistics, within which the greater efficiency in the treatment of Ro-Ro cargo in Tunisian ports compared to the treatment of containers should be pointed out.

Non-containerised cargo in European ports of Western Mediterranean by Maghreb country. Total. 2022

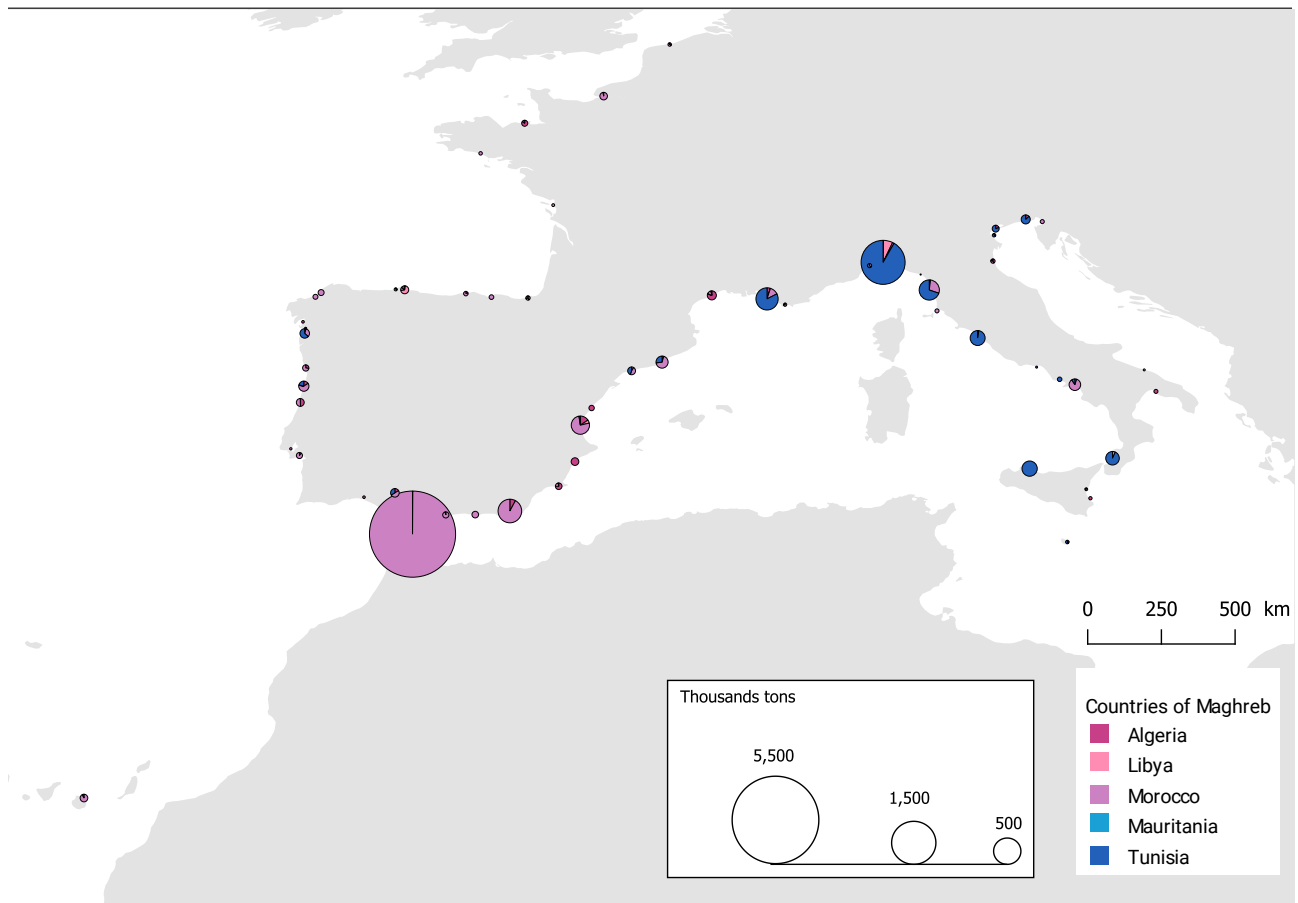


Figure 11 | Source: authors' elaboration on Eurostat

4. Reflexion: interrelation between types of cargo

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 (containerised or non-containerised cargo), the origin-destination of the goods (transoceanic or regionals) and the type of operation carried out on the goods at ports (transshipment 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 networks.

Currently, the organisation of different services has converted the transit role into a key part of the organisation 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. Non containerised general 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, may have transformed the conditions of competition between these means and may lead to redistribution of containerised and non-containerised cargo and, consequently, the reorganisation 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.

5. Trends that may affect the development of maritime flows

As has been shown, at the present time the flows of general merchandise in the Western Mediterranean must be contextualised both in the conditions of a local and global space. The complexity and interrelationships between the different elements that condition the structuring of these flows makes it risky to make a forecast of their future evolution. However, it is considered appropriate to point out some of the main processes that will frame this evolution.

First of all, attention should be drawn to the various infrastructure projects in the Maghreb countries that may have an impact on the way in which general cargo flows are currently organised. The development of deep-water ports and the improvement of container loading and unloading processes is a basic strategy in the infrastructure plans of the Maghreb countries. This is illustrated by the successful case of Tanger Med in Morocco, but also by the new port projects in Cherchell and Djen Djen in Algeria or Enfidha in Tunisia or the planned improvement in Radès, also in Tunisia. The development of these ports will make it possible for large container ships to call at these ports, thus eliminating the need for transshipment movements in the ports on the northern shore. The way in which flows are reorganised will depend on multiple factors, largely linked to the strategies of the major shipping and terminal companies.

Secondly, 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.

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 goals⁵.

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

⁵ Minutes of the sessions of the IMO MEPC and its working groups [<https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MEPC-Default.aspx>].

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 Pact⁶, 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.

For maritime transport⁷, 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 technology⁸.

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 new technological gaps and conditioning factors that affect how maritime transport works as well as the definition of future maritime flows.

The third element is related to new global pattern of production location. New relocation and regionalisation 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 Mediterranean⁹.

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 Turkey¹⁰.

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

⁶ 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.

⁷ 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.

⁸ 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/>

⁹ ITF (2022), Performance of Maritime Logistics. International Transport Forum Policy Papers, No. 106, OECD Publishing, Paris.

¹⁰ Torrent J., & Roman M. (2022, October), 'The evolution of maritime transport in the Mediterranean in an era of disruptions', in Towards Enhanced Connectivity and Sustainability in the Mediterranean Transport and Logistics Sector, CETMO and IEMED, Barcelona.

Finally, a set of disruptions to the established supply chain has occurred in recent years, and current geopolitical relations do not seem to provide greater stability. The impact of Covid-19 in 2020 highlighted just how vulnerable society and its activities are to disruptive situations. The closing of the Suez Canal due to the Ever Given obstruction, the war in Ukraine or attacks in the Red Sea, all show how maritime transport is no stranger to situations where its operations would be drastically altered.

On the other hand, 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 Report¹¹, 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).

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.

All these elements taken together suggest that the transport system in the Western Mediterranean will continue to evolve and transform in the near future, and not always at a pace or in a direction set by local actors. The maintenance, if not the improvement of transport conditions, whether economic, social or environmental, of general cargo flows in the Western Mediterranean will require a capacity for adaptation on the part of the multiple actors that intervene in and determine them. In this sense, reinforced collaboration between the different agents and actors should be the main tool for facing the future.

6. Conclusion

The presentation of the functioning of general cargo exchanges in the Western Mediterranean has made it possible to understand how a system of regional flows is integrated into the global system of maritime cargo flows. In the case studied, that of flows between the Maghreb and European countries of the Western Mediterranean, the interrelation between global flows and local container flows has been shown, along with the importance of transshipment operations in European ports in this relationship. These flows are also complemented by non-containerised general cargo flows. All this means that the general cargo transport system between the two shores of the Western Mediterranean has to be considered as a more or less complex system with multiple relationships between types of goods, types of handling, operations and infrastructures.

The set of databases used in this study has made it possible to obtain this complex view of the system. However, the limitations deriving from the use of these databases should not be forgotten. The most extensive and homogeneous information is that provided by Eurostat, thus excluding detailed information on the ports of the Maghreb. Nor is the detailed information on transshipment operations accessible for all the ports in the study area, being limited to the ports of Spain. Finally, access to information on port performance, which until recently was possible for all countries, has recently been limited. Hence the

¹¹ IPCC Sixth Assessment Report, Working Group II. Climate Change 2022: Impacts, Adaptation and Vulnerability. Cross-Chapter Paper 4. Mediterranean Region.

opportunity to highlight the need for improvement and expansion of existing information on maritime flows in the Western Mediterranean. More information should confirm or correct the ideas set out in this article, but above all provide data decision-makers with better tools during this time of major transformations and uncertainty.

Finally, it should be noted that the evolution of the maritime transport system for general cargo in the Mediterranean is currently undergoing changes and transformations in many areas. From technology to geopolitics, energy, the business structure of shipping companies and the effects of climate change, among others. Once again, it should be stressed that knowledge and information on the current functioning of transport must provide the basic tools for decision-making in a context of disruption and uncertainty.

Chapter 7 | **Analysis of Turkish ports and management models**

The port sector, which was labour intensive in the past, has gradually become capital intensive. The importance of port investments has increased exponentially due to their direct and indirect economic impact on trading countries. For almost all regions in the world, port authorities provide port infrastructures and aim to achieve the highest economic benefit not only for regional economies but also for global supply chains.

Although a structured port authority model has not been adopted in Turkey, the legislative power of the central government has been dominant in port-related practices. Especially after the 1950s, the state directly financed some vital port investments. After the 1990s, however, this situation has changed significantly. The government started to privatise state-owned ports and recently only two large-scale ports in Turkey are operated by the state. All other ports are today mainly operated by the private sector.

In this chapter, the ports operating within the borders of Turkey are evaluated. In this context, firstly, the geopolitical importance of the ports in the geography in which they are located is examined, and then the cargo volumes of the ports are presented. In the last part of the study, an evaluation of the management models of the ports is presented.

1. Turkish ports in numbers

In this section, the position of Turkey and the ports in Turkey on global and regional trade routes, the geographical distribution and clustering of ports, as well as the cargo volumes at Turkish ports in the last 10 years are analysed.

1.1 Turkish ports on maritime trade routes

Turkey is located on the main Far East-Europe (East-West) maritime trade route with a low deviation distance. This deviation distance is approximately 300 nautical miles considering Turkey's coasts in the Eastern Mediterranean. Moreover, a merchant ship passing through the Suez Canal and sailing to the Mediterranean can enter the Black Sea after approximately 750 nautical miles.

As can be understood, Turkey is located on the Black Sea-Mediterranean (North-South) sea routes. In particular, the Canakkale and Istanbul Straits in Turkey play a key role in the access of the Black Sea coastal countries to the sea. Therefore, Turkey is a country with easy access to the main sea routes and increasing local and transit freight potential (Esmer et al, 2016). As this potential is supported by Turkey's local industrial strength, enormous cargo volumes are generated. Details on the volume of cargo

handled in ports will be given in the following sections. However, in general terms, the volume of cargo handled at ports in Turkey is over 500 million tonnes.

The maritime trade routes over Turkey can be analysed in Figure 1.

Location of Turkey on maritime trade routes

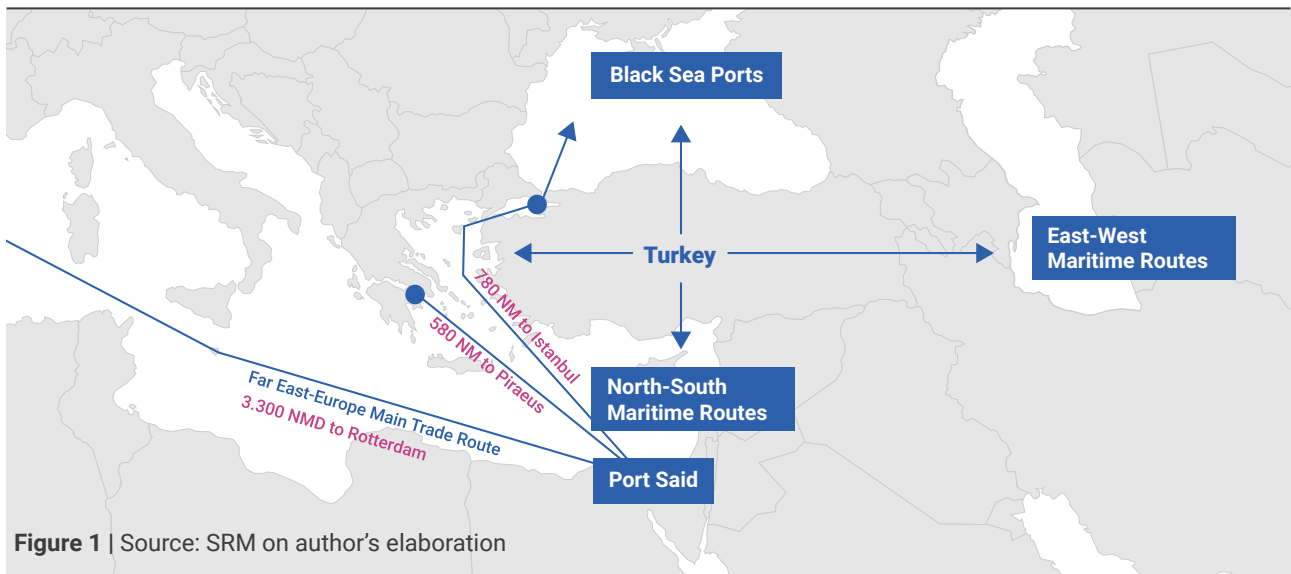


Figure 1 | Source: SRM on author's elaboration

1.2 Geographical distribution of ports in Turkey

As of 2023, the number of coastal facilities serving maritime trade (in the form of piers, buoys, dolphins and platforms) is 216. 192 of these coastal facilities are actively serving maritime transport. Approximately 43% of these coastal facilities are located in the Marmara Region (81), 26% in the Mediterranean Region (50), 16% in the Black Sea Region (31) and 15% in the Aegean Region (28) (Türklım, 2023).

Geographical regions with seacoasts in Turkey

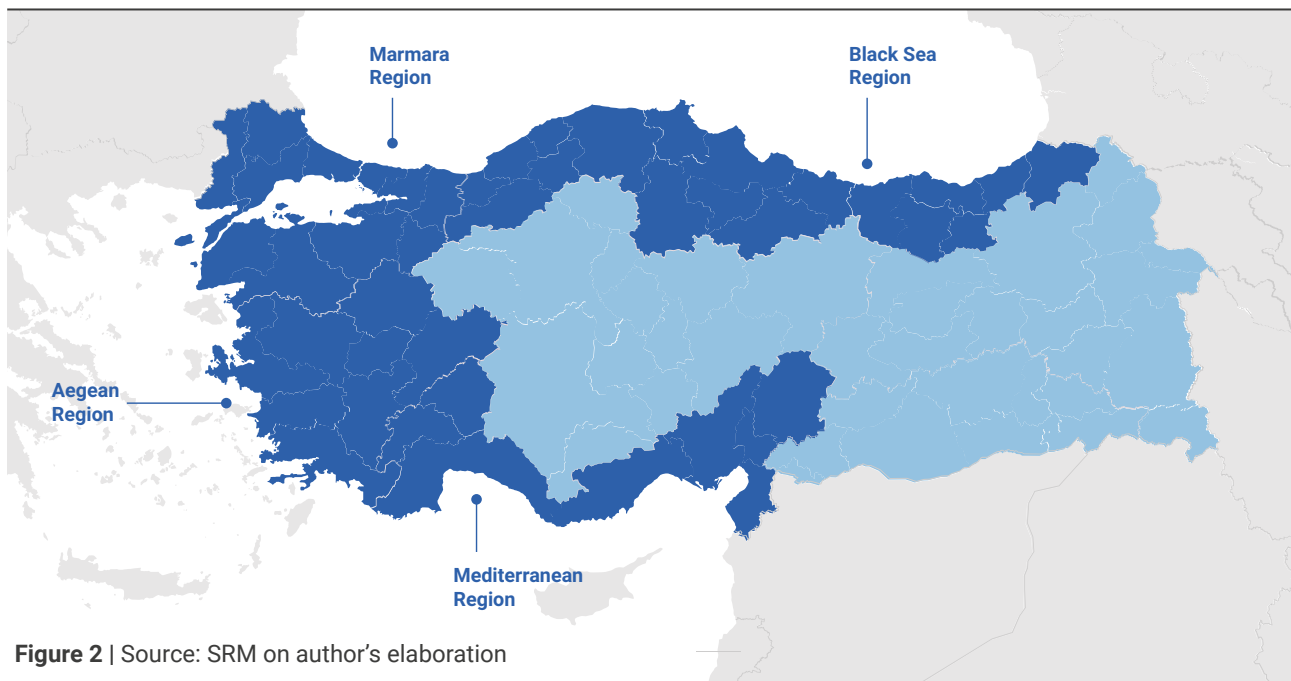


Figure 2 | Source: SRM on author's elaboration

As can be seen in Figure 3, ports are clustered in some regions. These regions are naturally important industrial and production regions. Turkey's population of more than 85 million is mainly concentrated in these regions. In addition, especially the port clusters in the Marmara region (Gemlik, Ambarlı and Izmit Bay) and Asyaport port are transshipment areas for transit container traffic mainly to the Black Sea countries. The rest of the ports are stretched through Turkey's coastal areas.

Ports and terminals in Turkey

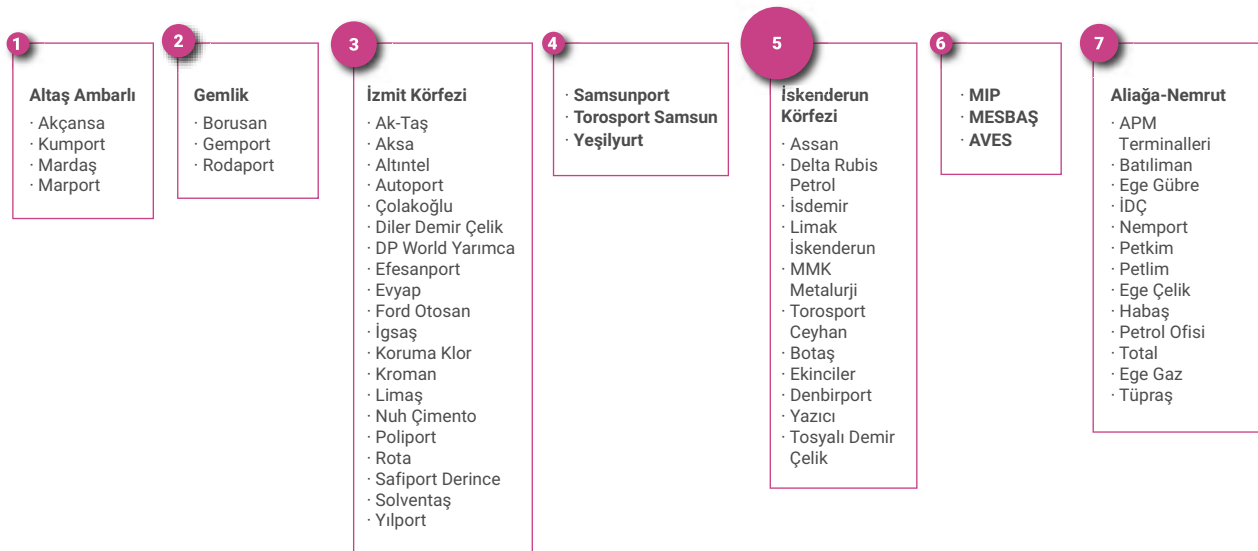
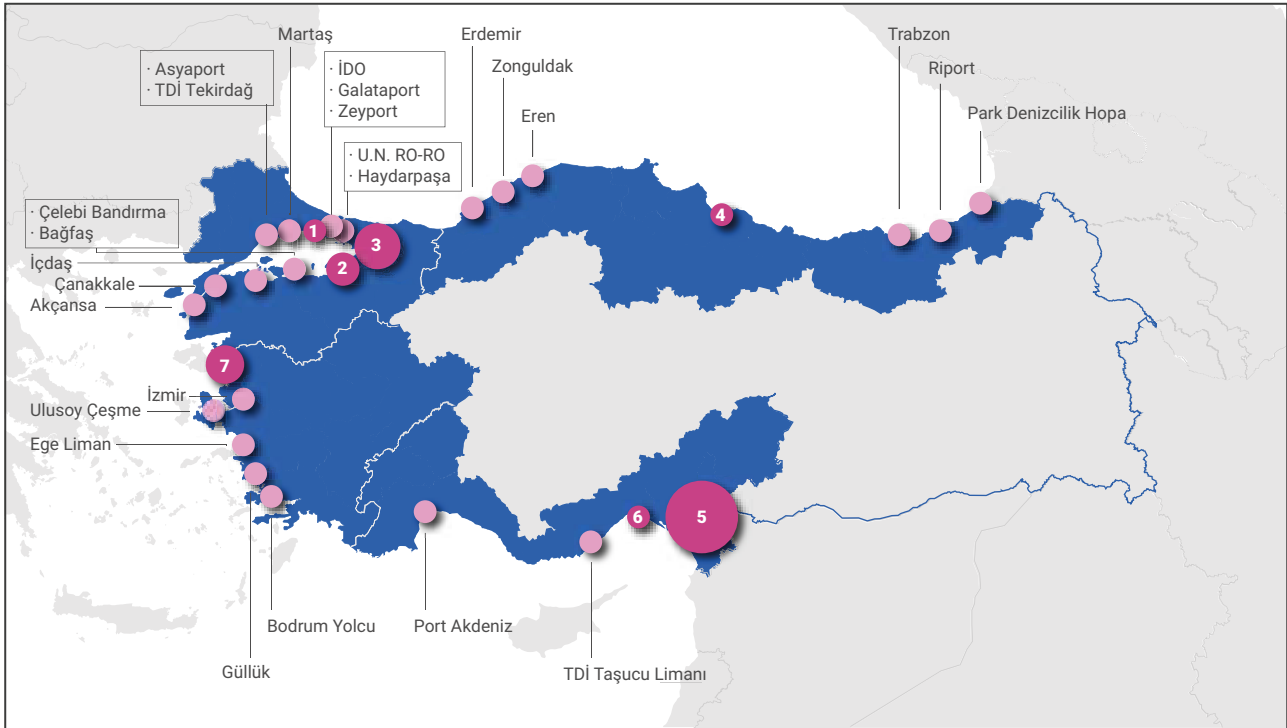


Figure 3 | Source: SRM on author's elaboration

● Port clusters

● Individual ports

1.3 Last 10 years development of port data in terms of cargo types

According to the data of the Republic of Turkey, Ministry of Transport and Infrastructure, when analyzed on the basis of main cargo groups, it is seen that there is an increasing trend except for general cargo loads in the ports in Turkey in the last 10 years (2014-2023).

10-year development of main cargo groups in Turkey (tons)

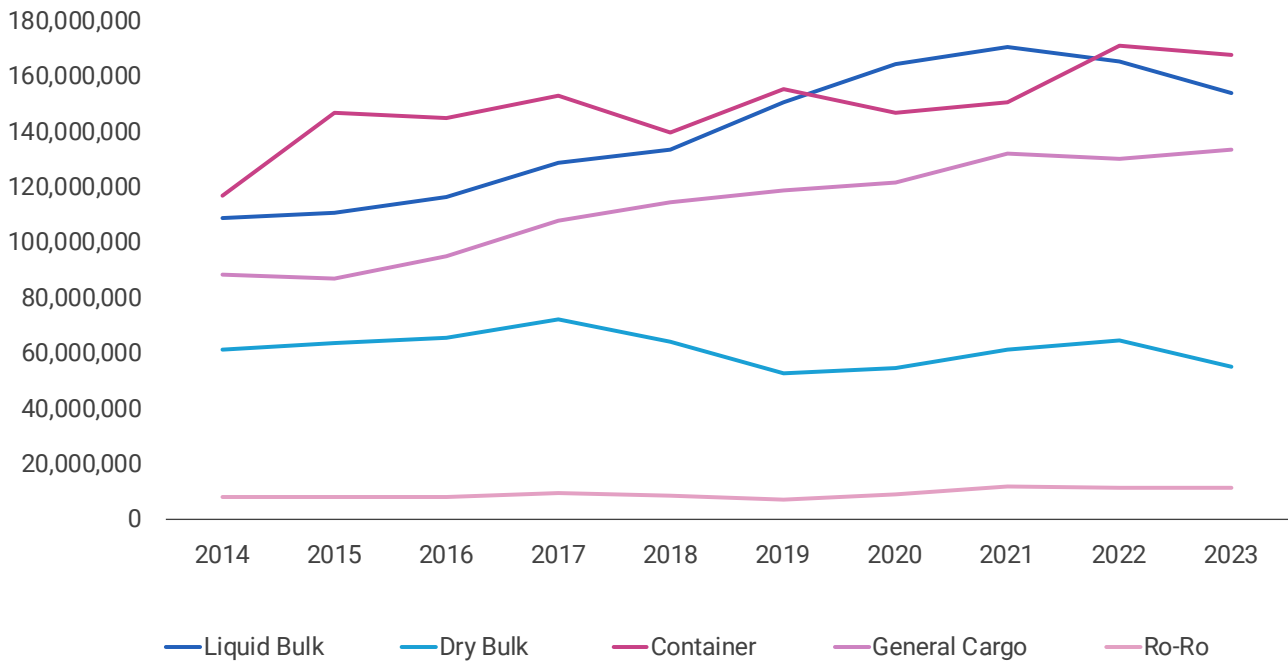


Figure 4 | Source: the Republic of Turkey, Ministry of Transport and Infrastructure

In 2023, a total of 521 million tonnes of cargo was handled at Turkish ports. Liquid bulk cargoes are the cargo group with the highest share of 32% and a volume of 168 million tonnes. Dry bulk cargoes ranked second with a share of 29% in total cargo. The volume of dry bulk cargoes is 154 million tonnes for 2023. Container is evaluated separately in terms of TEU, but ranks third in terms of tonnage with 133 million tonnes. There has been a downward trend in general cargo loads for the last 10 years (-1.8%). On the other hand, Ro-Ro transports, mainly with Italy, have been increasing at an average rate of 3.5% per year for the last 10 years.

Distribution of main cargo groups (tons)

Cargo Type	2022	2023	Change 22/23	CAGR 14/23
Liquid Bulk	171,201,149	167,788,070	-2.0%	3.2%
Dry Bulk	165,295,741	153,714,732	-7.0%	4.0%
Container	130,244,809	133,467,400	2.5%	4.7%
General Cargo	64,567,384	54,864,485	-15.0%	-1.8%
Ro-Ro	11,301,200	11,245,117	-0.5%	3.5%
Total	542,610,283	521,079,804	-4.0%	3.1%

Table 1 | Source: the Republic of Turkey, Ministry of Transport and Infrastructure

Distribution of main cargo groups (%)

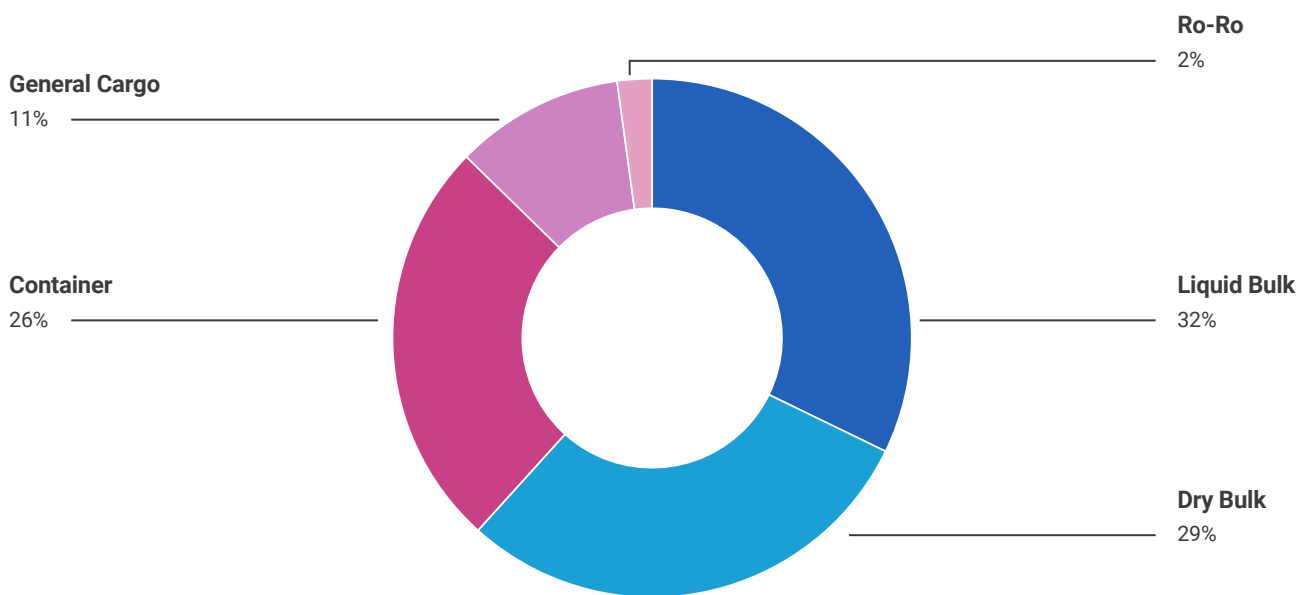


Figure 5 | Source: the Republic of Turkey, Ministry of Transport and Infrastructure

On the other hand, when container handling in TEU units is evaluated, it is seen that the volume reached in 2023 is 12.7 million TEU. Of this volume, 3.2 million TEU was recorded as transshipment.

Growth of Container Port Traffic in Turkey (TEU)

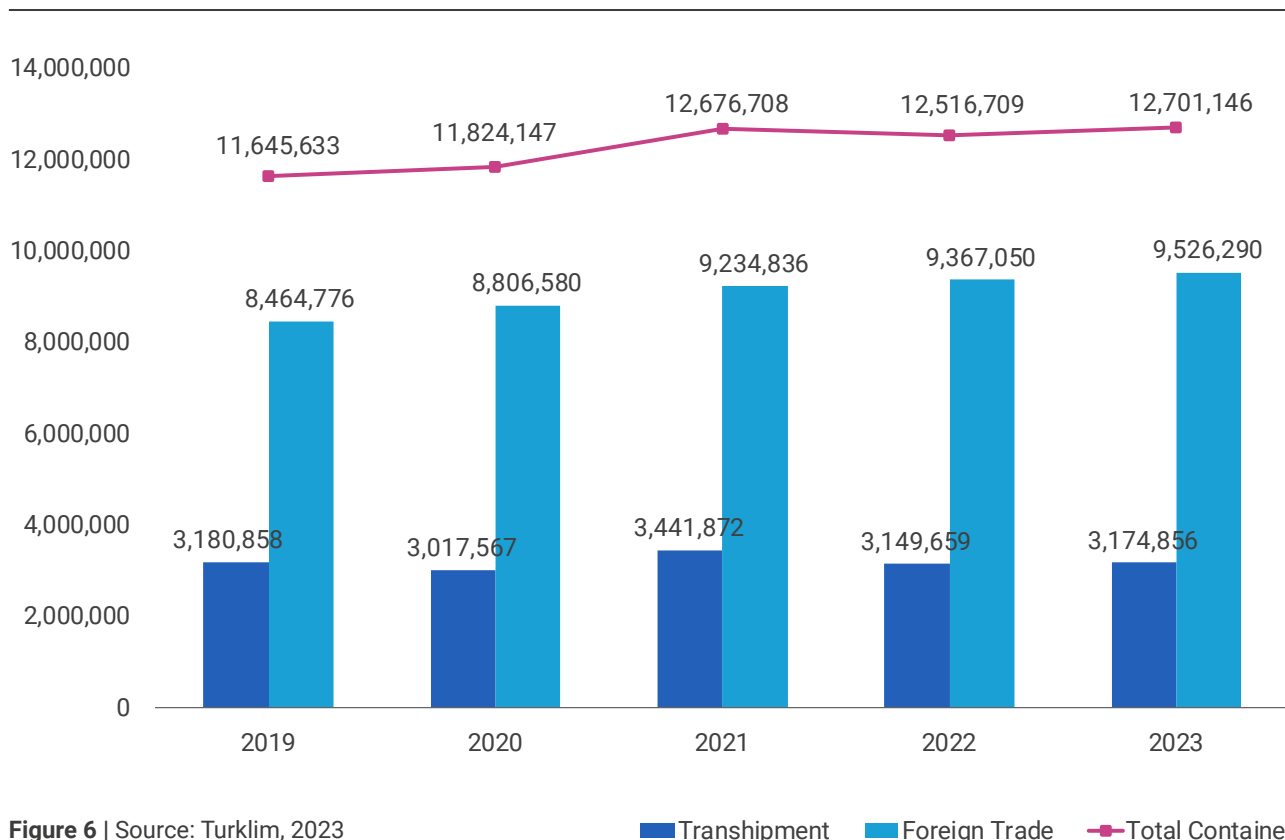


Figure 6 | Source: Turklim, 2023

■ Transshipment ■ Foreign Trade ■ Total Container

It is observed that the transit container has increased by 5% on average every year in the 10 years since 2014. The development in other transports consisting of Turkey's local cargoes was 4.6%. The development in total is 4.7%.

Distribution of container regime (TEU)

Container Regime	2022	2023	Change 22/23	CAGR 14/23
Transshipment	3,149,659	3,174,856	0.8%	5.0%
Foreign Trade	9,367,050	9,526,290	1.7%	4.6%
Total	12,516,709	12,701,146	1.5%	4.7%

Table 2 | Source: the Republic of Turkey, Ministry of Transport and Infrastructure

As can be seen, with some exceptions, the development rates of cargo volumes in Turkish ports are above the world average.

2. Port management models

In Turkey, the role of the public sector in port operations has decreased considerably with the transfer of public ports to the private sector through the transfer of operating rights. The public sector now carries out its regulatory and supervisory role. Under this heading, port management models in Turkey will be summarised.

2.1 A brief review of 100 years of historical development

Turkey has an important place in the Mediterranean since ancient times. The presence of many ancient harbours on the Turkish coast strengthens this data. The Republic of Turkey was founded in 1923 and thus foreign enterprises were prevented by law from operating ports in Turkey. Since there was no private capital and know-how specialised in port management in the early years of the Republic, the public sector took a special interest in this issue and undertook the management of the ports available at that time. This issue was given special importance because foreign trade was seen as one of the financial instruments required for the restructuring after the long wars and the newly established Republic. At this point, the need for ports became evident.

The first port operated by the state was Haydarpaşa Port. Haydarpaşa Port has been operated by the relevant institutions of the Republic of Turkey since 1924. With increasing trade volumes, new ports were needed. For this reason, port investments of the public sector increased especially in the 1950s and today's large public sector ports were built in this period. As the private sector started to develop after the 70s, some piers were built in coastal areas to meet the needs of large manufacturing companies, and these ports started to serve third parties with special permission from the state since 1987. Finally, the first private port (Gempont) was established in the early 90's and 5 years later, in 1997, the commercialisation process was initiated with the transfer of operating rights of publicly owned ports. These stages, which are very important for port management in Turkey, are shown in Figure 7 (Esmer, 2019).

Milestones of port operations in Turkey

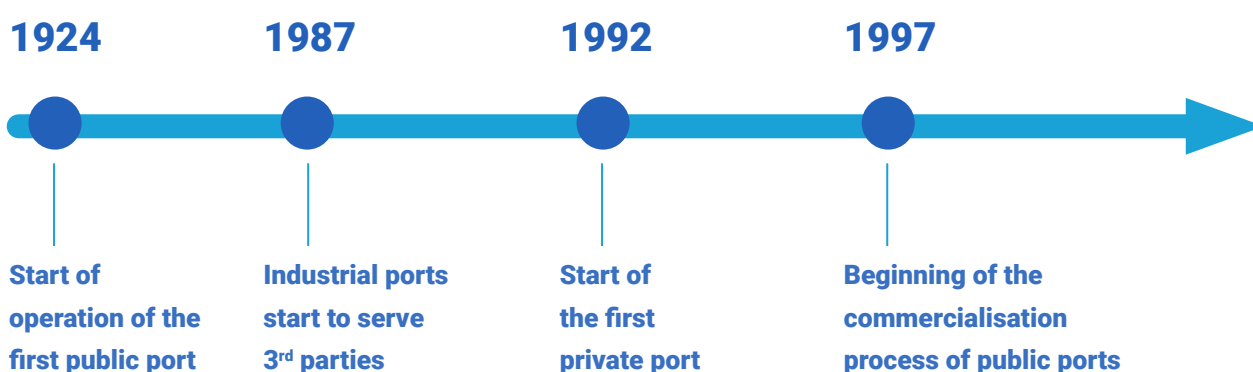


Figure 7 | Source: SRM on Esmer, 2019

With the 1990s, port management in Turkey has undergone a change. Under the next heading, port management models and the changes they have experienced are given.

2.2 Changing port management models in Turkey

Considering World Bank typology, there are four basic governance models in the world: service port, tool port, landlord port and private port (World Bank, 2007). From this point of view, only 2 large-scale service ports (Port of Izmir and Port of Haydarpaşa) are operated by the public sector in Turkey as of November 2018. On the other hand, according to Esmer and Duru (2017), past privatization experiences are typical examples of the tool port model while recent port devolution projects are governed with more of a landlord type. Additionally, private and privatized ports operated by private sector do not directly fit into the World Bank typology definition and these ports may be categorized as private ports without complete ownership of land and/or sea facilities. At this point, it is more accurate to call these ports commercialised ports rather than privatised ports.

In light of the above information, management types of ports in Turkey can be grouped into two main categories: Ports operated by public and private sector (Figure 8).

Classification according to the operators of ports in Turkey

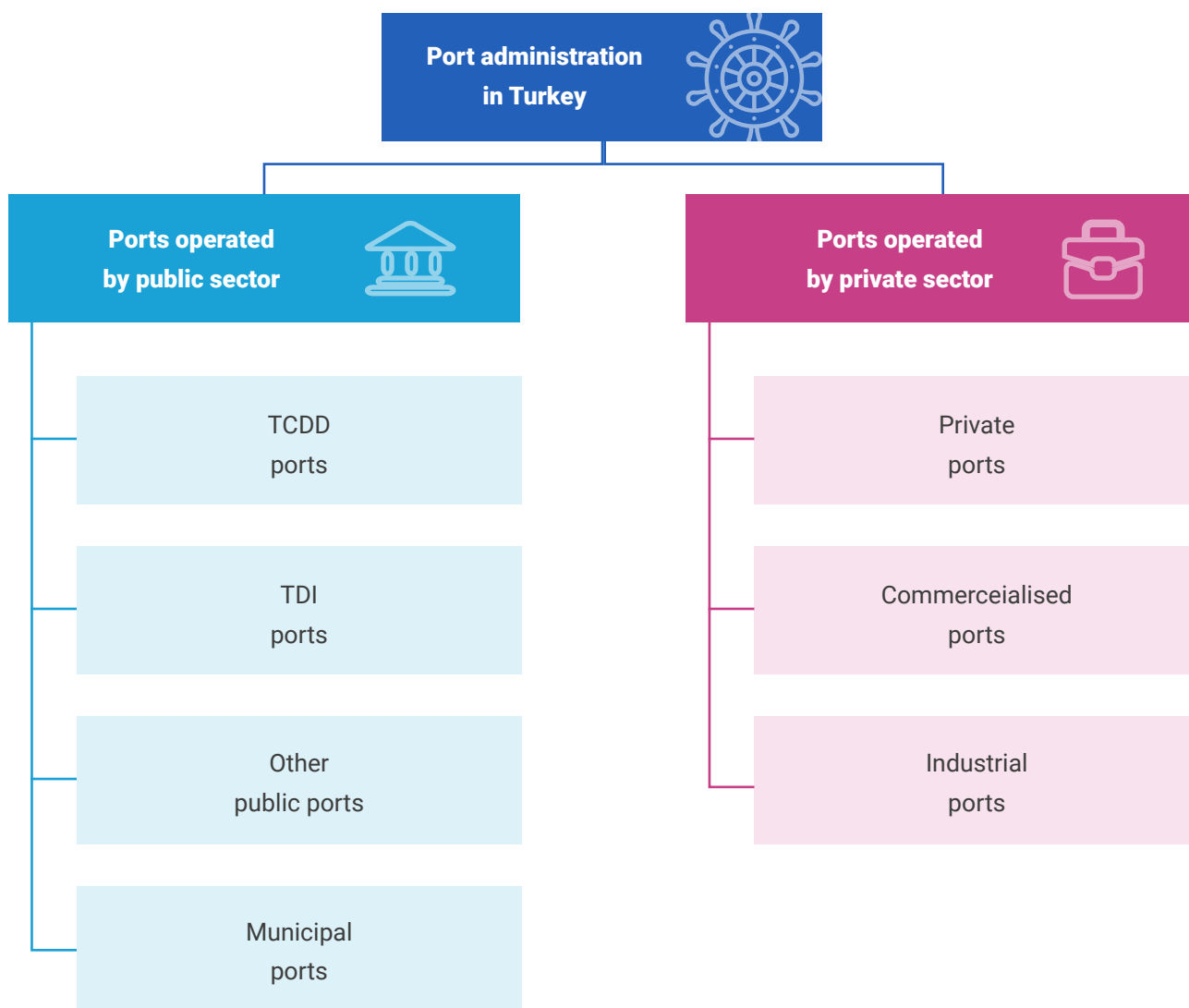


Figure 8 | Source: SRM on Karatas Cetin, 2012 & Yeni, 2017

As can be seen from the classification, there are 2 main operator groups in Turkey. In addition, public ports operated by the private sector due to the privatisation process can also be included in the private category due to their operators.

The public authorities operating the ports in Turkey have changed since the establishment of the Republic in 1923. In the 1980s, it took its present appearance. Today, publicly owned ports in Turkey are owned by two state economic enterprises. These enterprises are called Turkish State Railways (TCDD) ports and Turkish Maritime Administrations (TDI) ports.

In the 90s, private capital and know-how development and private port operations started in Turkey. With the increase in foreign trade, private ports started to be established as an alternative to public ports that were insufficient to meet the increasing cargo volumes. In this very process, the public sector decided to privatise. Thus, the commercialisation process of TCDD and TDI ports started in this way. TCDD and TDI ports are ports whose operating rights have been transferred to the private sector for a certain period of time. Like TDI ports, TCDD ports were commercialised by the method of transfer of operating rights, but the periods, however, are longer than TDI ports ranging between 36 and 39 years due to investment requirements. Concession agreements for TDI ports started to be signed in 1997 and for TCDD ports in 2007.

Today, almost all of the ports owned by these companies are operated by the private sector.

Basic information about these enterprises is as follows:

- **Turkish State Railways (TCDD) ports:** These are ports operated by TCDD, which is a State Economic Enterprise. Today only Haydarpaşa and İzmir Alsancak port are under the control of TCDD. Other ports of TCDD, Mersin, İskenderun, Bandırma, Derince and Samsun have been commercialised. The common feature of these ports is that they all have railway connections and have relatively large port areas. Today, the economic and commercial value of these ports located in the centres of big cities is quite high. Therefore, the concession fees of these ports are quite high compared to TDI ports.
- **Turkish Maritime Administrations (TDI) ports:** As another State Economic Enterprise, TDI has controlled many ports in Turkey. Most of the high capacity TDI ports have been commercialised (Trabzon, Rize, Sinop, Alanya, Marmaris, Marmaris, Kuşadası, Dikili, Hopa, Antalya, Çeşme, Tekirdağ ports). Although these ports are located in city centres, they are not as high capacity as TCDD ports. In addition, there is no railway connection in these ports and the industry in the hinterland shows a more limited development. Therefore, the commercial volumes of these ports are relatively low.

Apart from these two large public structures, there are other public operating structures.

These are as follows:

- **Other public sector ports:** These are ports operated by other state-owned enterprises except TCDD and TDI such as as Petroleum Pipeline Cooperation (BOTAŞ) and Turkey Hard Coal Enterprises (TTK). These ports handle the loads of the factory/mine/industry to which they are partly or fully connected.
- **Municipal ports:** Small-scale ports operated by municipalities such as Ayvalık, Gemlik Belediye and Ordu. The number of these ports is quite small.

Today, the dominant party in port management activities in Turkey is private enterprises. These enterprises operate in a fully competitive environment according to private sector dynamics. On the other hand, industrialized ports primarily serve the industry they serve. These ports provide port services to 3rd parties if the factory management approves, thus generating additional income.

As of 2023, the cargo volume of the ports operated by the public sector is below 5% of the total cargo and this ratio tends to decrease day by day. In the near future, it can be expected that the public sector will completely withdraw from port operations in Turkey.

3. Conclusion and discussion

This study evaluates port management in Turkey, a newly industrialised country with a high growth rate in terms of trade and cargo volume. The geostrategic position of Turkish ports in international maritime trade routes and the actual cargo volumes are also analysed. As can be seen, the ports in Turkey serve not only the local industry but also transit cargoes, especially towards the Black Sea.

Turkey, as a newly industrialising and developing country, has a steady increase in trade volume and cargo transport. This increase leads to a significant growth in the logistics sector. Therefore, the need to invest in port infrastructure is increasing day by day. As a result of the significant increase in cargo volumes, global terminal operators are also interested in and directly investing in Turkish ports. Today, especially container terminals are predominantly operated by global terminal operators and these investments can be made through new port investments as well as through the acquisition of an existing port.

Unlike the past, port investments in Turkey are now carried out by the private sector. Public institutions related to the port sector act as supervisors and regulators of competition. At this point, some expectations of the private sector emerge and the most important of these is that the public sector should establish rules to ensure the continuity of port investments. For this purpose, the national port policy, all legal regulations and bureaucracy related to ports should be re-evaluated and redesigned.

The ownership structure of ports in Turkey has changed significantly since 1997 as presented in this paper. In the last two decades, port transfer activities have mainly revolved around the transfer of operating rights from public to private entities for a certain period of time without transfer of ownership and almost all public ports have been commercialised. New entrepreneurs operating privatised ports have upgraded existing terminal infrastructure and equipment or built new facilities. In the near future, it can be expected that there will be no more publicly operated ports and that ports will be fully operated by the private sector.

Chapter 8 | Sustainable strategies for a resilient future: Egyptian investments in port development

The maritime sector's importance is increasing with time, and any deficiency in this sector has a large impact on the global economy. Due to the importance of this sector, it witnesses development to serve global needs, which include: Environmental factors, climate change considerations, economic growth and trade facilitation, social responsibility, and legal and regulatory compliance. This development should be sustainable and resilient, in this regard, Egypt is working hard to achieve sustainable development goals with all its elements and within the framework of implementing Egypt's Vision 2030. The development of maritime and river transport sector in Egypt has been a top priority in the government's policy since 2014, because of its many positive effects on creating a boom in Egypt's trade with the countries of the outside world, as this is considered the main gateway to achieving major recovery in the Egyptian economy. Egypt has many commercial ports and 3,000 kilometers of coastal areas, in addition to its strategic and geostrategic location at the crossroads of Africa, Asia, and Europe, in addition to owning the most important navigational channel in the world, the Suez Canal, which it is working to exploit optimally in a way that attracts investments, as development is carried out per the latest international systems so that Egypt will become a global hub for trade and logistics.

The country takes pride in owning 15 ports on the Mediterranean Sea, 33 on the Red Sea, and 44 additional ports supporting key sectors like fishing, mining, petroleum, and tourism¹. Approximately 90% of Egypt's international trade is seaborne, with the port of Alexandria handling around 60% of foreign trade.

Egypt's Vision 2030 aims to enhance its maritime sector by modernizing infrastructure, increasing capacity, and attracting foreign investment in shipbuilding and vehicle manufacturing to boost its economy and global trade relations. The Egyptian government aims to develop the Suez Canal Economic Zone to attract foreign investment and strengthen industrial, commercial, and residential developments. Egypt's maritime industry is a key driver of economic growth, with further enhancement it can secure higher economic revenues and investment opportunities.

¹ Maritime Transport Sector (2023), Egyptian Maritime Transport Sustainable Development strategy up to the year 2030, 10 May 2024 [<https://www.mts.gov/ar>].

The key impacts of Egypt's investments in port development include:

- **Enhancing Egypt's strategic position as a global maritime trade hub:** besides Egypt's ownership of the Suez Canal and its extensive coastlines on the Mediterranean and Red Seas position there are ongoing investments to modernize and expand ports like Alexandria and Damietta aim to increase capacity, attract more trade, and solidify Egypt's role in global supply chains.
- **Boosting the country's blue economy and economic growth:** developing ports infrastructure and maritime sector is a key part of Egypt's Vision 2030. The government, with the help of the private sector, plans to transform ports into smart, multimodal hubs and increase their global competitiveness. By achieving the expected goals it is expected to raise profits, reduce transport costs, and enhance the competitiveness of Egyptian exports. The blue economy is projected to contribute more significantly to Egypt's GDP, creating thousands of direct and indirect jobs. Furthermore, Egypt is formulating a National Strategy for the Blue Economy to maximize the management of marine natural resources and address the impacts of climate change.
- **Attracting foreign investment and strengthening international trade ties:** Egypt is signing agreements with investors from different countries to boost trade through its ports, leveraging its strategic location. The Damietta port expansion, supported by an international consortium, aims to increase the port's competitiveness as a regional hub. Damietta has access to the Nile River as well as the Mediterranean which makes it a hub between the African countries and European continent. Overall, Egypt's substantial investments in port development are expected to solidify the country's position as a global maritime trade center, drive economic growth, and enhance the efficiency and sustainability of its maritime industry.

1. Sustainable and resilient practices in port development

Sustainability and resilience are important concepts that humanity in general should be keen to apply to different sectors of life and specifically in the maritime sector and port development to ensure their long-term viability and adaptability. To achieve economic growth and environmental protection, sustainability and resilience can be applied to ports in different aspects, here are some of the sustainability and resilience applications²:

- **Social aspects:** Ports can prioritize the well-being of local communities by minimizing noise pollution, and creating job opportunities. Sustainable port development also involves engaging with stakeholders to ensure their concerns and needs are considered and addressed.

² Buzinkay M. (19 February 2024), Ports development with sustainability in mind [<https://www.identecolutions.com/news/ports-development-with-sustainability-in-mind>].

- **Economic factors:** Sustainable ports aim to be economically viable in the long term. This involves adopting efficient operational practices and diversifying their activities to reduce reliance on a single sector or commodity.
- **Resilience:** refers to a port’s ability to withstand and recover from disruptions, whether natural disasters, climate change impacts, or other crises cause them. This includes:
 - » Risk assessment and planning: Ports need to identify potential risks and vulnerabilities, such as rising sea levels, extreme weather events, and/or geopolitical uncertainties. Some of the risks cannot be prevented but can be mitigated by identifying the risks and by appropriate planning to minimize or eliminate the impacts.
 - » Business continuity: Ports should be designed for non-stop operation and if any disruption occurred operation should be quickly restored. To assure the operation continuity some measures should be implemented as backup power systems, redundancies in equipment and communication networks, and coordination with emergency services.
 - » Collaboration and information sharing: through collaboration among ports, government agencies, private sectors and other stakeholders. Sharing best practices, lessons learned, and information on emerging risks can help ports collectively improve their resilience strategies and response capabilities.

Sustainable port development aligns with the United Nations’ Sustainable Development Goals (SDGs) and aims to achieve economic, environmental, along with social sustainability as mentioned earlier. This will lead to one of the most important programs that ports in general, and in Egypt in particular should consider while applying sustainable practices, which is the World Port Sustainability Program (WPSP), which is a program constructed by the International Association of Ports and Harbors (IAPH) and derived from the United Nations’ Sustainable Development Goals. The WPSP program aims to support global ports’ leadership concerning the Sustainable Development Goals of the United Nations. The program empowers the port community worldwide to engage with business, governmental and societal stakeholders to create sustainable added value for the local communities and wider regions in which their ports are embedded. The program covers six areas (originally, it covered only five but was updated in the year 2022³, after the Coronavirus hit as a consequence of the changed world after the pandemic), these areas are:



³ Harbors T.I. (27 March 2018), WPSP areas of interest, 2 [retrieved May 2024, from World Port Sustainability Program: <https://sustainableworldports.org/>].

2. Overview of the Egyptian port development strategy

As discussed previously Egypt is investing in the maritime sector and adopting several strategies to achieve the required development. These strategies include:

Enhancing Port Infrastructure and Efficiency: Egypt is investing in improving the operations' infrastructure of its major ports, such as Alexandria, Damietta, and Port Said. This includes expanding container handling capacity, dredging navigational channels, upgrading storage facilities, and enhancing customs and trade facilitation processes⁴.

Implementing Sustainable Practices: by using renewable energy, and implementing water recycling systems. There have been different agreements between the Egyptian government and other public and private stakeholders to initiate green hydrogen production in Egyptian ports and use green and renewable sources of energy. Egypt is currently focusing its efforts on producing green hydrogen to become a major exporter. These efforts come as a part of a global trend towards decarbonization and the transmission of renewable energy sources. As Egypt has abundant clean energy resources, including wind and solar energy; thus, it aims to generate 42% of its electricity from renewable sources by 2035. Furthermore, Egypt has signed new 7 cooperation agreements related to the green hydrogen production field and renewable energy, with 7 international developers. This represents a new step in the series of investment partnerships with major international companies, to launch such projects in the Suez Canal Economic Zone, explaining that the agreements include expected investments for the pilot phase of about 12 billion dollars, in addition to about 29 billion dollars for the first phase, bringing the total investments to about 40 billion dollars within 10 years.

Establishing Free Trade and Economic Zones: Egypt is creating free trade zones and special economic zones near its ports to attract investments, boost exports, and diversify economic activities. Key examples include the Suez Canal Economic Zone and free trade zones in Alexandria, Damietta, and Port Said.

Integrating Ports into Global Trade Networks: Egypt aims to transform its ports into global logistics hubs by improving their connectivity, leveraging the strategic location of the Suez Canal, and attracting a larger share of transit containers from competing regional ports. In addition to the location of ports on the Egyptian coasts and with the country owning 53 seaports, including 15 commercial ports and 38 specialized ports Developing the blue economy can help Egypt achieve goals like food security, poverty alleviation, improved living standards, increased incomes, and job creation, Egypt is implementing comprehensive plans to develop its ports, starting with the Alexandria Port, to boost its competitiveness and role in global trade and working on the Development of multimodal transport, smart port technologies.

⁴ Bevan A. (2014), Mediterranean Containerization. *Current Anthropology*, 55(4), 387–418.

The Egyptian government, with consideration of the previously mentioned strategies, has consolidated a general policy for developing the port sector until 2030⁵, which consists of:



Supporting the role of the private sector participating in developing transportation systems and providing facilities and services so that it can play its role by investing or participating in transportation sector projects in general.



Strengthening the vital role of maritime transport, as Egyptian seaports are the country's lifeline from an economic standpoint, due to their connection to foreign trade, as they dominate the majority of goods transport activities.



Achieving a balance between different means of transport and setting regulations to governing it, with attention to multimodal transport, especially sea ports, railways and river transport.



Strengthening human resources through developing training and motivation programs, especially for professional cadres working in the Ministry of Transport.



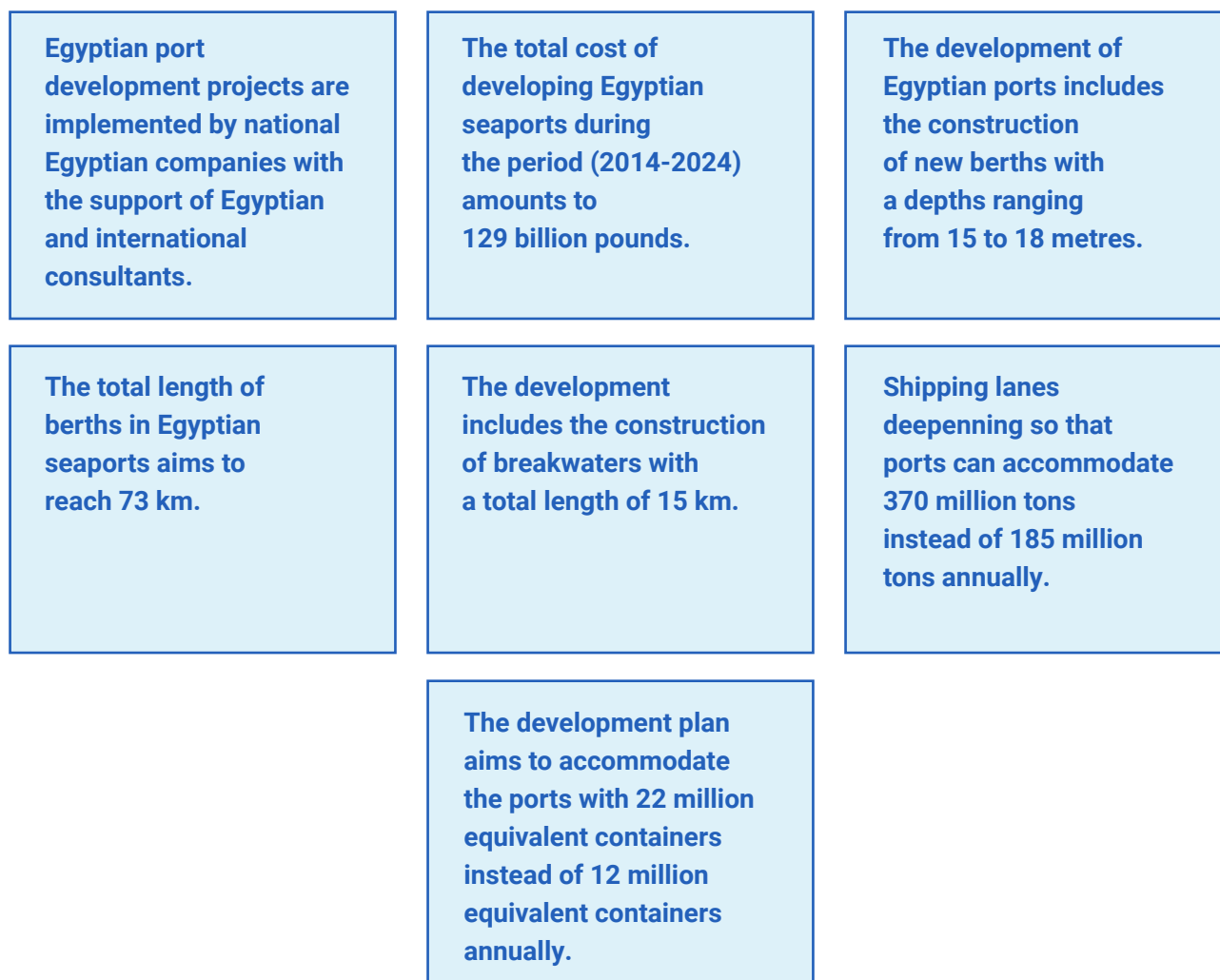
Updating legislation and setting regulations that guarantee freedom of competition in the field of providing transportation services.



Setting environmental goals that promote sustainable development of transport, especially with regard to reducing marine and river pollution.

⁵ State Information Services (8 May 2023), Strategy for developing maritime and river Transport [<https://sis.gov.eg/?lang=en-us>].

More specifically, the Egyptian government is currently working on a more target-related port development plan that is being carried out following the latest international systems, so that Egypt can achieve its goal of becoming a global centre for trade and logistics, while Egypt's strategic location is being better exploited, this plan includes the following main features⁶:



3. Challenges and opportunities facing Egyptian port development

Egypt faces several challenges related to the development of its port. Some of the key challenges include:

- **The intensity of competition** regionally and globally in the field of the maritime transport industry in general, especially in light of the volatile political and economic situation in the Arab region.
- **Lack of funding** required to develop, operate and maintain the port infrastructure, and to burden the ports with the financial burdens resulting from construction, development and maintenance projects.
- **Climate Change Resilience:** Egyptian ports are vulnerable to the impacts of climate change, including sea-level rise, extreme weather events, and changing weather patterns. Ensuring port infrastructure

⁶ Sobhy R. (September 2023), IDSC Policy Perspective, in Afify A., Ed.) Transforming Egypt into Global Trade Hub (45), p. 32.

and operations are resilient to these challenges requires incorporating climate change adaptation measures, conducting risk assessments, and implementing robust contingency plans⁷.

- **Human Resources and Skills Development:** although the Egyptian population is 60% youth, however, it still lacks a skilled workforce with sufficient human resources with expertise in port operations, logistics, and maritime services, and more importantly human resources that are trained for the future profiles and new professions emerging in this constantly and rapidly changing field. This is highly critical for the sustainable growth of Egypt's ports. Investment in training programs, educational institutions, and capacity-building initiatives is a must to address this challenge.
- **Land and Space Constraints:** many Egyptian ports face land and space constraints due to urbanization and competing land uses. Acquiring land for port expansion or developing port-centric industrial zones and hinterlands can be challenging. This is clearly shown in the case of Alexandria Port Authority as shown in the figure below. Accordingly, effective land-use planning and collaboration with relevant stakeholders are essential to optimize land utilization and address space limitations⁸.

At the same time, investing in Egyptian ports' development can benefit from several potential opportunities for growth and innovation in port development. Some of these opportunities include:

- **Renewable Energy Integration:** opportunities to integrate renewable energy sources into their operations. This can involve installing solar panels on port buildings, utilizing wind energy, or exploring the potential for offshore wind farms. Renewable energy integration can reduce greenhouse gas emissions, enhance energy efficiency, and contribute to Egypt's renewable energy targets.
- **Green Port Initiatives:** implementing green port initiatives can enhance sustainability in port operations. This can include the use of shore power to reduce ship emissions while at berth, implementing energy-efficient lighting systems, adopting eco-friendly practices for waste management and recycling, and utilizing electric or hybrid vehicles and equipment within port premises.
- **Eco-friendly Infrastructure:** developing eco-friendly infrastructure within ports can contribute to sustainability. This can involve the construction of green buildings, incorporating sustainable design principles, and implementing green roof systems to reduce heat island effects and manage stormwater runoff.
- **Smart Port Technologies:** embracing smart port technologies can enhance efficiency and sustainability. This can include the use of Internet of Things (IoT) devices and sensors for real-time monitoring of cargo, optimizing berth allocation and vessel traffic management systems, implementing smart grid solutions for energy management, and utilizing advanced data analytics for predictive maintenance and optimization of port operations.
- **Port Industrial Zones:** developing port-adjacent industrial zones can create opportunities for sustainable economic growth. These zones can attract industries that complement port activities, such as logistics, manufacturing, and assembly.
- **Collaboration with Research and Academic Institutions:** collaborating with research institutions and academia can foster innovation in port sustainability. Establishing partnerships for research and development projects can lead to the development of new technologies, sustainable practices, and solutions tailored to the specific challenges faced by Egypt's ports.

⁷ Sharaan M., Ibrahim M.G., Moubarak H., ElKut A.E., Romya A.A., Hamouda M., Soliman A., & Iskander M. (2024), 'A qualitative analysis of climate impacts on Egyptian ports', in *Sustainability* 2024, 16(3):1015 [<https://doi.org/10.3390/su16031015>].

⁸ Logistics Cluster (2022), Egypt Port of Alexandria [<https://dlca.logcluster.org/211-egypt-port-alexandria>].

- **Circular Economy Practices:** embracing circular economy principles can promote resource efficiency and waste reduction in port operations. This can involve implementing recycling programs, encouraging the reuse and refurbishment of materials and equipment, and exploring opportunities for waste-to-energy conversion. By adopting circular economy practices, ports can minimize their environmental footprint and contribute to a more sustainable economy.

4. Investment in Egyptian shipping and port technologies

Investments in innovation are fundamental for the development of Egypt's maritime and port enterprises. Innovation can expand the area's efficiency, well-being, and ecological supportability. Along with private sector accomplices, the Egyptian government has been putting resources into different advancements to improve the presentation of the shipping and port industry. Here are a portion of the mechanical ventures made by Egyptian transport and ports:

- Efforts and resources have been carried out for **mechanization of different sectors** in the port dealing with the handling of goods.
- The overhauling of the Port of Alexandria incorporates the establishment of a **robotized freight dealing framework**. This will further develop freight dealing with productivity and cut transport holding up times.
- The dependency on innovation did not stop at the mechanization of goods handling but also became **dependent management systems either partially or fully computerized systems** for higher safety, and efficiency.
- The use of **Vessel Traffic Management System (VTMS)** to build the security of vessels crossing the Suez Canal. The VTMS licenses the observation of vessel developments, weather patterns, and different factors influencing transport security.
- **Container Tracking System Frameworks:** the public authority has put resources into holding global positioning systems (GPS) to build the security of items conveyed through ports. The GPS beacons grant constant observation of product developments and help in the counteraction of freight burglary and pirating.
- **Computerized devices to smooth out port activities and increase proficiency:** one of the computerized systems used is the Port Community System (PCS) is a computerized stage that brings together all port-related operations and permits partners to share data.

5. Investment in Egyptian shipping and port sustainability

As mentioned earlier, Sustainability has turned into a vital part of the overall maritime and port industry's development, and Egypt is no special case. The Egyptian government, in cooperation with private sector partners, have been putting resources into various projects to improve the area's sustainability. Below is a portion of Egypt's shipping and port investments in sustainability programs:

- The public authority has put resources into **green ports** to reduce the ecological effect of port tasks. To decrease fossil fuel byproducts, the Port of Alexandria has executed different green measures, including the utilization of electric vehicles and sun-based controlled lighting.

- Regarding the sustainability of different ports operation efforts can be significantly seen in **lowering carbon emissions**. The Sokhna Port has raised a sun-powered energy framework that produces a fifth of the port's power prerequisites. Investments in innovation for Egyptian maritime transport and ports mean building the area's efficiency, security, and natural maintainability. Nonstop investment in technology and innovation is expected to guarantee the area's drawn-out competitiveness and sustainability.
- **Environmental Management System**: to diminish the natural effect of port activities, the public authority has been supporting the improvement of the Environmental Management System (EMS) in ports. The EMS assists port administrators with perceiving natural worries and direct countermeasures.
- **Waste Management**: The public authority is putting resources into waste management to decrease the effect of port activities on the climate. The Port Said East Container Terminal has executed a waste administration framework that takes into consideration the partition and reusing of port-created trash. The public authority is pushing social obligation among the maritime and port industries. For example, the Suez Canal Authority has made a program that gives medical care administrations to occupants of canal-side settlements.
- **Sustainability ventures** for Egyptian maritime transport and ports plan to encourage financial development, social obligation, and environmental sustainability. Supported investments in sustainability are expected to guarantee the area's drawn-out competitiveness and viability.

6. Conclusion

It is thought that the investments in Egypt's shipping and seaports field would assist the country's competitiveness in the global transport industry, attract real shipping business, and open work doors.

Despite the privilege of the geopolitical position of Egypt, there are some shortcomings facing the maritime industry in Egypt, however, Egypt managed to successfully address most of the problems facing the evolution of maritime sector and work on the proposed solutions.

Egypt aims to maintain its position as a key transport player and boost economic growth. Egyptian maritime and port administrative system investments are intended to attract new investments, improve area proficiency, and simplify operations. Investment in the administrative climate is targeted to improve the business environment and boost local investment. Framework, innovation, and human resources must be continuously invested in, as well as development-advancing regulations and policies.

The Port Development Strategy implemented by the Egyptian Government aims to enhance efficiency, security, and natural maintainability. The long-term competitiveness and survival depend on continued investment in technology and innovation. Moreover, financial development, social responsibility, and environmental sustainability are the goals of Egyptian maritime transport and port sustainability ventures. These noticeable achievements in the Egyptian maritime sector demonstrate the country's dedication to improving its adequacy, efficiency, and competitiveness. Consistent investment and development are needed for controlled growth and progress. The Egyptian shipping and port business's future is bright if innovation, sustainability, infrastructure, and combined efforts are pursued.

Chapter 9 | Requirements for the soft environment in the globalization strategy of port and shipping enterprises

1. External environment faced by port and shipping companies in globalization operations

1.1 Macro environment faced by port and shipping companies in globalization operations

Since economic globalization, port and shipping companies have been expanding their business scales and reducing operational costs by turning their attention to overseas, seeking broader development space through implementing globalization business strategies. However, compared to the domestic market, the complex and variable international environment has brought significant challenges to the globalization operation strategies of port and shipping companies. Especially impacted by the global Covid-19 pandemic, the uncertainty of the world economy has increased, further deepening the macro-environmental impact on the globalization strategies of port and shipping companies. Overall, the macro environment affecting the globalization business strategies of port and shipping companies mainly includes political, economic, financial, legal, and socio-cultural environments.

1. Political environment

A stable political environment is the primary condition for the globalization business strategies of port and shipping companies. Against the backdrop of a pessimistic global economic situation, anti-globalization, and prominent historical issues, political risk has become one of the most unpredictable risks for overseas operations of port and shipping companies. Potential political risks can at least cause delays or interruptions in investment projects of port and shipping companies, and at worst lead to significant asset losses.

Affected by political systems, national consciousness, national security, and domestic political situations, political risks are common worldwide, but the political risks faced by different countries or regions vary significantly. The political risks in developed countries or regions mainly stem from political systems and national security. Due to relatively stable political situations, large-scale confrontations and terrorist attacks are less likely in developed countries or regions, which is favorable for port and shipping companies to implement globalization business strategies. However, due to certain differences in political party systems of different countries or regions, changes in ruling parties and policy stances during globalization operations could still bring uncertainties to the globalization business strategies of port and shipping companies. Less developed economies, with their immature market economies, are in dire need of foreign investment, bringing opportunities for port and shipping companies to expand overseas, but their political risks are complex. Firstly, less developed economies face political risks caused by political party systems. Secondly, the impact of political turmoil and terrorism in less developed regions is more apparent. Lastly, severe war risks exist in less developed regions.

2. Economic environment

An open economic environment is the precondition for the globalization business strategies of port and shipping companies. As economic globalization deepens, countries around the world are increasingly integrated into the global production system, and a highly open economic environment has become an important precondition for a country to participate in global competition, also creating favorable conditions for port and shipping companies to advance their globalization business strategies.

The level of economic development in host countries has a significant impact on the globalization operations of companies. Countries and regions with higher levels of economic development usually have a more mature and complete industrial system, a more systematic and complete legal, financial, intermediary, and other supporting services, a more robust and stable government, legal, and market environment, providing continuous market demand and relaxed operating conditions for port, which help port and shipping companies to better achieve their strategic objectives in globalization. According to the “Xinhua-Baltic Shipping Development Index Report” the world’s leading international shipping centers are mostly concentrated in countries and regions with higher levels of economic development, such as Singapore, Shanghai, and Hong Kong in Asia, London and Rotterdam in Europe, and New York in North America. International shipping centers are usually the preferred locations for port and shipping companies to implement their globalization business strategies. Priority layout in these countries or regions is mainly due to the strong local demand for freight transport and shipbuilding, a complete port and shipping industry system, a perfect supporting service system and an excellent integrated business environment, which provide assistance for port and shipping enterprises to accelerate their globalization strategy.

Additionally, the closeness of the host country’s economy to the world economy is one of the important factors for port and shipping companies to choose overseas markets. In order to meet the needs of international competition, countries with open economies are usually more aligned with international rules in terms of institutional systems and policy tools, providing a more free, fair, and transparent development environment for companies’ globalization operations. In the long run, host countries with high economic outward orientation can provide multinational companies with convenient trading platforms and open communication environments, facilitating the international development of business operations. For example, Singapore and Hong Kong, China have quickly integrated into the global economic system with their highly open economic systems, becoming important bases for the globalization operations of port and shipping companies. However, a high degree of economic outward orientation also means that the country or region is more susceptible to the impact of international political and economic situations and more vulnerable to shocks during global economic crises, posing potential risks to the globalization operations of port and shipping companies.

3. Financial environment

A developed financial environment is a key condition for the globalization business strategies of port and shipping companies. The port and shipping industry is capital-intensive. A better financial development scale in the host country can effectively reduce investment risks, and a perfect financial ecological environment can reduce investment resistance and improve investment efficiency.

However, as the global economic downturns, some countries have adopted relatively strict financial regulatory measures to stabilize their domestic economies. For multinational companies, the host country’s strict investment and financing environment and capital inflow and outflow controls may have varying degrees of impact on their production and operation activities. Additionally, due to the deepening

development of global economic integration, the economic ties between countries are very close, and financial risks can often spread at a global level when a crisis is triggered. For example, the 2008 U.S. subprime mortgage crisis led to a global financial crisis. Affected by this, the global production and trade pattern underwent significant changes, emerging economies developed rapidly, developed countries' trade protectionism gradually emerged, and trade frictions with emerging economies escalated.

4. Legal environment

A sound legal environment is the guarantee condition for the globalization business strategies of port and shipping companies. The host country's sound and complete judicial system can effectively regulate corporate behavior, maintain market fairness, and protect the legitimate interests of port and shipping multinational companies in local operations.

Due to differences in the execution power and hidden clauses of judicial systems and laws and regulations at the practical operation level, there are still significant differences in judicial protection, operation efficiency, and other aspects, affecting the globalization operations of port and shipping companies. In recent years, a considerable number of developing countries have hosted overseas investments by multinational companies. As the Global Rule of Law Index shows, these countries often face relatively backward issues in the construction of the rule of law, making it difficult for multinational companies to accurately judge the safety of investment activities in these countries. Hidden regulations also exist in some developed countries and developing countries with stable political situation. These countries, for the purposes of protecting national interests and transferring domestic conflicts, may also modify or enact temporary laws and regulations to restrict foreign companies, especially in industries related to national security, competitiveness, and commercial cooperation in related infrastructure.

Host countries generally have strict management regulations for the overseas business of multinational companies, especially in terms of environment, labor, intellectual property, and business modes. In recent years, port and shipping multinational companies have increased their investment and construction in overseas ports, undertaking local port expansion and renovation projects. During the specific project construction process, port and shipping multinational companies may easily encounter environmental protection issues. Some companies may not have a deep understanding of the host country's relevant environmental protection regulations or may not have paid enough attention, possibly violating local environmental protection regulations. Labor risk is a common issue faced by port and shipping multinational companies in overseas investments. Some countries, in order to ensure domestic employment, may propose regulations on the employment ratio of foreign employees. Intellectual property protection is one of the important ways for the host country to maintain market fairness. For example, the Singapore government pays great attention to intellectual property protection, actively creating a policy and business environment conducive to the industrialization of intellectual achievements. Its related laws mainly include the Patent Act, Trademark Act, Registered Design Act, Copyright Act, etc., and promote healthy market competition by implementing the Competition Act to prohibit certain business practices that restrict market competition.

5. Socio-cultural environment

An inclusive socio-cultural environment is an important condition for the globalization business strategies of port and shipping companies. Cultures vary around the world, with different ideologies, social customs, religious etiquettes, etc., and attitudes towards globalization business strategies are not consistent. According to a survey in Canada, cultural conflicts caused 70% of all failed joint ventures in the country. When implementing globalization business strategies, port and shipping companies must cautiously

handle cultural issues and adopt appropriate localization strategies to reduce potential cultural conflicts. Due to differences in social culture, countries around the world have different thinking patterns, work styles, language environments, etc., which may bring potential development opportunities to companies' globalization operations but also easily cause cultural conflicts, bringing immeasurable risks to companies' overseas operations. In the process of implementing globalization business strategies, the external cultural environment of companies, such as social values and cultural ethics, will directly affect the strategic choices of companies. If managers do not appropriately and fully utilize the differences in the host country's culture for strategic deployment, they may lose potential customers and miss development opportunities. The internal cultural environment of companies, such as work styles and customs, will affect the daily operations of companies. Improper handling may cause employees to be unable to truly integrate into the work environment, becoming unable to support the corporate culture, making it difficult for the company to "root" locally.

1.2 Micro environmental faced by port and shipping companies in globalization operations

In global operation strategy beyond macro level influences, it requires attention to specific operational impacts from market, policy, governmental, and talent environments. Unlike macro environments, micro-environments directly impact the overseas production and operations of port and shipping companies. For instance, market access determines a company's eligibility to enter a host country's market and is a focal point at the operational level of globalization strategies. The World Bank's "Doing Business 2020" report showed that the economic prospects of many countries were not optimistic as the global economic downturn became more apparent in recent years. Many countries were improving business convenience and enhancing attractiveness to foreign companies, thereby actively promoting sustainable economic development.

1. Market environment

The market environment mainly refers to the regulations of host country related to market access, equity ratio, and qualification review that foreign companies face when entering a country. Globally, standards for market environment convenience include openness and transparency of investment policies and management; predictability and consistency of investment-related policies; stability of investments & protection of property safety and investments; efficiency and effectiveness in handling investment procedures which creates a more attractive investment environments through simplifying investment regulations, accelerating investment approval processes, and reducing business costs; and fairness of disputing resolution channels.

To promote foreign trade and investment development, countries now are increasing openness to foreign investment while protecting domestic industries, adopting a negative list management model to relax and simplify foreign investment access. Right now, more than 70 countries and regions globally have adopted this model, including the United States, Japan, European Union countries, and Saudi Arabia, achieving positive outcomes. China introduced the foreign investment access negative list management model in 2013, based on the establishment of free trade pilot zones. In the 2020 version of the national negative list which went through several amendments, the item number for foreign investment access was reduced to 33, and the number was dropped to 30 for those in free trade pilot zones.

However, with the noticeable global economic downturn and the rise of trade protectionism, many countries have raised requirements for foreign investment access or even prohibited foreign capital from entering their markets for national security reasons, affecting port and shipping companies' overseas

market expansion. For example, host countries may impose foreign investment equity ratio restrictions for national interest purposes, keeping control of related business activities in domestic companies. Equity distribution affects the control over the company and involves profit distribution, especially in areas and projects with wide-ranging interests and significant impact on national development, where host country governments pay more attention to equity ratio regulations. Moreover, due to discrimination and labeling of multinational companies from their home countries, host countries set barriers to the overseas operations of port and shipping multinational companies.

2. Policy environment

The policy environment refers to the policies and measures that a host country enacts to achieve its economic development goals. Particularly for developing countries, infrastructure construction and industrial development rely on substantial capital investment and technical support. Enacting preferential policies to introduce foreign capital and technologies is crucial to achieve economic development goals. To be in line with the needs of its own economic development, the government of host countries often provide more favorable and convenient operation conditions for foreign investors to enter the local market through perspectives of promoting the upgrading of the industrial structure, adjusting the balance of market supply and demand and guiding industrial development through industry policies. They encourage and attract the agglomeration of foreign-funded enterprises, so that they can form new points of economic growth and achieve the sustained and healthy development of the economy. For example, the rapid development of the Singapore International Maritime Centre benefited from its aggregation of numerous small and medium-sized companies providing services to the shipping industry. To support the development of small and medium-sized maritime companies, Singapore has introduced various special support programs. The core concept is to create a dynamic ecosystem and promote the formation of a maritime community. These programs include tax reduction and preferential tax rate reward schemes for the maritime sector supported by fiscal measures, maritime cluster human resource development programs, and maritime cluster business development and productivity improvement programs supported by joint funding.

3. Governmental environment

A convenient governmental environment is not only an important manifestation of economic soft power but also a key element of national competitiveness. The governmental environment includes work systems, approval processes, efficiency, and integrity of civil servants and administration in accordance with the law. The quality of the governmental environment directly affects the satisfaction degree of companies with local production and operations. Singapore, Hong Kong, China, Denmark, the United States, and other countries and regions have established relatively complete governmental systems through years of development, leading the world in government transparency, rule-of-law administration, and operational efficiency. In recent years, with the rapid development of emerging economies, many countries have made significant progress in the construction of government affairs. For example, China has actively promoted the “one-network, one-door, one-time” reform of governmental services, improved the “one-time completion” capability for high-frequency matters that meet conditions, and taken measures such as “instant approval” to significantly enhance the governmental environment and attract foreign investment. With the rapid development of information technology, e-government has become a powerful tool for improving the governmental environment, attracting widespread attention from governments worldwide. The advantages of e-government are manifested in various aspects, including reducing processing time and costs and creating a more efficient and convenient environment for company production and

operations. For example, after the electronation of business establishment processes, entrepreneurs can complete certification procedures using electronic devices. Electronic tax filing simplifies taxpayer procedures through paperless and online declaration methods. Since the Covid-19 pandemic, foreign companies registering in China have faced numerous obstacles. To optimize and solve difficulties in business establishment and operation, China has accelerated the “full-process online” service reform, expanding the popularity and coverage of e-government, receiving welcome and recognition from foreign companies.

4. Talent environment

When a port and shipping company develops overseas markets, in addition to considering factors such as the market, policies and government affairs of the country or region in which it operates, talent is also one of its key concerns. For port and shipping companies, high-level international talent is an indispensable part of implementing globalization strategies. The convergence and utilization of international human resources by host countries and the ease of free movement of personnel all play an important role in the smooth promotion of the globalization business strategy of port and shipping enterprises.

Facing the complex political, economic, financial, legal and socio-cultural environments of the host countries, the implementation of the globalisation strategy of the port and shipping enterprises requires that the relevant talents not only have strong professional abilities, but also have an international vision. They need to seek a balance between the complex environment and the enterprise strategy, understand and implement the objectives, directions and priorities of the enterprise globalisation strategy, grasp the company’s value concept, corporate culture and management style, and make the company’s globalisation strategy integrated with the host country’s environment. International talent in the host country has a natural advantage in understanding cross-border management policies and laws, playing a bridge role between the host country and the parent company, and helping the company’s globalization strategy progress smoothly.

The implementation of port and shipping companies’ globalization strategies involves extensive cross-border personnel exchanges, including project inspections, technical exchanges, negotiations, and contract signings. Host country regulations on foreign business personnel entry procedures, permanent residency application conditions, and recognition of foreign professional service qualifications have a significant impact on personnel mobility. Strict regulations on cross-border personnel movement may affect project implementation progress, company management, and increase company operation and management costs.

2. International comparison of the soft environment for global operations of port and shipping companies

2.1 Macro environmental international comparison

The Global Competitiveness Index (GCI) is a comprehensive evaluation system established by the World Economic Forum (WEF) to assess the overall competitiveness of major countries worldwide, being one of the most famous systems for competitiveness evaluation internationally. The 2020 GCI includes 12 competitiveness factors and 103 detailed indicators. We select factors representing the macro-level competitiveness as comparison indicators for the macro environment of companies’ globalization strategies, which are macroeconomic stability, financial systems, and legal systems.

1. Macroeconomic comparison

In terms of macroeconomic stability, countries or regions with developed port and shipping industries generally perform well macroeconomically. Supported by the global economic situation and efficient governance, Singapore's macroeconomy has maintained stable development. Although its ranking significantly declined in 2018 and 2019 compared to 2016 and 2017, the gap in scores with top-ranking countries and regions such as the United Kingdom and Hong Kong, China is not large. For Hong Kong, China, its macroeconomic stability has shown outstanding performance and ranked first in the world in 2019, maintaining steady growth at a high level for four consecutive years. Despite the severe economic situation in Hong Kong in 2019 due to violent incidents, its close economic ties with Mainland China and strong support from its legal system framework have kept Hong Kong's macroeconomy stable. The United Kingdom's macroeconomic stability was not ideal in 2016 and 2017 due to Brexit. However, as negotiations with the European Union progressed and the UK government effectively managed inflation and government debt, the UK's macroeconomic stability rapidly recovered in 2018 and 2019, tying for first place with Hong Kong, China. Affected by the global economic downturn and increased uncertainty in China-US relations, Mainland China's macroeconomic stability has shown a downward trend. However, with strong macro-control measures, Mainland China has maintained stable macroeconomic operation, performing excellently in the secondary indicator of inflation.

2016-2019 The ranks of some countries and regions' macroeconomic stability

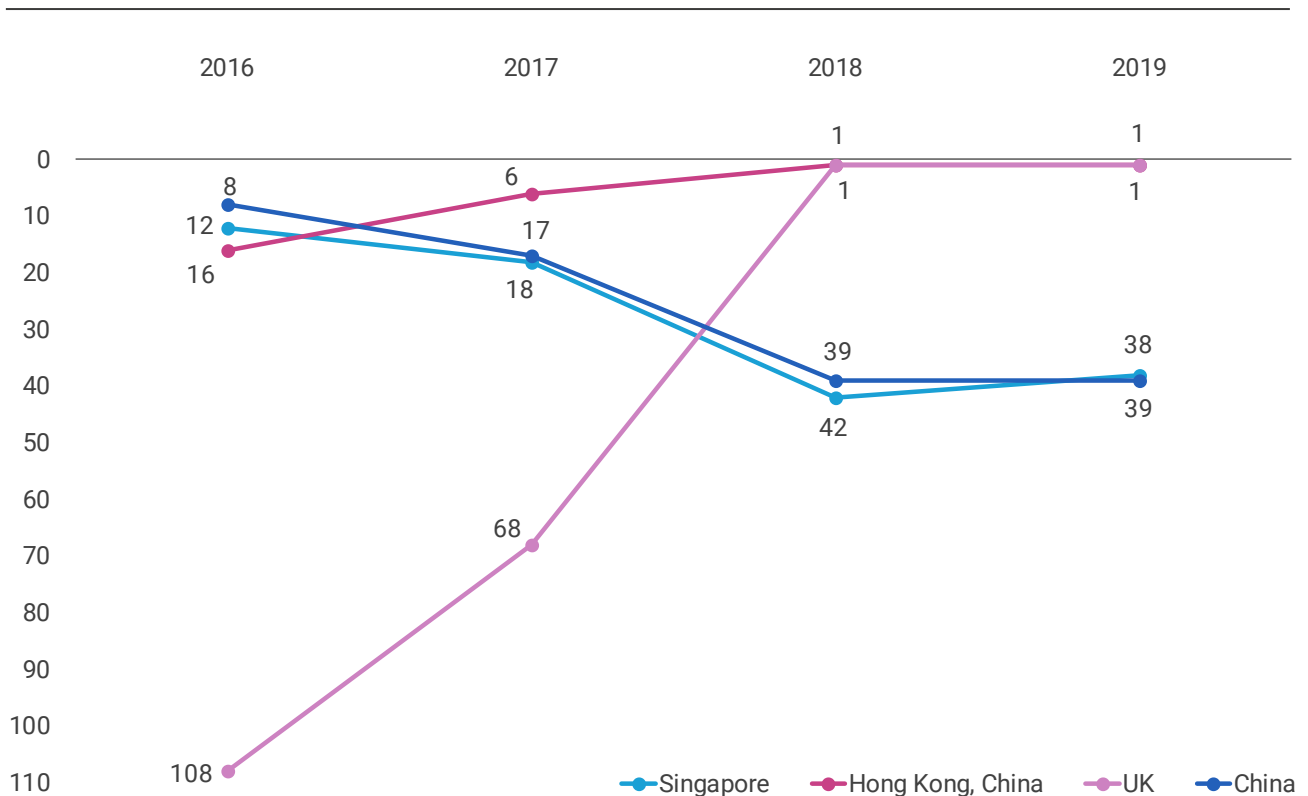


Figure 1 | Source: author's elaboration on "Global Competitiveness Report"

2. Comparison of financial systems

In terms of the financial system, Hong Kong, China and Singapore stand out. As important financial centers in the Asia-Pacific region, their well-developed financial systems are a key advantage in attracting foreign companies. In 2019, the financial system indices of Hong Kong, China, and Singapore ranked first and second respectively. Hong Kong, China was ranked in the top three for sub-indicators such as banking soundness, financial system stability, and credit gaps. Singapore's financial system has consistently been among the top five in the world, and has notable performance in banking soundness and financial system stability, reaching a world-leading level. The UK's financial system is robust and functionally comprehensive, with a steady rise in rankings from 2016 to 2019, especially in providing capital and equity financing services to companies, creating favorable financial conditions for the global operations of port and shipping companies. Although there is a gap compared to Hong Kong, China, Singapore, and the UK, the Chinese government has recently achieved significant improvements in world rankings for four consecutive years by actively promoting financial supply-side structural reforms. The financial system is continuously optimized, and service efficiency is consistently enhanced. Meanwhile, the Chinese government has introduced measures to open up the financial market, attracting more high-quality foreign financial institutions to invest and start businesses in China, further strengthening financial service capabilities.

2016-2019 The ranks of some countries and regions' financial system

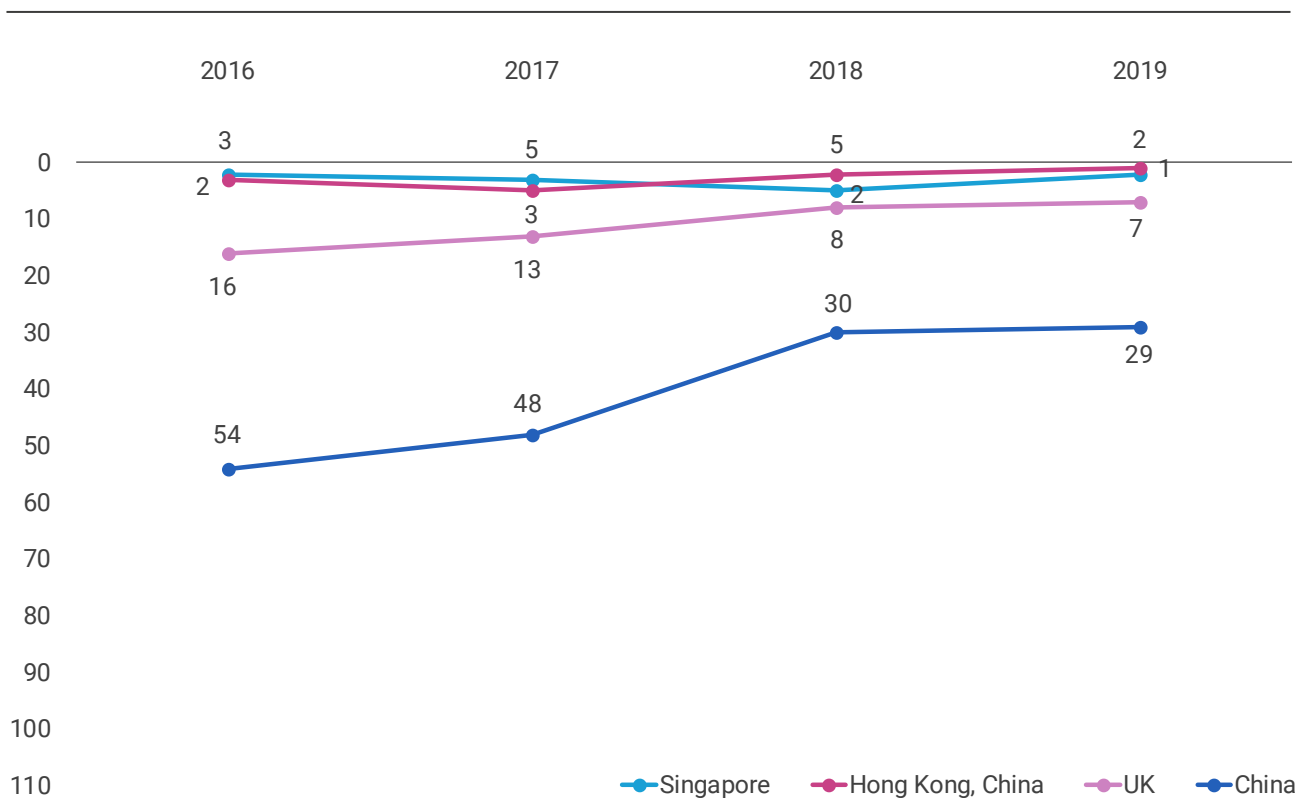


Figure 2 | Source: author's elaboration on "Global Competitiveness Report"

3. Comparison of legal systems

Among the world's major shipping countries and regions, Hong Kong, China has an outstanding legal and regulatory environment, with a world-leading level of judicial independence and legal efficiency. In accordance with the principle of "one country, two systems", the HKSAR Government and mainland China operate different judicial systems. Hong Kong courts conduct trials independently without any interference, reflecting the high degree of independence of the Hong Kong judiciary under the "one country, two systems" principle. Meanwhile, since China's accession to the WTO, international trade has grown rapidly. Due to the special characteristics of its legal system and favorable geographical location, Hong Kong has assumed the role of a third party in resolving disputes, which has contributed to the continuous improvement of local legal efficiency. Although Singapore's performance in legal regulation is not as good as that of Hong Kong, China, the independence of the judiciary is safeguarded through a sound constitutional system, as well as proactive reform measures to ensure an efficient judicial system, with judicial independence and legal efficiency at a high level in the world, and showing a steadily improving development trend. As the birthplace of modern Western rule of law theories and systems, Britain has a relatively perfect legal system, and its judicial independence and legal efficiency are at the forefront of the world. However, in the more than forty years since the UK joined the EU, the legal systems of both sides have integrated with each other, and the impact of Brexit on the UK legal system has affected the

Ranking of judicial independence in selected countries and regions, 2016-2019

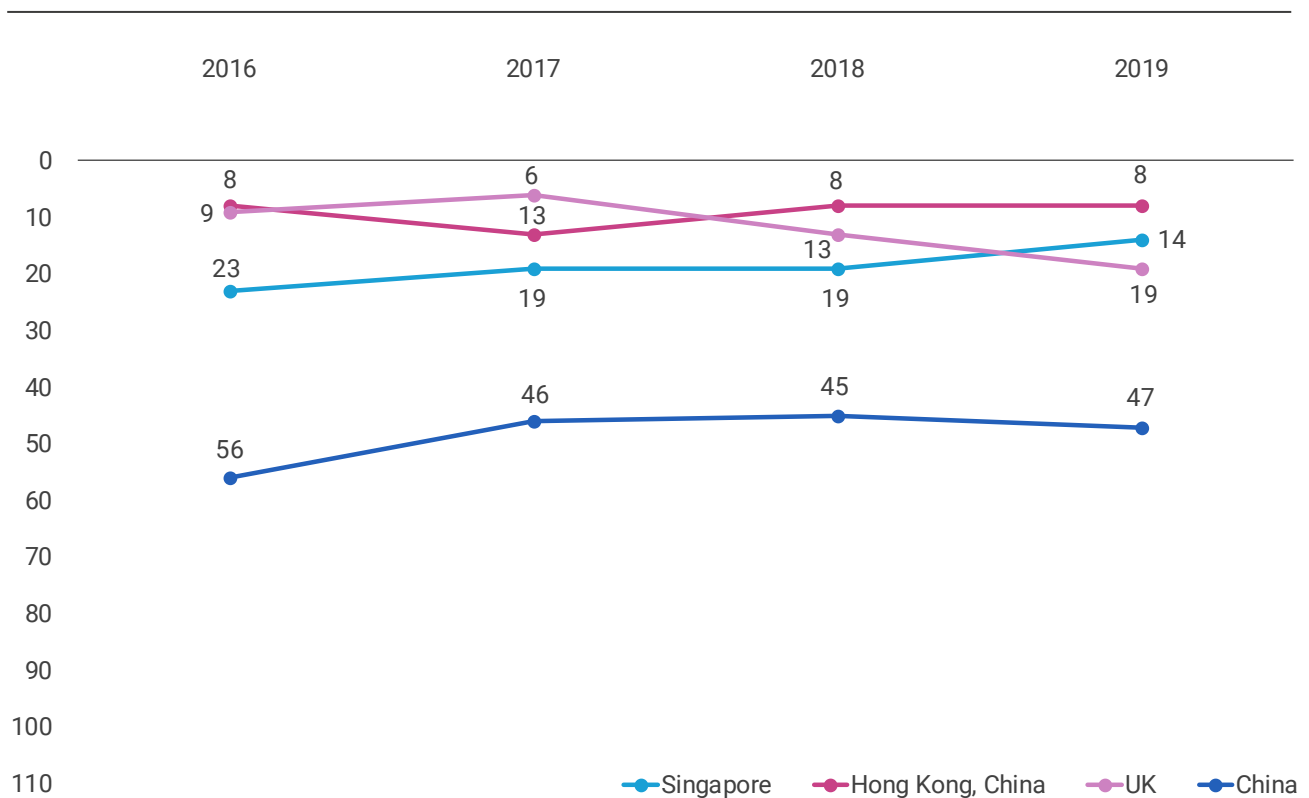


Figure 3 | Source: author's elaboration on "Global Competitiveness Report"

ranking of the relevant legal indicators, but it still maintains a high level of development. In comparison, there are certain gaps in judicial independence and legal efficiency in mainland China. In recent years, the Chinese Government has actively promoted judicial reform, constructed a reform framework centered on the judicial accountability system, established a sound system for the disclosure of judicial information, promoted the in-depth development of the concept of evidence-based adjudication, and broadened the avenues for public participation in the administration of justice, resulting in a steady improvement in the international ranking of judicial independence and legal efficiency.

Ranking of legal efficiency in selected countries and regions, 2016-2019

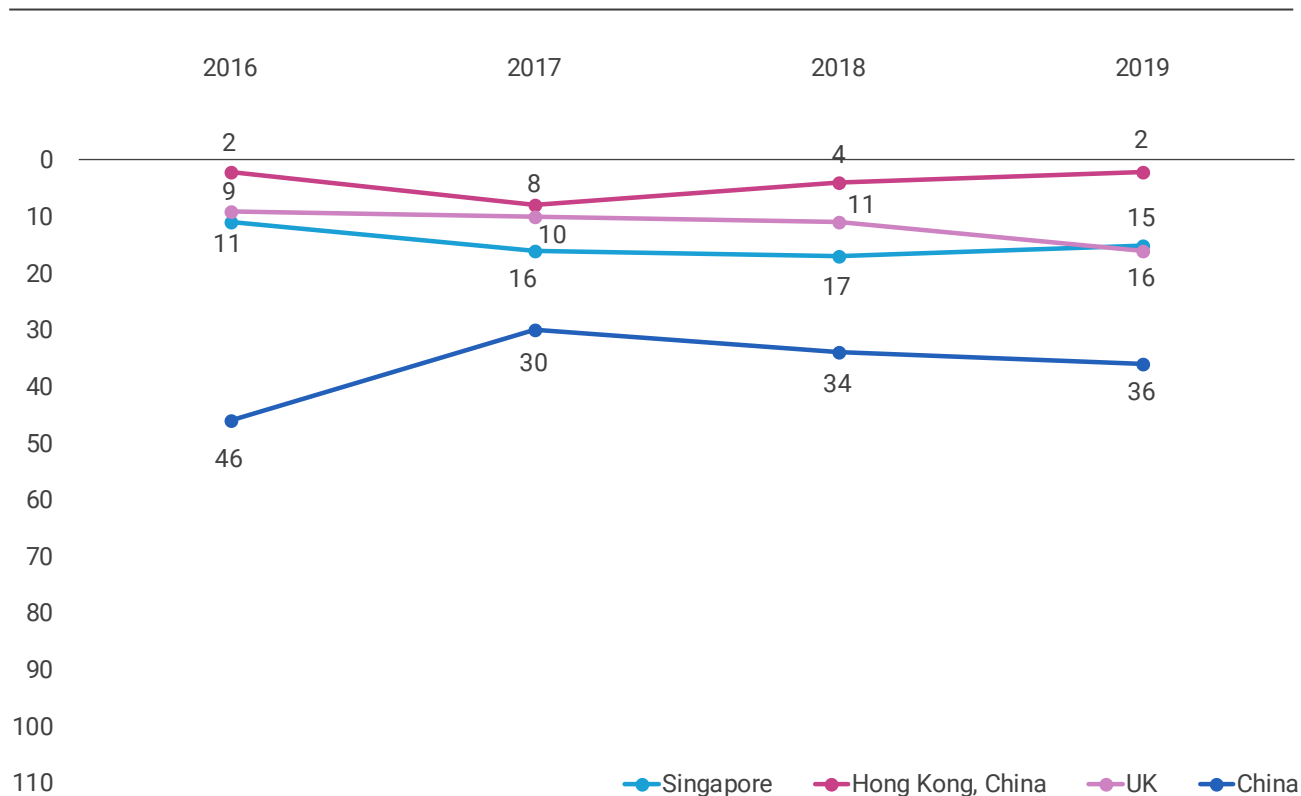


Figure 4 | Source: author’s elaboration on “Global Competitiveness Report”

2.2 International comparison of microenvironments

At present, among the international reports dealing with the evaluation of the micro-environment of globalized business, the Doing Business Report of World Bank and the Services Trade Restrictiveness Index Report of Organization for Economic Co-operation and Development(OECD) are relatively representative and recognized. The former assesses the business environment in 190 economies around the world and provides reference for countries to improve their business environment. The latter covers key indicators such as foreign investment access, restrictive measures, movement of persons and regulatory transparency in 22 industries, and provides reference for countries to grasp the development of and trends in trade in services.

1. Comparison of business environment

The World Bank's Doing Business report shows that countries and regions such as Singapore, the United Kingdom and Hong Kong, China have long been at the forefront of the world in terms of starting a business, obtaining credit, paying taxes, enforcing contracts and resolving insolvency. China is one of the countries with the most significant improvement in its business environment in recent years. According to the Doing Business 2020 report, China's business environment ranking was improved by 15 places to 31st out of 190 economies. What's more, China was among the top 10 most improved economies in the world for the second consecutive year.

2. Comparison of foreign access

The OECD Services Trade Restrictiveness Index Report (2020) showed that the Netherlands was the best foreign access environment in the field of maritime cargo transportation and shipping agency, the United Kingdom in the field of maritime law, France in the field of shipping insurance, and Germany in the field of shipping finance, and in comparison, mainland China basically ranked between 33rd and 37th.

In the field of marine cargo transportation and shipping agency, there were no restrictive measures in the Netherlands in terms of indicators such as examination of economic interests taken into account in the screening of investments by foreign-invested enterprises, the existence of cross-border merger and acquisition restrictions, and the permission of cross-border data streaming, etc. In mainland China, for cross-border mergers and acquisitions by foreign investors, there were anti-monopoly reviews, security reviews, and a number of specific merger and acquisition regulations.

In the field of shipping insurance, France had no restrictive measures on indicators such as whether a commercial presence is required in order to provide cross-border services, local availability tests for cross-border trade, etc. While in mainland China, there was a requirement for a commercial presence to be established for cross-border shipping insurance.

In the area of shipping finance, Germany had no restrictions on indicators how the percentage of shares that foreign investors could purchase in publicly controlled companies, whether quotas or economic needs tests were used in quota allocation, whether the criteria for foreign companies to obtain licenses were more stringent, whether there were cross-border M&A restrictions, whether commercial presence was required, whether some banking services were reserved for domestic suppliers, and whether cross-border data streaming was permitted. While, in mainland China, there were some limits on the total amount of working capital that foreign financial institutions can invest in their branches.

3. Comparison of restrictive measures

The OECD's Trade in Services Restrictiveness Index Report (2020) showed that the Netherlands, France and the United Kingdom performed better in terms of restrictive measures in the area of shipping services. Although mainland China was relatively low in the rankings, but each had its own characteristics in terms of specific restrictive measures. Mainland China did not set discriminatory provisions in terms of subsidies and tax incentives for foreign suppliers. According to the relevant provisions of the Dutch Commission Guidelines, tax reductions are acceptable state aid measures for EU shipping companies to improve their competitiveness compared to non-EU companies.

4. Comparison of staff movements

The OECD Services Trade Restrictiveness Index Report (2020) showed that Japan, South Korea, the United Kingdom and Germany had fewer restrictions on the movement of personnel in the field of shipping services. In mainland China, the regulation of the movement of personnel in shipping agency

and shipping finance is relatively easy, while the management of the movement of personnel in maritime law is stricter. There were no restrictions on the appointment of foreigners in the labor market of contract service providers and independent service providers in any of the aforementioned countries.

3. Development of international shipping centers in the context of the globalization of the operation of port and shipping enterprises

3.1 Evaluation of the development of the world's major international shipping centers

Xinhua·Baltic International Shipping Center Development Index is released by China Economic Information Service of Xinhua News in conjunction with the Baltic Exchange. The study selected 43 sample cities of shipping centers for evaluation, aiming at scientifically evaluating the comprehensive strength and development status of different shipping center cities. The index evaluation system consists of three parts: port conditions, shipping services and comprehensive environment. After screening, four international shipping center cities were selected for comparison, namely Singapore, London, Hong Kong and Shanghai. According to the Xinhua·Baltic International Shipping Center Development Index Report, in the past five years, Singapore has consistently maintained the first position in the world and is the most recognized international shipping center in the world. London, as a veteran international shipping center, is ranked steadily in the top three. Shanghai shows a continuous upward trend, replacing Hong Kong to obtain the third place in 2020.

Overall ranking of International Shipping Center Development Index 2017-2021

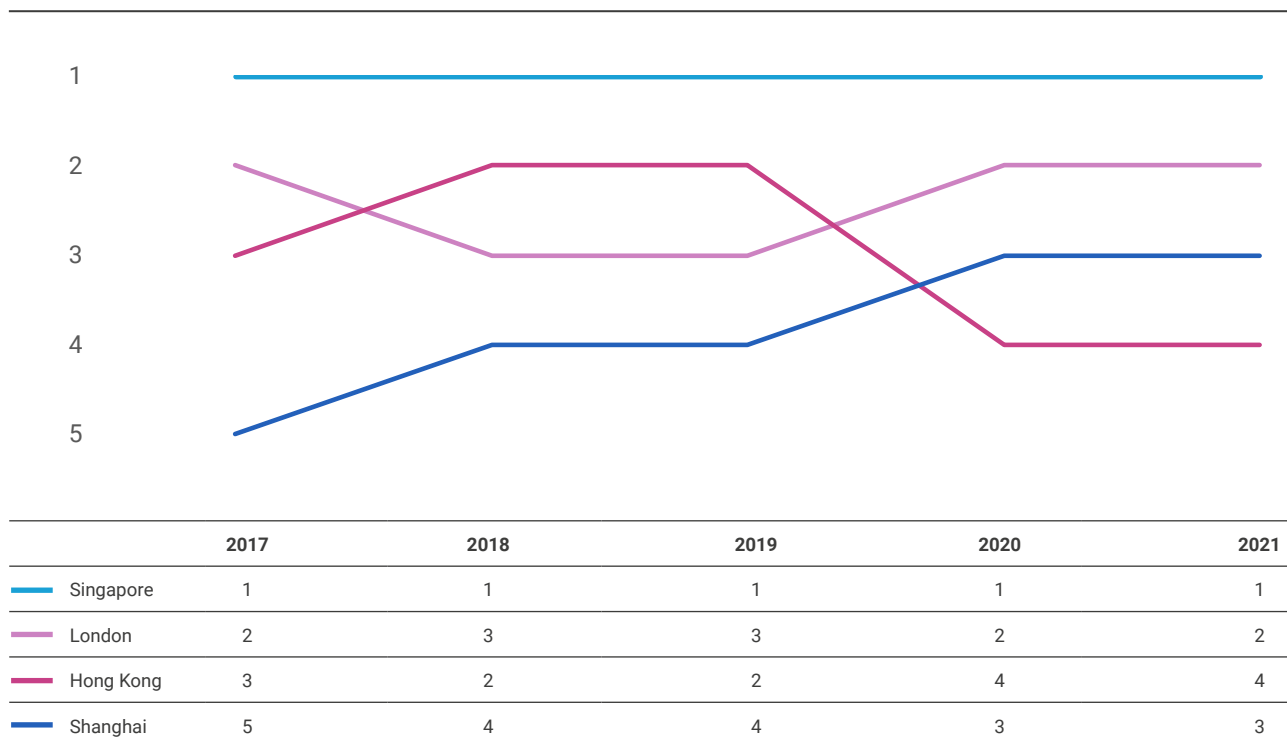


Figure 5 | Source: author's elaboration on "Xinhua Baltic International Shipping Center Development Index Report"

1. Port conditions

Under the impetus of economic globalization, shipping center cities with developed port functions, sound collection & transportation systems and complete port functions have become important nodes connecting international channels, and are important basis for regional participation in economic globalization and the international division of labor. Relying on good geographic location and developed hinterland economy, port cities have gradually formed shipping service industry, port-related industry and related shipping industry clusters around port functions by improving port infrastructure conditions and constructing collection and transportation system, and then developed into international shipping hubs. World famous international shipping centers, such as Singapore, Hong Kong, London, Rotterdam, etc., all rely on port development. Therefore, port conditions are an important foundation for the construction of international shipping centers and the clustering of shipping-related industries.

Xinhua-Baltic International Shipping Center Development Index takes port conditions as one of the important indicators for evaluating the comprehensive strength of shipping centers, specifically including container throughput, dry bulk cargo throughput, liquid bulk cargo throughput, the number of drawbridges, the total length of container berths, and port draught depth. The report shows that among the major international shipping centers in the world, Shanghai, as an emerging international shipping center, has made the most outstanding achievements in port construction. The construction and development of Yangshan Deepwater Port has greatly alleviated the problem of limited development of throughput capacity in the original port area of Shanghai Port due to the draught depth and the shortage of berths. It helped Shanghai Port realize a leap in development in the container throughput and rank first in the world for many consecutive years. In 2017, the world's largest single-unit automated terminal, Yangshan Port of Phase IV, opened, which is the world's one-time completion and commissioning of the world's largest fully automated container port area today, fuelling further growth in container throughput at the Port of Shanghai, reaching a new high of 43.5 million TEU in 2020 after the new Crown Pneumonia outbreak, from 40.233 million TEU in 2017.

The Port of Singapore has always been an important international hub port in the Asia-Pacific region, although its container throughput is not as high as that of the Port of Shanghai. The Port of Singapore has always been at the forefront of the world in terms of its construction and development, thanks to its favourable geographical location to create a world-class transshipment hub, and the Singapore Government's keen strategic vision to make full use of modern information technology to optimise and enhance port services. The Port of Singapore has been awarded "Asia's Best Harbour" many times for its efficient management and excellent hardware facilities. Container throughput is outstanding, and has maintained a relatively large growth since 2017, with a decline in 2020 compared to 2019, mainly due to its role as a global transshipment port, affected by international trade disputes and the reduction in global trade volume caused by the Singapore Crown Pneumonia epidemic, which is also an important manifestation of the Port of Singapore's dependence on the development of global trade. In the face of increasingly fierce competition from regional ports, the Singapore government put forward the construction plan of Tuas Port in 2013, with the designed annual throughput capacity of the terminal to reach 65 million TEUs, and continued to introduce and utilize advanced technologies, such as automated terminals, digital ports, and clean energy, to build a stable, efficient and modern port. Through the clustering and radiation effects formed by the port as well as the use of high and new technologies, it is designed to attract innovative and technological enterprises to develop together and promote the digital transformation of port and shipping-related enterprises. In recent years, the development of the Hong Kong port has shown a continuous downward trend. With the rapid rise of mainland China's ports

and the impact of fluctuations in the global economy, Hong Kong's port container throughput growth has been sluggish, with a decline in container throughput for three consecutive years. Lack of land for terminal construction is also one of the important factors restricting its port development. Hong Kong currently has 31 major berths with a shoreline length of 8,314 meters. With the deepening trade relations between Hong Kong and the Mainland, the volume of trade will increase in the future, but the problems of insufficient port capacity and limited land space will still constrain the further development of its port.

2. Shipping services

The modern shipping service industry is considered a core indicator for evaluating the competitiveness of international shipping centers. International shipping centers are essentially international shipping service centers, and their competitiveness is reflected in the radiation and influence of modern shipping services. The most typical example is the London International Shipping Center, which remains the world's leading international shipping center by virtue of its well-developed high-end shipping service functions, despite having fallen out of the world's top ranks in terms of container throughput.

Xinhua-Baltic International Shipping Center Development Index provides a comprehensive assessment of shipping services in five areas: shipping brokerage services, shipping engineering services, shipping operation services, maritime legal services and shipping financial services. The report shows that in recent years, the old shipping center represented by London still has a big advantage in shipping services. London has always maintained a global leading position in shipping finance, with more than 50 professional investment banks in shipping, and the loans provided for shipping and related enterprises each year are as high as 15 billion to 20 billion pounds, accounting for 15% to 20% of the total amount of global shipping loans, which strongly promotes the optimization of the capital structure of the shipping enterprises and their development and growth. The British Government has long supported ship investment with low-interest loans and exempted tariffs on merchant ship imports, while investment banks have also provided financing and consulting services to shipping companies. London is the world's largest shipping insurance center, with the shipping insurance market accounting for more than 20 per cent of the global market. Nine of the 13 members of the Global International P&I Club are headquartered in London, providing quick and convenient insurance services to relevant practitioners. London Clearing House is one of the world's three major clearing houses, with unique advantages in international shipping settlement business. London has an outstanding performance in maritime law, as a concentration of maritime legal resources, providing legal services for global port and shipping enterprises. London has been a global leader in the number of maritime arbitrators, law firms and their partners for a number of years, demonstrating the attractiveness of its resources and its ability to handle maritime dispute resolution. London handled 1,737 maritime arbitration cases in 2019, accounting for about 83% of the global total, compared with only 229 and 124 cases in Singapore and Hong Kong. Meanwhile, relying on rich shipping brokerage resources, London attracts a large number of shipowners and cargo owners to facilitate ship transactions every year, making it an important shipping transaction center in the world. Overall, London, as an traditional shipping center, continues to consolidate its position as an international shipping center by virtue of its well-developed modern shipping services industry, which provides professional and quality services to the global maritime industry, despite the serious decline in port throughput.

Singapore tops the Xinhua-Baltic International Shipping Center Development Index, not only thanks to its outstanding performance in ports, but also on the basis of the growing modern shipping service industry. Singapore and Hong Kong have a lot of similarities in the construction of shipping centers, both are globally important container transshipment ports, have a developed modern service industry, and

implement an open free port policy. However, relying on a more favorable geographical location and strong policy support, Singapore has focused on the development of shipping brokerage and ship management services, which has led to the continuous enhancement of the functions of related shipping services. The number of shipping brokers has been second only to London for many years, and ship management services are a global leader. In addition, Singapore has launched a large number of supportive policies to support the development of shipping finance and maritime legal services, so as to continuously narrow the gap with London. For example, it has launched the Maritime Finance Concession Scheme, set up the Asian Clearing House of the Singapore Exchange, reduced the tax burden of ship management companies, provided global settlement services for shipping practitioners, including shipping companies, and encouraged shipping investment and management companies to set up relevant investment organizations, so as to promote the development of Singapore's shipping economy. Although Singapore is generally inferior to London in terms of shipping services, it has attracted a large number of shipping and related enterprises to cluster in Singapore by virtue of its sound shipping service system and the tax concessions and policy incentives brought about by government support, thus establishing its status as a world-leading international shipping center.

Shanghai, as a fast-growing international shipping center in recent years, has performed well in the development of shipping services. According to Xinhua·Baltic International Shipping Center Development Index, Shanghai's shipping service surpasses Hong Kong to rank the third, but there is still a gap with London and Singapore. At present, Shanghai has become a regional shipping insurance center, with a total of 56 property insurance companies operating direct shipping insurance services in Shanghai, 3 reinsurance companies operating shipping-related reinsurance business in Shanghai, and the international market share of shipping insurance premium income is among the top. Compared with the past, enterprises in Shanghai can enjoy shipping insurance services more conveniently. In addition, Shanghai's shipping service industry has obvious advantages in ship repair services and ship engineering services. This is mainly due to the fact that Shanghai Port, as the world's largest port in terms of container throughput, has a large number of ships arriving at the port every year, boosting the leading position of ship repair and ship engineering services. In recent years, Shanghai has introduced a large number of supportive policies in the process of promoting the construction of an international shipping center, including building a shipping finance industry cluster, deepening the construction of "shipping service headquarters base" in the North Bund, attracting shipping service functional institutions to settle down, building an international maritime justice center, promoting shipping arbitration information service, deepening the reform of shipping insurance registration system, expanding the function of shipping insurance index, etc., which greatly promote the development of Shanghai's shipping service industry. This has greatly facilitated the development of Shanghai's shipping service industry and strongly promoted the transformation of Shanghai International Shipping Center from a single cargo center to a more competitive shipping service center.

3. Integrated environment

The development of international shipping centers cannot be separated from an excellent comprehensive environment, especially in the context of the globalization of port and shipping enterprises. A friendly comprehensive environment is an important factor in attracting the concentration of multinational enterprises in port and shipping. London, Singapore, Hong Kong and other leading international shipping centers are at the forefront of the world's comprehensive environment construction, which provides a solid guarantee for strengthening the attractiveness of shipping factors and enhancing the allocation of shipping resources.

The Xinhua Baltic International Shipping Centre Development Index provides a comprehensive evaluation of the integrated environment in terms of government transparency, digital government management, tariff rates, ease of doing business index and logistics performance index. The report shows that Singapore and Hong Kong are outstanding in terms of integrated environment, with indicators that are among the world's leading levels but with their own strengths. In terms of government transparency, Singapore has been in the top five in the world and number one in Asia for many consecutive years, reflecting Singapore's high standards in government governance, especially in anti-corruption crackdowns and institution-building. Singapore's strong political will, sound administrative system and zero-tolerance legal system have contributed to the success of the Singaporean Government's anti-corruption model. Although Hong Kong is not as good as Singapore in the overall ranking, it has remained in the top 10 in the world for many consecutive years. Hong Kong has a comprehensive anti-corruption legal system and institutions, such as the Prevention of Bribery Ordinance, the Independent Commission Against Corruption Ordinance, and the unique anti-corruption organization "Independent Commission Against Corruption", safeguarding the fight against corruption in Hong Kong. The three-pronged approach of the Independent Commission Against Corruption (ICAC) in enforcement, prevention and education for all has ensured the integrity of Hong Kong society. In terms of government e-government, Singapore's e-government has developed into a leading international e-government office system after more than three decades of development and innovation and six construction phases. Singapore and Hong Kong are also in the top tier of the global business environment, ranking second and third respectively in the 2020 rankings, demonstrating the excellent business friendliness of both. In recent years, with its excellent business environment, Singapore has become the preferred location for enterprises to globalize their operations, and more and more multinational enterprises have set up their Asia-Pacific and even global headquarters in Singapore. According to statistics, Singapore currently has about 23,000 international companies and is an important headquarters base for multinational corporations in the Asia-Pacific region. Hong Kong's 2020 Business Environment Ranking was second only to Singapore. The SAR Government has continued to reform the current regulatory regime and is committed to improving management efficiency and reducing corporate compliance costs. In 2018, according to a survey conducted by Invest Hong Kong, 35% of Hong Kong's entrepreneurs came from all over the world, demonstrating its attractiveness to foreign-invested entrepreneurs. The logistics performance of Singapore and Hong Kong is equally impressive. According to the World Bank's Logistics Performance Index composite rankings from 2012 to 2018, Singapore and Hong Kong were ranked fifth and ninth, demonstrating their strong competitiveness in integrated logistics.

London, as a traditional international shipping center, has maintained a world-leading comprehensive environment for a long time, providing support and guarantee for its effective allocation of global shipping resources. In terms of government transparency, the UK doesn't perform as well as Singapore, but still remains at the forefront for many consecutive years. The UK is the birthplace of the world's first property declaration law, the Purification of Elections, Prevention of Corruption Act, and the first anti-corruption law, the Corrupt Practices in Public Bodies Act, and is relatively well-established in terms of the government's anti-corruption system and legal construction. At the same time, the UK is also continuously improving its anti-corruption mechanisms, and in 2016 established the International Anti-Corruption Group, marking the growing maturity of the UK's anti-corruption law enforcement system. The United Kingdom has been ranked among the top five countries in the world in terms of government digital management for many consecutive years, and was ranked first in the world in 2016. The UK government has positioned itself as "the best e-commerce environment in the world" and has fully supported e-commerce development

through the launch of policies such as the “Government Portal Project” and “Smart Government”. The performance of the UK in terms of business environment is not as good as that of Hong Kong and Singapore, but thanks to the government’s active introduction of a variety of protection policies and supporting measures to support business investment, such as the “Enterprise Investment Scheme”, “Seed Enterprise Investment Scheme”, etc., it is still more attractive to foreign investment. In terms of logistics performance, the UK’s overall ranking in 2010-2018 was only second to Singapore, ranking sixth in the world. However, as the UK’s international trade volume decreases, its willingness to improve its logistics infrastructure has declined.

Compared with the outstanding port conditions and improving shipping services, the indicators of the comprehensive environment of the Shanghai International Shipping Center are characterized by unevenness. The business environment, logistics performance, and digital government management perform relatively well, but there is still a significant gap in government transparency. In recent years, China has made great efforts to optimize the business environment, and the World Bank’s relevant ranking has steadily improved, rising to 31st place in 2020. As the frontier of China’s reform and opening up, Shanghai is aiming at the highest standards and the best level to create an international first-class business environment and continue to enhance its attractiveness to foreign enterprises. The Chinese government attaches great importance to the construction of e-government, and its ranking has risen from 70th in 2014 to 45th in 2020. Shanghai’s e-government development started early in the country, with the opening of an online government affairs hall in 2010 and the promotion of “Internet + government services” as a priority for many years in a row, with the overall level of e-government services being among the highest in the country. In terms of logistics performance, the ranking has been rising steadily since 2014, and it is in the leading position in developing countries. The timeliness of logistics services and logistics infrastructure are the core strengths of China’s logistics performance, which is also boosted by Shanghai’s huge advantage in port construction. In terms of government transparency, the international ranking has steadily risen thanks to increased anti-corruption efforts. However, due to the lack of an independent monitoring system and transparency, the overall ranking is still far from the international advanced level.

Part Three

Models of port
development:
innovation,
sustainability,
intermodality

Chapter 10 | **The development of hydrogen in ports. From facilitators of Hydrogen Valleys to hubs and enablers of the energy transition. The case of Leghorn**

In the context of increasing attention to sustainability, to green issues, and more generally to the use of ESG indicators as elements of qualitative assessment of companies in every commodity industry, even the Blue Economy system has for some time now been investigating its ability to be a promoter of a development model based on innovation and experimentation with new technologies, and a fundamental role is played by renewable sources.

This chapter delves into alternative fuels, with a specific focus on hydrogen. It examines the role of Port Authorities, using the case study of the Port Network Authority of the Northern Tyrrhenian Sea and its pilot project on hydrogen, to illustrate how these entities can evolve into agents capable of reshaping their mission. Beyond their established importance within the economic ecosystem, Port Authorities can emerge as catalysts for development and innovation, aligning with the ambitious objectives outlined by the international community. Notably, the European Green Deal aims for climate neutrality within the Union by 2050, with an interim target of reducing greenhouse gas emissions by at least 55% compared to 1990 levels by 2030.

Renewable energies play a key role in achieving these goals, as the energy sector currently accounts for more than 75% of total greenhouse gas emissions in the Union.

The decision to address these issues is based on the fact that research content has always had an economic implication, and recent geopolitical events make it necessary, in order to achieve the long-term goal of an energy system independent of third countries, to accelerate the green transition based on an emissions reduction energy policy that limits dependence on imported fossil fuels and promotes fair and affordable prices for the Union's citizens and businesses in all sectors of the economy.

The Union's hydrogen strategy, set out in the Commission's communication of 8 July 2020 entitled 'A hydrogen strategy for a climate-neutral Europe', recognises the role of renewable and low-carbon hydrogen in helping to achieve the 2030 decarbonisation targets of end sectors such as industry and mobility.

1. Hydrogen: strengths and weaknesses compared to other fuel types

Strengths. The strengths of hydrogen are briefly considered, starting with its **high energy content**: its high energy density is evidenced by the fact that it has the highest energy per mass of any fuel in addition to

the production of hydrogen that can be generated from a variety of resources, including water, natural gas and biomass. When produced using renewable energy sources, such as wind or solar, the process can be completely sustainable. The most obvious property, moreover, is hydrogen's **versatility**: hydrogen can be used in a wide range of applications, including transport, power generation and as a raw material in some industries.

Another strength is its **compatibility** with existing infrastructure: hydrogen can be transported and stored using an infrastructure similar to that currently used for natural gas.

Finally, another advantage is hydrogen's contribution to **source diversification** and **energy security**: produced from different sources, hydrogen represents a good opportunity to reduce dependence on imported fuels, improving energy security, a strategic goal as mentioned in the introduction.

Weaknesses. Clean production of this energy carrier is not yet widespread as more than 90% of hydrogen globally is produced from fossil fuels.

Another issue is related to **energy consumption**: electrolysis, a hydrogen production method that splits water using electricity, is energy-intensive and requires large amounts of electricity.

Admittedly, **economic factors** still represent a critical issue for hydrogen use. The cost of the final hydrogen today is not competitive with fossil fuels; hydrogen technologies are currently more expensive and the energy required has a strong impact on the final cost.

Another element still to be developed is **scalability**: scaling up clean hydrogen production to meet global energy demand is a significant challenge and requires substantial capital investment including in renewable plants.

What is certainly still limiting the development of this fuel in other sectors than industry, where it has been used and known for years, is safety concerns, starting with **flammability**: hydrogen is highly flammable and leaks can be difficult to detect because the gas is colourless and odourless.

Comparison with other fuel types. Unlike fossil fuels, for instance, hydrogen can be a zero-emission energy source. However, unless hydrogen production is de-carbonised throughout its supply chain, it may not offer significant environmental advantages over fossil fuels. Hydrogen vehicles provide a longer range than electric vehicles and faster refuelling times. In comparison with biofuels, however, it should be noted that the latter are renewable but can still produce emissions during combustion while hydrogen, when produced sustainably, has the potential for lower overall emissions.

With regard to combustion and related safety, it should be noted that hydrogen has a flammability range of between 4% and 75% in air, which is wider than that of other fuels.

When comparing it with petrol and natural gas, it can be mentioned that petrol has been the predominant transport fuel for over a century. However, its combustion produces harmful emissions such as nitrogen oxides, hydrocarbons and particulate matter. In contrast, hydrogen fuel cell electric vehicles (FCEVs) emit only water and hot air, presenting significant environmental and health benefits. In terms of energy density, petrol has a higher volumetric energy content than hydrogen, making it more convenient for storage in vehicles. A real-life example of this concept is the comparison between the range of FCEVs and petrol vehicles. On the other hand, natural gas, a fossil fuel, has gained popularity due to its lower carbon footprint compared to coal and oil. Composed mainly of methane, natural gas shares similarities with hydrogen in being colourless and odourless. However, the energy industry adds a sulphur-containing odorant to natural gas for leak detection by smell, a feature not yet applicable to hydrogen due to technical constraints.

Other advantages. Technological innovations can make hydrogen production more efficient and environmentally friendly, and these include, for instance, improvements in electrolysis.

Finally, hydrogen can be transported using Liquid Organic Hydrogen Carriers (LOHCs), which can store hydrogen in a liquid state at ambient conditions, potentially simplifying both transport and storage processes.

2. Hydrogen in the Blue Economy

In the context of the ambitious goals set at the European level and based on the fundamental technical elements characterizing hydrogen, we now delve into the applications of hydrogen in the blue economy. Indeed, there are numerous opportunities for application, beginning with the design and construction of hydrogen-powered vessels, such as small boats, to initiate the necessary experiments. Also of interest are areas related to the conversion of yard and dockside vehicles for goods handling, including reach stackers and forklifts, among others. Hydrogen also directly impacts the entire development of the logistics chain for medium to long-distance transport, indirectly affecting the handling of materials passing through ports. Furthermore, it influences the proliferation of light and heavy vehicles for public transport linked to the world of cruises, departing from and arriving at port docks engaged in the interchange between ships and other modes of transportation.

As with other commercial players, climate and energy policies incentivize stakeholders in the maritime economy (e.g., port authorities, terminal operators, etc.) to establish decarbonization targets and implement decarbonization solutions for underlying assets and operations. In particular, hydrogen/carrier fuel could play a role in this shift away from fossil fuel use in the following activities: maritime and inland shipping; onshore traditionally fuelled cargo handling and terminal equipment; industries and activities located in port areas (e.g., refineries, ammonia plants, other chemicals, etc.); and related heavy truck refuelling (for loading/unloading activities) in port areas.

Hydrogen is poised to become the energy carrier of the future. However, its high production costs currently hinder its competitiveness and widespread adoption. Alternative fuels like LNG can mitigate CO₂ emissions, albeit to a limited extent. Despite these challenges, the advantages are evident: by using hydrogen to fuel just one reach stacker at a terminal, CO₂ emissions can be reduced by 10%. Scaling up usage of hydrogen-powered vehicles by 2050 has the potential to entirely eliminate CO₂ emissions.

3. Examples of hydrogen projects in European and Italian ports

PORT OF ROTTERDAM Netherlands

The Port of Rotterdam is taking significant steps to become a central hub for green hydrogen in Europe, with the goal of reaching 4.6 million tonnes per year by 2030. By 2025, the port will be equipped to handle millions of tonnes of hydrogen arriving by ship, while several logistics companies are investing in hydrogen storage and handling infrastructure. Furthermore, the port has entered into agreements with a number of countries to import green hydrogen, and is working with companies such as Shell to construct hydrogen plants, including the 200-megawatt plant in Maasvlakte.

More specifically, the port unveiled plans for a hydrogen-powered cargo truck unloader, which will be operational by 2024. In addition, the port is developing a hydrogen filling station for heavy vehicles and

a pilot project to test hydrogen-powered shipping. The Port of Rotterdam's hydrogen initiatives are part of the broader 'Rotterdam Hydrogen Masterplan'. The planned hydrogen-powered Cargo Truck Unloader is a collaboration with the Dutch company VDL Groep and will be one of the world's first fully electric and hydrogen-powered unloaders. The port's hydrogen filling station, due to open in 2024, will be able to supply up to 50 trucks per day with green hydrogen produced locally through electrolysis. In addition, the port participates in the 'Hydrogen Import Coalition' to facilitate the large-scale import of green hydrogen from countries with high availability of renewable sources.

PORT OF VALENCIA

Spain

The Port of Valencia has taken significant steps towards the adoption of hydrogen. In 2021, the port commissioned Europe's first hydrogen-powered mobile crane. This pioneering initiative aims to demonstrate the feasibility of using hydrogen in port equipment, paving the way for wider implementation in all port operations. The EU-funded 'H2Ports' project is at the heart of this transition, aiming to introduce hydrogen as an alternative fuel to reduce the environmental impact of port operations. The project envisages the use of fuel cell technologies to increase the energy efficiency and safety of port terminals. The technological innovations envisaged in H2Ports include the following:

- **Hydrogen Yard Tractor:** The first fully hydrogen-powered port tractor was developed as part of the H2Ports project. This vehicle is designed to reduce emissions during freight handling in European ports, with the aim of saving more than 500 tonnes of CO₂ per year.
- **Hydrogen Reach Stacker:** Another selected prototype is a reach stacker for container handling, which uses fuel cell technology.
- **Mobile Hydrogen Supply Station:** To support these vehicles, a mobile hydrogen supply station is also planned.

The hydrogen-powered mobile crane presented by the Port of Valencia is the result of a collaboration with Spanish companies such as Hyster Europe and MSC Terminal Valencia. The crane, which has a lifting capacity of 64 tonnes, is powered by a hydrogen fuel cell system, eliminating emissions during operation. This pioneering initiative serves as a feasibility test of hydrogen technology in port equipment, paving the way for further adoption in all port operations.

PORT OF ANTWERP-BRUGES

Belgium

The port of Antwerp is at the forefront of hydrogen development, with several ambitious projects underway, including 'HyTrucks', 'Pioneers' and 'H2Global'. The port is working with partners to establish a hydrogen import coalition, facilitating the import of green hydrogen from regions with abundant renewable energy sources. In addition, the port is exploring the use of hydrogen in container handling operations and truck fleets. The Port of Antwerp Hydrogen Import Coalition aims to establish a supply chain for the import of green hydrogen from regions with abundant renewable energy sources, such as Chile, Oman, Namibia, Egypt, Brazil.

The port is also exploring the use of hydrogen in container handling operations, with plans to implement a hydrogen-powered container stacker. In addition, the port is working with haulage companies to shift their fleets to hydrogen-powered vehicles, with the aim of reducing emissions from port logistics.

Recognising the vital role of hydrogen in the energy transition, the port is actively working to become a European benchmark for the import of green hydrogen, exploring local hydrogen production through renewable energy from solar panels and wind farms. Projects such as 'HyoffWind' and 'Plugpower' aim to produce green hydrogen by 2025, while the 'Antwerp@C' consortium focuses on capturing, storing and reusing CO₂ to produce blue hydrogen, an intermediate step towards green hydrogen.

As it acknowledges the limited availability of solar and wind energy in Belgium and Western Europe, the port is committed to importing hydrogen and its carriers from regions where these resources are abundant. The Port of Antwerp-Bruges is developing the necessary infrastructure for the distribution and consumption of hydrogen, including pipelines, terminals and a hydrogen network. The port already has the necessary infrastructure to receive various hydrogen carriers such as methanol, ammonia and methane and is working to increase storage and distribution capacity.

The port's industrial and transport sectors are already using hydrogen and its derivatives, such as ammonia and methanol. The 'NextGen' district is a testing ground for new hydrogen-based technologies and the port is experimenting with the use of hydrogen for its fleet, including the hydrogen-powered tug 'Hydrotug'. Initiatives such as the Hydrotug, which offers hydrogen as an alternative fuel for shipping and promotes the use of hydrogen in various vehicles and equipment, underline the port's commitment to a sustainable energy future.

The port of Antwerp-Bruges is therefore acting as a leader in the construction of a hydrogen economy with a clear commitment to sustainability and innovation. Through the production, import and strategic use of hydrogen, the port is moving closer to its goal of climate neutrality by 2050.

PORT OF GOTHENBURG

Sweden

The Port of Gothenburg has embraced hydrogen as part of its commitment to sustainable operations. In 2022, the port unveiled plans for a hydrogen refuelling station, which will allow hydrogen-powered ships and vehicles to refuel within the port premises. This initiative is part of a broader strategy to make Gothenburg a hub for hydrogen distribution and bunkering. The hydrogen fuelling station at the Port of Gothenburg is the result of cooperation with several partners, including Volvo Trucks, Scania and the Swedish Energy Agency.

The station, which will open in 2024, will be able to supply both heavy vehicles and seagoing ships with green hydrogen produced on site through electrolysis. This initiative is part of the port's broader 'Gothenburg Green City Zone' project, which aims to make the city a hub for sustainable transport and logistics.

The Port of Gothenburg and Norwegian energy company Statkraft are planning to build a hydrogen production plant in the port. Hydrogen has the potential to replace fossil diesel in all heavy equipment used for transport by sea, rail and road. The plant will have an initial capacity of 4 MW, producing up to two tonnes of hydrogen per day, equivalent to 2,200 litres of diesel. This could help reduce carbon emissions by at least four tonnes every day. Further capacity expansions will be possible based on demand and newly emerging areas of use. Production has been planned to start in mid-2023 with an investment of approximately SEK 60 million.

Statkraft emphasises that renewable hydrogen will be key to achieving carbon-free transport soon, contributing to a fossil-fuel-free transport sector on land and at sea. The goal is in line with Sweden's target to reduce emissions from domestic transport by 70 per cent by 2030.

The planned hydrogen project in Sweden aims to reduce more than 30 per cent of the country's total carbon emissions. The Port of Gothenburg's climate target mirrors the national target and includes reducing emissions not only in the port, but also from transport to and from the port in the entire Gothenburg region, as evidenced by the 'Tranzero' initiative, which focuses particularly on land transport, with hydrogen as a key component.

PORT OF AMSTERDAM

Netherlands

The Port of Amsterdam is undertaking an ambitious initiative to integrate hydrogen as a key energy resource in its port operations. The port is actively working on the import, production and use of hydrogen, with the aim of supplying only green hydrogen, produced from renewable sources such as wind or solar energy.

- **Import and Storage.** Recognising that demand for hydrogen in the Netherlands will soon exceed domestic production capacity, the port is working with H2A, a consortium of local and international partners, to establish a completely green value chain. This includes the seaborne transport, storage, handling and distribution of hydrogen. In addition, the EOS project, in collaboration with Zenith Energy, explores the possibilities of importing cryogenic hydrogen.
- **Infrastructure.** As an energy port, Amsterdam aims to develop the necessary infrastructure and capacity to transport and store hydrogen, serving industry and the region. The infrastructure includes underground pipelines and above-ground storage tanks. In cooperation with Hynetwork Services, the national government and the authorities of the North Sea Canal Region, work is underway to create a regional hydrogen infrastructure that will extend from IJmuiden to the Amsterdam port area, and connect to a national hydrogen network.
- **Production.** The port is collaborating with Tata Steel and HyCC to set up a 100 MW hydrogen plant in IJmuiden, on the Tata Steel site, called H2ermes3. Using renewable electricity, this plant will be able to produce up to 15,000 tonnes of green hydrogen per year. The H2era project, also in collaboration with HyCC, aims to build a 500-megawatt green hydrogen plant, the largest in the Netherlands, with the goal of having it operational by 2027.
- **Use.** Green hydrogen produced and supplied at the port will be used in industry as a substitute for fossil energy. Tata Steel, for example, plans to switch completely to green hydrogen for its steel production process. Hydrogen will also be used as a sustainable input material in the chemical industry and in the production of sustainable fuels, such as synthetic kerosene, significantly reducing CO₂ emissions. The Port of Amsterdam thus demonstrates a significant commitment to sustainability and innovation, adopting green hydrogen as a key element for a clean and renewable energy future.

4. The Port Network Authority of the Northern Tyrrhenian Sea: a case of European excellence for innovation and hydrogen projects

Among the port authorities bidding to become 'engines of development through innovative projects', we have decided to take a closer look at an Italian case: the Port Network Authority of the Northern Tyrrhenian Sea (AdSP-MTS), which stands out for its vision and clear intention to look to the future with the courage of change, driven also by a deep interest in the challenges of the ecological and energy transition.

In particular, as far as the development of the extended hydrogen supply chain is concerned, the relevance and excellence on a national and European scale of the strategic approach implemented by the AdSP-MTS are testified by the awarding of a 'Hydrogen Valley Certificate' to the 'Hydrogen Valley of the Tuscan Coast', issued by the Clean Hydrogen Partnership in June 2023. This significance was then confirmed, as we shall see in more detail, once again by the Clean Hydrogen Partnership, which in 2023 included the North Tyrrhenian port system among the four European ports subject to case study in the 'Study on hydrogen in ports and industrial coastal areas'. The AdSP-MTS emphasised how these achievements are the result not so much and not only of its own initiative, but of the joint action with the Tuscany Region and, above all, of the significant Tuscan industrial fabric in hydrogen 'core' and 'ancillary' technologies, combined with the presence of universities (Pisa, Scuola Sant'Anna, Scuola Normale, IMT of Lucca), research centres and technological poles that make the Tuscan Coast one of the areas with the highest 'research intensity' in the national scene.

Before outlining the strategy for the extended hydrogen supply chain, it is necessary to briefly introduce the Port Network Authority of the Northern Tyrrhenian Sea, a governing body whose territorial jurisdiction, since the 2016 reform, includes the ports of Leghorn, Capraia, Piombino, Rio Marina, Portoferraio and Cavo. Therefore, the AdSP-MTS represents a unique example at the national level because it has jurisdiction over all possible dimensions of ports: Leghorn, a large international port in the core network of the TEN-T; Piombino, a 'Comprehensive' port with significant passenger traffic and a historical vocation as an industrial port; the other ports on the islands that have the typical characteristics of service ports. The geographical and morphological characteristics of the ports of this authority give it a strategic role in the western Mediterranean. The new port network is among the first national ports for multipurpose goods, among the first in Italy with specialised full container terminals, and moving over 39 million tonnes of goods and 9 million passengers every year; Leghorn is the first Italian port of call for forest products and new cars and one of the most important for Ro-Ro traffic. By virtue of its position, the characteristics of its infrastructure, the services it offers, and its connections to the inland areas, the North Tyrrhenian port network performs the function of a European-level gateway for many types of traffic.

The potential of this authority is well represented by the huge resources invested in the seaward extension project named 'Piattaforma Europa', conceived and designed to accommodate large ships, which will offer 3,000 metres of quays, 2 large terminals, and a new port entrance with depths down to -20 metres, with a total area of 800,000 square metres. This new project under construction will be divided into two phases, with the first involving the construction of the new container terminal, and the second dedicated to the motorways of the sea and Ro-Ro and Ro-Pax traffic. The total public funding earmarked amounts to € 630 million.

The port of Leghorn can also boast proximity to the important Amerigo Vespucci freight village, which, together with the Faldo car park, the Pisa-Florence airport and the Prato freight village, represents a connection point with the Scandinavian-Mediterranean corridor to central, eastern and northern European markets. Thanks to new motorway routes and the strengthening of the railway infrastructure that will allow 750-metre trains to access the port system, Leghorn will be the centre of the Tuscan integrated logistic platform.

Since 2015, the AdSP-MTS has launched a series of actions, initiatives and innovation projects with the aim of making the system's ports an advanced point for innovative technologies and solutions, adding a new function to the traditional role of managing the infrastructure, with the AdSP as an enabler of innovation and the system's ports as a natural testbed for technological clusters connected to the maritime economy.

Area of the 'Piattaforma Europa'



Figure 1 | Source: SRM on AdSP-MTS and European House Ambrosetti

Innovators, start-ups, companies will find an ideal environment for 'test before invest', i.e. for pilot projects, prototypes, demonstrators in a large-scale real environment. In a nutshell, the port system thus adds to its historical function of transport and energy hub the function of 'innovation hub', at the service of the research and business system, providing a 'ready-to-use' infrastructure that helps to overcome the 'death valley' that in Europe, and particularly in Italy, separates research and business, preventing ideas, solutions, technologies, and experiments from being transformed into products and services on the market. It should be noted that this vision has been accompanied by the organisational choices of the AdSP-MTS which, first in Italy, has equipped itself with a dedicated organisational unit: the 'Development, Innovation and European Projects Department'.

In the first phase, the widely prevailing innovation was related to digital transition. In a complex structure of about 170 direct employees and 16,000 people working in the area, even the management and monitoring of port data becomes an issue where innovation can be a strategic element: in particular, it should be noted that Leghorn was among the first Italian ports to design and implement a Port Community System (the 'TPCS' - Tuscan Port Community System).

This platform digitalises and simplifies information flows related to the import and export of goods and is used by Terminals, Shipping Companies, Shipping Agencies, Institutional Offices, Freight Forwarders, Hauliers and Ship Forwarders. TPCS facilitates the sharing and exchange of information between public and private players involved in cargo handling and control processes: the digitisation process enabled by TPCS allows not only the elimination of paper for the presentation of documents, but also a reduction in queues and waiting times at terminal gates with a consequent reduction in CO₂ emissions and noise pollution. As proof of the excellence achieved in this area, it is recent news that, for the first time in Italy, other Port Network Authorities have asked to 'reuse' the software developed in Leghorn. The digital transformation and the valorisation of the data that the port network generates have also led to an even

more innovative perspective on port monitoring tools, 5G networks, Cooperative Intelligent Transport Systems, and IoT. In each of these areas, projects are underway at different levels of technological readiness, leveraging European funding and, above all, partnerships with leading research organisations, industrial and institutional players. We will limit ourselves to mentioning the experimentation of the Maritime Autonomous Surface Ship in the port of Leghorn and the investments in the port monitoring platform called 'MONICA' (Monitoring and Control Architecture) which, in an initial phase nearing completion, acquires and integrates heterogeneous data coming from a multiplicity of information sources, whether they are applications or sensors distributed throughout the area, and provides 'services' organised in specific functional modules and intended for a plurality of subjects, both public (e.g. port network authorities, port captaincy, customs, financial police, etc.) and private (e.g. port operators, logistic operators, road hauliers, passengers, etc.). For example, the platform is able to calculate the carbon footprint: a measure that expresses the total greenhouse gas emissions generally expressed in tonnes of CO₂ equivalent associated directly or indirectly with a product, service or organisation. In the second phase, at the design stage MONICA will evolve towards a true 'digital twin', capable of supporting the strategic and operational decisions of the AdSP-MTS.

It is by leveraging this vision and background that, starting from 2020, innovation action has progressively focused more and more on the objectives of ecological and energy transition. This integrated system of innovation makes the decision maker capable of assessing the future of ports with a strategic vision, and creates the conditions for the entire ecosystem to work towards winning and shared development scenarios: this context has given rise to the strength of the project on hydrogen issues, the subject of analyses and in-depth studies also by European Union institutions that have chosen the Port Authority of the Northern Tyrrhenian Sea as an Italian example for developing hydrogen hubs for production, storage, transit, and use.

The Tuscan system, with the support of the Hydrogen Valley and Green Ports projects, is a candidate to seize these opportunities, not only by supporting the construction of the Hydrogen Valley of the Tuscan Coast, but also by looking at the strategic role that the North Tyrrhenian Sea can play at the national and European level in the import of green hydrogen produced in other areas of the Mediterranean, MENA and Latin America from renewable sources, mainly wind and solar power.

5. A strategic approach to the Hydrogen Valley of the Tuscan Coast

In line with the European-level approach and the experiences of other ports and coastal areas, the first aspect on which the AdSP-MTS has focused its attention from 2020 is the potential to make the Tuscan Coast a Hydrogen Valley.

In this regard, it should first be noted that the rationale behind Hydrogen Valleys is that of building hydrogen-based 'local systems'. In fact, Hydrogen Valleys are intended to create an integrated system on a local scale that encompasses the entire green hydrogen supply chain: the production-transport-storage-distribution-end-usage phases take place in 'geographical proximity'. In the literature, and in European-level planning documents, Hydrogen Valleys are characterised by four key elements, namely:

1. **Maturity:** investment in projects that go beyond the scale of a pilot or demonstration project;
2. **Defined geographical boundary:** projects with specific territorial competencies, both in terms of geographical boundaries and the actors involved;

3. **High supply chain coverage:** coverage of different sectors of the supply chain, from hydrogen production to storage, from transport to end usage;
4. **Multi-sector supply of hydrogen:** versatile use of hydrogen in more than one sector or application.

At a global level, there are 36 Hydrogen Valleys in 20 different countries, with around €32.5 billion in investments. The timing is therefore crucial to be able to design and define the characteristics of new Hydrogen Valleys in Italy: this explains the efforts of the Tuscany Region itself to make the entire coastline an attractive pole on these issues. Incidentally, it should also be noted that in the context of the 'Green Ports' project, the Ministry of Ecological Transition has earmarked €62 million for the purchase of hydrogen-powered service vehicles operating within the port, such as AdSP service vehicles and vessels, mobile cranes, waste collection vehicles, tractors, reach stackers, elevators, and locomotives.

Coinciding with the definition of the national and regional hydrogen development strategy and the launch of the first NRRP announcements managed by the Tuscany Region, the AdSP-MTS defined its strategic approach, investigating the role of the port system and mapping the different components of a Hydrogen Valley consistent with the characteristics of the local economic fabric.

Through an ongoing dialogue with industrial, energy, port, logistics and shipowning players, the AdSP has drawn up the 'Strategic Blueprint of the Hydrogen Valley of the Tuscan Coast'. In fact, in the face of a multiplicity of inputs, initiatives, and projects, which are profoundly heterogeneous and often poorly coordinated, it is necessary to equip ourselves with tools capable of supporting strategic and operational level decisions. The Blueprint, whose results are summarised below, has provided the key elements for future investments and actions by the AdSP-MTS, clarifying scenarios and priorities that are progressively included in the planning and programming tools provided for by the port law. As we shall see in the conclusions, the introduction of strategic projects related to hydrogen development in these pivotal instruments of port governance represents to some extent a 'moment of truth', in terms of the commitment of public actors and the credibility of the initiatives in relation to private actors.

The Blueprint analyses the projects that make up the Hydrogen Valley, defining the role of the AdSP-MTS as a facilitator of development opportunities for the hydrogen supply chain and the governance model of the Hydrogen Valley, which embraces the entire coastal area, clearly transcending the boundaries of the port area. For the purposes of this report, it is necessary to highlight that at the basis of the Blueprint there are 4 'work sites', driven by the involvement of territorial stakeholders, as follows:

1. **Hydrogen supply chain:** mapping and analysis of the hydrogen 'extended supply chain', from production to end usage, according to a scheme consistent with the approach of the 'H2 Italy 2050' document, which can be described in Figure 2.
2. **Reference area:** analysis of the area's distinctive characteristics in relation to the hydrogen supply chain. This analysis was developed with a multi-level methodology based on: i. Discussions with experts; ii. Literature review with an in-depth desk analysis; iii. Strategic analysis of the territory's specialisations; iv. Quantitative assessment models of energy needs and industrial skills.
3. **Significant technologies along the hydrogen supply chain:** mapping of enabling technologies and solutions for hydrogen production, transport and consumption, with a focus on the level of technological maturity.
4. **Specific industrial and technological competitiveness of the area:** analysis of the potential for the economic and industrial sectors of the Tuscan Coast and classification of their attraction potential.

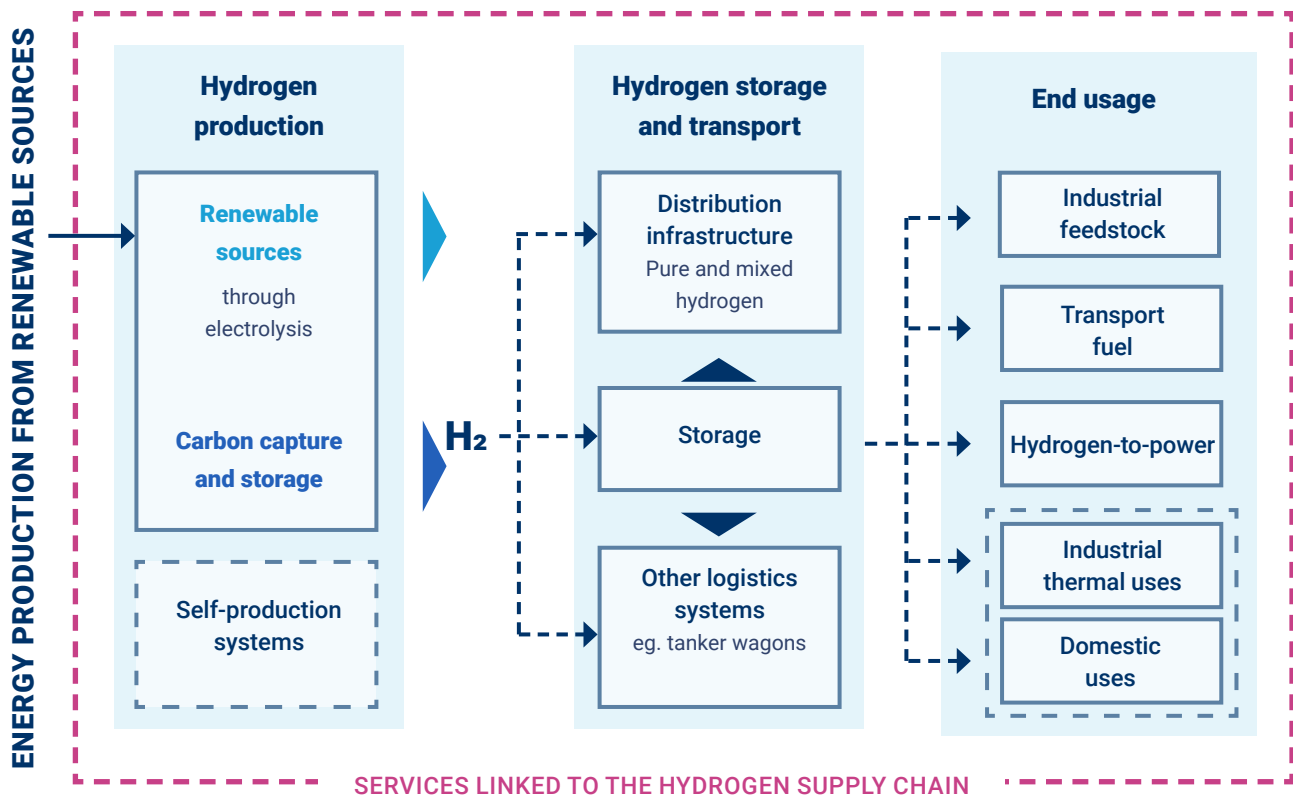
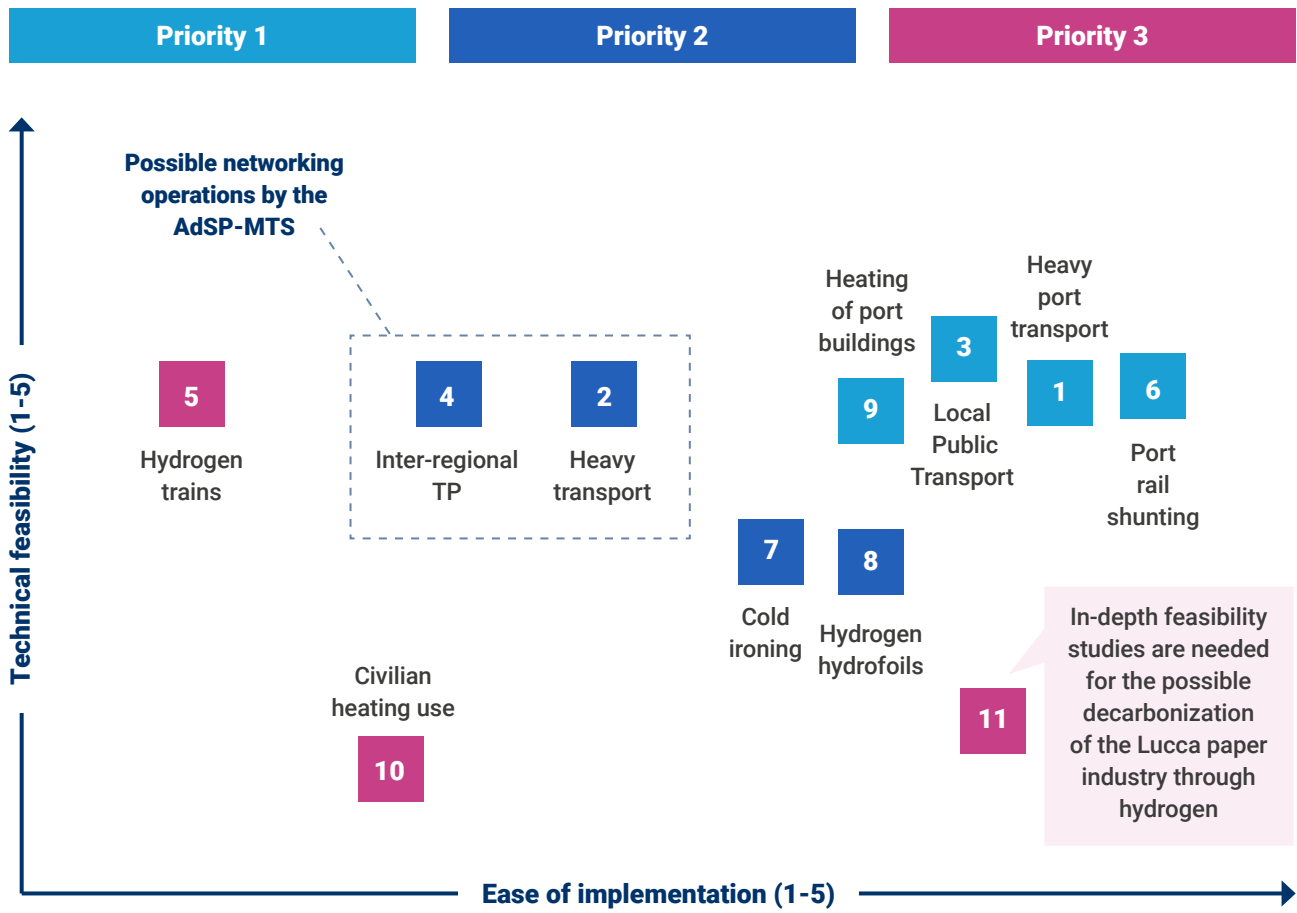


Figure 2 | Source: AdSP-MTS and European House Ambrosetti

Projects for the Tuscan Coast

Opportunities in transport	
1. Heavy transport in the Port of Leghorn	
2. Heavy road transport along the Aurelia in the Leghorn area and role of the port of Leghorn along the north-south axis	
3. Local Public Transport in the provinces of Leghorn and Pisa	
4. Extra urban road public transport with a focus on the Port of Leghorn	
5. Hydrogen conversion of non-electrified railways in the provinces of the AdSP-MTS	
6. Hydrogen conversion of rail shunting in the Port of Leghorn	
7. Hydrogen-powered cold ironing in the Port of Leghorn	
8. Hydrogen powered ferries	
Opportunities in the public civilian sector	
9. Residential use in the ports of Leghorn and Piombino	
10. Residential use in civilian applications	
Opportunities in industry	Opportunities in islands
11. Decarbonization of hard-to-abate sectors	12. Production and consumption in a circular economy perspective

Table 1 | Source: AdSP-MTS and European House Ambrosetti



Technical feasibility (1-5)

Considered factors

- » TRL technology
- » MRL technology
- » Readiness of the current system
- » Technological competitiveness vs decarbonization goals

Ease of implementation (1-5)

Considered factors

- » Commitment of public players
- » Commitment of private players
- » Advantages for the community and social acceptability
- » Significance for the local area

Figure 3 | Source: SRM on AdSP-MTS and European House Ambrosetti

Within the framework of hydrogen-related projects, the Port Network Authority of the Northern Tyrrhenian Sea is a partner in an initiative to develop the maturity of the Hydrogen Valley and, more generally, to strengthen the image and role of ports as catalysts for the hydrogen-based energy transition. H2MOVE, financed by the Italy-France Maritime cross-border programme and coordinated by the Chambre de Commerce et d'Industrie du Var (Toulon, FR), focuses on the transport sector for the integrated planning, promotion and market deployment and scalability of innovative solutions for hydrogen production, transport, storage and utilisation starting from the ports of the cross-border cooperation area, including Sardinia and Corsica, the maritime provinces of Tuscany and Liguria and the French departments of

Alpes-Maritimes and Var. In particular, within the framework of H2MOVE, the Port Network Authority is committed to carrying out two actions consistently with its aforementioned Blueprint:

- 1. Online platform for matching projects in the extended hydrogen supply chain.** H2MOVE foresees the creation of an online platform that can channel the various hydrogen-related initiatives within the cooperation area of the project itself. The online platform will be based on a geographical database, providing useful information to identify the activity, topic, target, technology, etc. The platform will be composed of different levels according to the themes represented and will aim to bring together individual industrial initiatives, public subjects, research organisations and European projects, both with the aim of dissemination and with the broader objective of integration and synergy between the various activities carried out. This platform is the result of an analysis carried out by the AdSP-MTS of the industrial actors present in the Tuscan territory, with the aim of assisting the Tuscan Region in the preparation of funding calls for the hydrogen supply chain, in order to avoid the funding of 'stand alone' projects. In fact, there is a clear need to promote the clustering of initiatives capable of creating complete hydrogen supply chains (production, storage, distribution, usage), albeit on a small scale but significant at cluster level and, above all, capable of breaking the vicious circle between lack of supply - lack of demand.
- 2. Pilot hydrogen-powered ferry.** The long-term objective of the Port Network Authority of the Northern Tyrrhenian Sea, obviously as far as the areas of its own interest are concerned, is to achieve decarbonisation of maritime transport, obviously starting with short-haul. Hydrogen fuelling of short-haul ferries, such as Piombino - Portoferraio, for example, evaluating the number of trips and passengers per year, would generate an average reduction in pollutant emissions in the surrounding areas of 0.018 kg of CO₂ per passenger per km. Environmental benefits go hand in hand with social and economic benefits for the entire port system, given the possibility of playing a key role in energy imports and facilitating the supply of energy to the Italian and European hinterland. Certainly, the costs of the investments needed to implement the project must be considered, but the cost of 'doing nothing' must also be assessed, with the growing regulatory pressures reflected in the gradual addition of the maritime transport sector to the Emission Trading System (starting gradually in 2024 and to be completed in 2026) which will require the achievement of the aforementioned decarbonisation targets.

The study carried out by the Clean Hydrogen Partnership to evaluate the introduction of hydrogen as a marine fuel took as a reference a ferry with a hypothetical annual consumption of 23 tonnes of H₂ and a container ship with an annual consumption of 16,906 tonnes of ammonia. These annual consumption values were supplemented by input parameters necessary for additional economic evaluations, including, for the ferry, a distance of 56 km for a round trip between Piombino and Portoferraio and a capacity of 100 passengers. For the container ship, the parameters are obviously different, given the different scale and objectives, with a capacity of 1913 TEU and an average annual distance of 160,000 km. These input data provided very specific and timely indications regarding the hydrogen supply chain, especially from an economic point of view.

A first result that emerges is that of the potential demand for hydrogen in the area of interest, assessing this parameter from the current stage until 2050, taking into account industrial uses, mobility, port activities and urban areas. Until 2030, the demand for hydrogen is shown to remain at the level of 2019, due to the need to develop a complete supply chain, no longer based solely on supply from external sources, but moving towards local production of green H₂.

Thereafter, an increase of 83% is assumed by 2050, also due to a significant increase in mobility and port activities, which will increase by 100% and 125% respectively between 2040 and 2050. This increase will of course lead to a gradual reduction in the cost of the carrier, from around 13.7 €/kg in 2020 to around 2.50 €/kg in 2050.

A second result is related to the investment required to supply and operate a hydrogen-powered ferry, compared to a conventional diesel-powered ferry. The operating costs of an H₂ ferry compared to a conventional ferry, taking CAPEX and OPEX into account, are 17% higher. There is a significant gap in fuel costs due to low bunkering prices (H₂ is obviously more expensive than diesel) and a large gap in related construction investments (of about 40%), which is only partly offset through lower maintenance costs and avoided carbon taxes.

The current CAPEX investment for the modernisation of a hydrogen-powered ferry with a capacity of 100 passengers is estimated at €5.4 million, taking into account the cost of the ferry (€2.0 million), the fuel cell system (€2.2 million, including both the permanent and degradation components), the hydrogen storage tank (€0.5 million) and modifications of the power electronics (€0.8 million). Upgrading a hydrogen-powered ferry requires a significant investment, which adds to the cost base of operating these vessels.

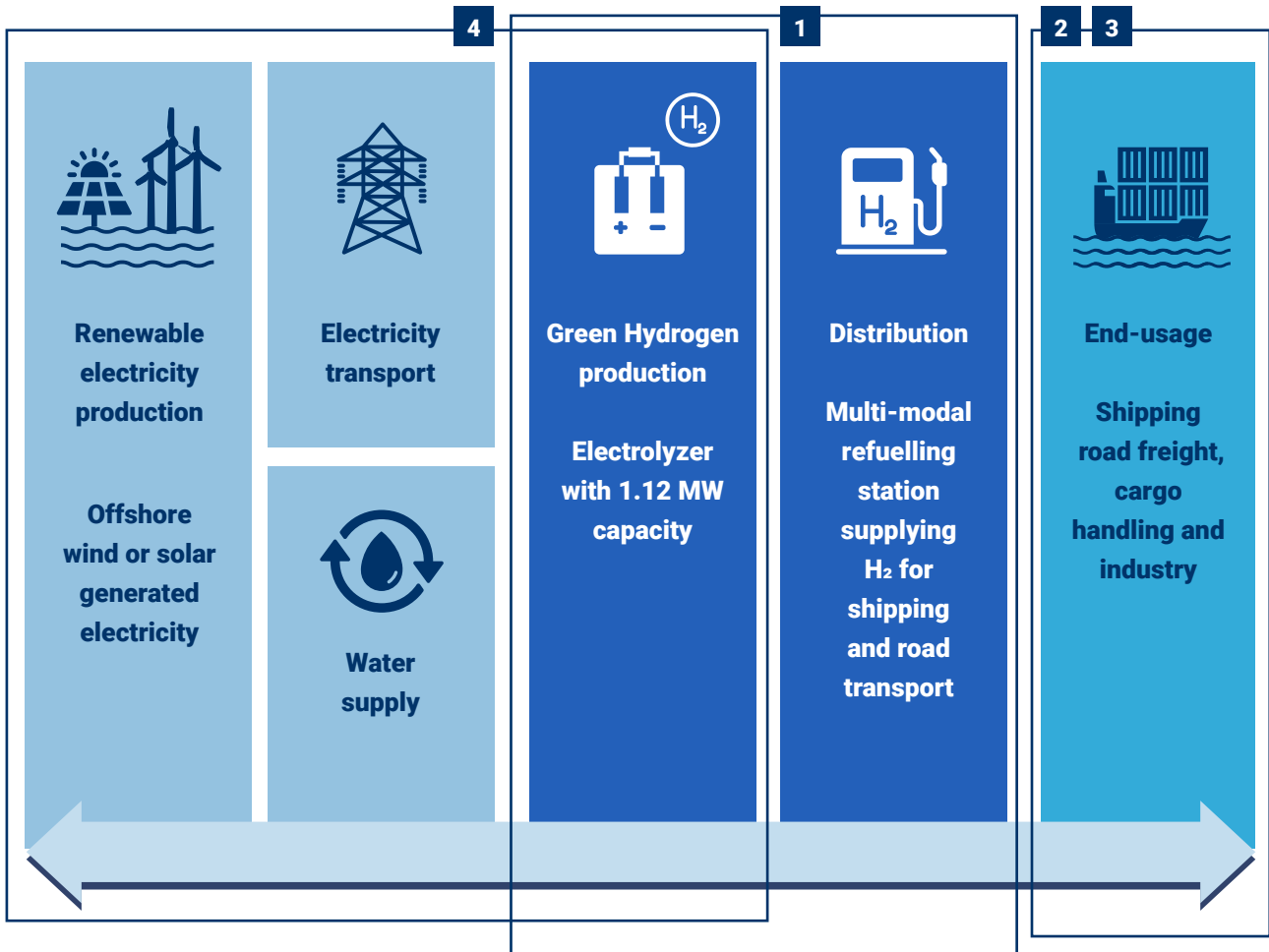
However, the cost of doing nothing is also associated with significant risks, as regulatory pressures (stricter standards, inclusion of shipping in the EU ETS, etc.) will increase and vessels will need to be adapted.

These actions will be linked to the preparation of a comprehensive feasibility study for a Mediterranean supply chain to import green hydrogen produced in the MENA region to Europe.

Indeed, the European Commission and the Clean Hydrogen Partnership highlight that the targets for importing green hydrogen into Europe can be achieved on schedule by leveraging maritime connections for transporting hydrogen in its liquid state. This strategic approach not only aligns with the production capacity but also capitalizes on the technological expertise of the Tuscan Coast region. Historically, this area has demonstrated proficiency in handling liquid-state gas operations at the port of Leghorn, alongside the presence of industrial players equipped to fabricate essential components like tanks and plant engineering required for the maritime liquid hydrogen supply chain.

Given the specific characteristics and scale of these industrial activities, their optimal location is at the quayside within port areas. From this perspective, the ports within the North Tyrrhenian system emerge as pivotal players, offering both industrial and strategic advantages. Their strategic positioning enables the realization of initiatives directly linked to ecological and energy transition goals.

Lastly, it is worth summarising the results of the study released in December 2023 by the Clean Hydrogen Partnership and the European Commission, entitled 'Study on hydrogen in ports and industrial coastal areas - Case studies' (carried out by Deloitte). As mentioned, the study conducted an in-depth analysis of 4 case studies of European interest, namely Rotterdam (The Netherlands), Antwerp-Bruges & Duiburg (Belgium, Germany), Klaipeda (Lithuania) and, precisely, the North Tyrrhenian Port System, the only one in the Mediterranean. The results were officially presented during the 'European Hydrogen Week' (Brussels, November 2023), organised by the European Commission, Hydrogen Europe and the Clean Hydrogen Partnership.



SCOPE

Caste study 1	Port of Klaipeda ■	▶ Hydrogen production – electrolyser
Caste study 2	Port of Antwerp-Bruges ■ ■ ■ Duisport ■ ■	▶ Hydrogen consumption – port equipment
Caste study 3	Port of Leghorn ■ ■	▶ Hydrogen consumption – transport (shipping)
Caste study 4	Port of Rotterdam ■ ■ ■ Port of Pecém ■ ■	▶ Hydrogen import

Link with archetypes: ■ Industrial ■ Logistics and Transport ■ Bunkering ■ Urban

Figure 4 | Source: SRM on Clean Hydrogen Partnership and Deloitte

After dealing specifically with the end-usage related to transport and shipping, the study highlights the considerable environmental, social and economic advantages for the Tuscan Coast related to the start-up of the Hydrogen Valley and, more generally, to the development of the hydrogen economy and logistics, among which we particularly mention the following:

- Reconverting existing productive assets towards green technologies.
- Enhancing the North Tyrrhenian port system as an innovation hub for technological hubs linked to the hydrogen supply chain.
- Reshaping traditional industry in the direction of the 'green industry cluster', in particular by leveraging existing industrial know-how on the Tuscan Coast (e.g. plant engineering for liquid gases).
- Developing the coastal area as a 'key energy import hub' towards the Italian and European hinterland, strengthening partnerships with non-European countries.

It should also be noted that, in the evaluation of the Clean Hydrogen Partnership, the start-up of the extended hydrogen supply chain of the Tuscan Coast represents a significant contribution to the 'Mission Restore our Oceans and Waters by 2023' launched by the European Commission, whose 'Charter' was signed by the AdSP-MTS.

This document, which constitutes the basis for the definition of the 'European Roadmap for Hydrogen in Ports and Coastal Areas', fully recognises the presence in the North Tyrrhenian port system and the Tuscan Coast of all the prerequisites to become a European-level player. From the point of view of the AdSP-MTS, of course, this is not a mere recognition, but an additional working tool, available to public and private subjects of the Tuscan Coast who will be able to present their own initiatives as protagonists within the European programmes dedicated to the green and energy transition.

6. Strategic conclusions and food for thought

Based on the outlined initiatives and projects, it becomes apparent that within the Italian context, particularly along the Tuscan Coast, the Port Network Authority holds the potential to serve as a facilitator during the inception and stabilization stages of the Hydrogen Valley. As previously noted, the Hydrogen Valley concept inherently operates on a local scale. Even within the Clean Hydrogen Partnership framework, emphasis is placed on the development of 'small', yet interconnected supply chains encompassing the production, storage, distribution, and utilization of green hydrogen.

In addition, the same study aligns with official forecasts of European institutions and the analyses of international organisations and specialised research centres, highlighting that the growing demand for hydrogen opens up valuable opportunities for European ports not only as facilitators of coastal Hydrogen Valleys, but as natural gateways capable of responding to the supply needs of green hydrogen. Within the framework of the Clean Hydrogen Partnership endorsed by the Commission, the establishment of hydrogen supply chain infrastructure is underscored as a 'no-regret investment'. Indeed, considering the projected demand, it's estimated that by 2050, 25% to 70% of hydrogen will need to be imported, contingent upon the pace at which individual Member States can ramp up their utilization of local renewable energies. Irrespective of the scenarios, Europe's heavy reliance on hydrogen imports is evident, primarily sourced from North Africa, the Middle East, and Latin America. In anticipation of this trajectory, the North Tyrrhenian port system holds the promise to emerge as a hub at the European level, thereby positioning the Tuscan Coast as a pivotal hydrogen gateway region.

Ports stand as pivotal infrastructures within the maritime economy, capable of redefining their historical

strategic role as energy hubs, now targeting sustainable energy sources and future carriers. Engaged in a challenging yet promising endeavour, ports embark on a new mission, epitomizing the concept of a 'development engine'. This entails the establishment of dedicated infrastructures for the supply, storage, and distribution of hydrogen, directed towards destinations of both national and European significance. Examples include the 'core economic regions', encompassing areas such as north-central Italy, southern Germany, Mitteleuropa, and Eastern European countries, which hold particular relevance for a port system like the North Tyrrhenian one.

In the domain of green hydrogen imports, ports function as vital 'enablers'. This poses a significant challenge: integrating designated areas into port planning tools to establish import hubs, followed by equipping ports with essential infrastructure and navigating the complex process of concession allocation to terminal operators.

Comprehensive analyses and tests, both pre and post-construction, are essential to ensure the efficient establishment of port terminals dedicated to hydrogen. Furthermore, consideration must be given to infrastructure for hydrogen supply and distribution beyond the port area. Embracing these innovative interpretations of the port's role will stimulate the development of manufacturing supply chains and foster a new phase of technology transfer crucial for realizing this energy revolution.

A final strategic element of paramount importance for the activation of the hydrogen economy is the development of the hydrogen-related economic fabric and the industry that produces the necessary components. Italy and the Tuscany region, particularly the coastline, are rich in players with key roles in the 'core' and 'ancillary' technologies required.

Due to their size, some components can only be constructed and assembled within port areas, requiring ports equipped for transportation, as in the case of hydrogen tanks. This aspect also presents a governance challenge for ports and introduces another potential use of port areas, which competes with alternative infrastructure uses. From this point of view, it seems clear that ports can be 'enablers' of the energy transition. To fulfil this role and benefit the national economic production system, it's essential to re-evaluate the traditional industrial function of ports, updating it to align with sectors demonstrating the highest development potential.

Chapter 11 | The energy transition in shipping. The viewpoint of Italian players

The shipping sector is currently dealing with the implications of recently introduced environmental regulations, namely ETS, Afir and FuelEU, which require shipowners to make investment in new vessels or in the environmentally friendly reconversion of existing ones to maintain fleet competitiveness both technically and commercially. Consequently, operational costs are expected to rise, leading to obvious impacts on freight rates.

1. European regulations on the energy transition

Since 1 January 2024, the maritime sector has been included in the ETS (Emission Trading Scheme)¹ involving an obligation to pay an emission surcharge for greenhouse gas emissions from ships over 5,000 gross tons (passengers and freight) calling at European ports.

Under the ETS, shipping companies will gradually need to purchase and transfer permits (EUAs) for every tonne of CO₂eq emissions released into the atmosphere during a calendar year, starting from 2024.

Inclusion in the ETS will be gradual, with obligations set at 40% for 2024, 70% for 2025, and 100% from 2026 onwards. There will also be a gradual inclusion for offshore vessels below and above 5,000 dwt, as well as for passenger and cargo vessels above 400 dwt.

The allocation of allowances and surrender obligations shall apply to the totality of emissions for ships making voyages from a port of call under the jurisdiction of a member state and arriving in a port of call under the jurisdiction of a member state, and for ships within a port of call under the jurisdiction of a member state. In contrast, emissions from ships between a port under the jurisdiction of a member state and a port outside the jurisdiction of a member state are only counted at 50%. Any emissions counted in this way (100% or 50%) are then subject to a surrender obligation in accordance with the above timetable. From 2024, monitoring and reporting obligations for greenhouse gas emissions from maritime transport (MRV) will gradually include methane (CH₄) and nitrous oxide (N₂O) emissions in addition to carbon dioxide (CO₂). Greenhouse gas emissions are subject to the surrender obligations of the EU ETS Directive according to the following schedule:

- Carbon dioxide: from 1st January 2025 (reference period: 2024);
- Methane and Nitrous Oxide: from 1st January 2027 (reference period: 2026).

The European Commission also published the list of shipping companies and their authorities for the inclusion of maritime transport in the EU ETS greenhouse gas emission allowance trading scheme, which came into force on 1 January.

¹ Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport and amending Directive 2009/16/EC.

Last July, the Council of the European Union definitively approved the new Alternative Fuels Infrastructure Regulation (AFIR) on recharging and refuelling infrastructures for alternative fuels and the FuelEU Maritime Regulation on the decarbonisation of maritime transport, as part of the European Commission's 'Fit for 55' programme.

The **AFIR regulation** envisages, among other things, that a minimum supply of shore-side electricity for container ships and passenger vessels in TEN-T maritime ports shall be ensured by 1 January 2030².

The new **European FuelEU Maritime regulation**, whose rules will apply from 1 January 2025, establishes limits on the greenhouse gas ('GHG') intensity of energy used aboard ships over 5,000 gross tonnage arriving in, within, or departing from ports of the Member States. Additionally, it mandates the use of shore-side power or zero-emission technology in ports of the Member States to promote the continued adoption of renewable and low-carbon fuels, as well as substitute energy sources.

The planned reduction will be gradual, with a decrease of 2% in 2025, 6% from 2030, 14.5% from 2035, 31% from 2040, 62% from 2045, reaching an 80% decrease by 2050.

The regulation also introduces an incentive scheme for the use of renewable fuels of non-biological origin (RFNBO) with high decarbonisation potential. It excludes fossil fuels from the certification process outlined in the regulation and mandates, from 2030 onwards, the use of shore-side electricity for passenger ships and container ships during stops in major EU ports to mitigate air pollution. Some exemptions apply, including berth stops of less than two hours and unavailability of connection points in port.

Time-limited exemptions are granted for connections to the outermost regions, smaller islands and areas highly economically dependent on their connectivity.

The regulation also includes a voluntary pooling mechanism, allowing ships to combine their compliance balances with one or more other ships. Additionally, it outlines the role of an independent verifier, separate from the company or ship operator, responsible for evaluating the reliability, credibility, and accuracy of data and information concerning the quantity, type, and emission factor of energy utilized onboard ships. Funds derived from penalties imposed for non-compliance will be earmarked to support collaborative projects aimed at the swift adoption of renewable and low-carbon fuels within the maritime sector.

On 6 February, the European Commission published an in-depth impact assessment on the guidelines for achieving zero emissions by 2050, recommending a 90% reduction by 2040 compared to 1990 levels. It also stated that a legislative proposal will be presented after the European elections.

The European Shipowners' Association (ECSA) welcomed the Commission's assessment, also with regard to regulatory measures to promote the production of sustainable fuels. Additionally, the WSC (World Shipping Council) urged the EU Commission to move towards achieving the emission reduction targets by developing a concrete investment plan and providing the necessary regulatory support for the transition.

² Article 9 - Targets for shore-side electricity supply in maritime ports:

- a. TEN-T core and TEN-T comprehensive maritime ports whose average annual number of port calls over the last three years by seagoing container ships above 5000 gross tonnes, in the previous three years, is above 50 have sufficient shore-side power output to meet at least 90% of that demand;
- b. TEN-T core and TEN-T comprehensive maritime ports whose average annual number of port calls over the last three years by seagoing Ro-Ro passenger ships and high-speed passenger craft above 5000 gross tonnes, in the previous three years, is above 40 have sufficient shore-side power output to satisfy at least 90% of that demand;
- c. TEN-T core and TEN-T comprehensive maritime ports whose average annual number of port calls over the last three years by passenger ships other than Ro-Ro passenger ships and high-speed passenger craft above 5000 gross tonnes, in the previous three years, is above 25 have sufficient shore-side power output to meet at least 90% of that demand.

On 29 February, the European Commission allocated €1 billion through the Connecting Europe Facility Transport (CEF Transport) - Alternative Fuels Infrastructure Facility (ARIF) programme. This funding is intended for project submissions by December 2025, aimed at constructing or enhancing European transport infrastructure to promote the utilization of alternative fuels in air, sea, river, and road transport.

2. The viewpoint of industry associations

On 21 December 2023, Assarmatori, Confitarma, and RINA presented the study **'From Today to 2050: Challenges and Opportunities for the Maritime Industry'** at the Italian Parliament. The study, resulting from collaboration between RINA's Italian Committee for the Decarbonisation of the Maritime Industry and the two Italian shipowners' associations, outlines the current state of the industry and potential solutions. It emphasizes the necessity of a clear and uniformly implemented international regulatory framework, investment in research and development, appropriate infrastructure for clean fuel availability, and training for the safe handling of new fuels. Additionally, it outlines various technological solutions for both new and existing ships. Notably, regarding alternative fuels, the study explores biofuels for blending with conventional fuels, liquefied natural gas, and carbon capture and storage technologies for short-term emission reduction. The potential use of small modular reactors is also discussed, alongside other solutions such as cold ironing and operational measures to reduce consumption.

Assarmatori and Confitarma subsequently sent the updated document **'The route to net zero. Together to decarbonise the maritime sector'** to the Committee of Experts of Cipom (Interministerial Committee for Sea Policies) and to the Chief of Staff of the Ministry for Sea Policies and Civil Protection. This was drafted together with Eni with the collaboration of Wärtsilä, WinGD and Man Energy Solutions, as well as Unem, Federchimica/Assogasliquidi, Assocostieri and Rina, as supervisor. The study analyses, among other things, the technological evolution of engines and the availability of infrastructures, as well as the options available in the short and medium term for the decarbonisation of the sector, also in terms of costs, in order to comply with the "targets of the FuelEU Maritime regulation, the requirements of the Ets (Emission Trading System) and Imo directive, as well as other national obligations". Finally, the research points out that the ETS will cost ship owners around three billion euros.

Finally, the ETD (Energy Taxation Directive), the last proposal still under discussion among those contained in the 'Fit for 55' package, could involve the taxation of marine fuels. According to Assarmatori, there is still a need for assessment regarding the overall impact of the various measures.

3. An analysis of the main technological solutions

Below is an in-depth discussion of possible solutions.

Bio-fuels derive from the transformation of organic substances of plant or animal origin, differently from e-fuels of synthetic origin which consist of hydrogen isolated by electrolysis of water, through electricity from renewable sources and carbon dioxide captured directly from the air or, much more conveniently, from concentrated source, including energy-intensive industries such as refineries, cement factories, steelworks, etc. According to a survey conducted on behalf of Accelleron Industries AG³, 92% of industry

³ World leader in turbocharging technologies and optimisation solutions for engines in the marine, energy, rail and off-highway sectors.

decision-makers claim that e-fuels can have a greater impact on emissions reduction than biofuels, LNG, fossil-derived hydrogen and conventional fuels combined with carbon dioxide capture systems.

Norwegian shipping company Color Line, which operates maritime connections with Sweden and Continental Europe, has started using biodiesel, supplied by Danish supplier Bunker One, to fuel its SuperSpeed 1 and SuperSpeed 2 ferries operating on the route between northern Denmark and southern Norway. The use of biofuel, which is obtained by refining animal fat and cooking oil mainly from local agriculture, has already reduced the CO₂ emissions generated by the two ferries by around 85%, according to the company, with the added advantage that no modifications to the ships' engines were necessary.

Nestlé is one of the big names in the global consumer goods industry that had already announced similar agreements with CMA CGM. Nestlé stated in late 2023 that it had signed biofuel agreements with the French carrier, as well as with Maersk and Hapag Lloyd. CMA CGM concluded another agreement with Nike for the use of biofuel, covering 36% of the volumes transported by sea. These agreements are part of the company's Net Zero by 2050 plan, launched in 2020, which includes the use of LNG and biomethane. At the conference last February, 'Energy for the Transition: From Ship to Quayside and Back to Port,' organized by the Propeller Club of Livorno, Giacomo Rispoli of MyRechemical illustrated the advantages of using biofuels, which result in almost total emissions reduction. Rispoli specifically highlighted 'circular methanol' derived from the transformation of waste into methanol, a technology that could render incinerators obsolete.

Caronte & Tourist S.p.A. has announced, through its chief executive officer, the initiation of negotiations for the supply, via tanker trucks from Sicily, of biomethane produced by various biodigesters. It is also noteworthy to highlight the development of biomethane⁴ incentivized through the Biomethane Decree for the establishment of new plants or the conversion of old biogas power plants.

LNG makes it possible to reduce carbon dioxide by approximately 20-25% and to significantly cut nitrogen oxide emissions and particulate matter. In this context, eight projects for LNG liquefaction plants have been awarded funding through the Supplementary Fund of the National Recovery and Resilience Plan (NRRP) dedicated to developing maritime LNG.

Assogasliquidi-Federchimica has stated that, as of December 31, 2023, there were 22 LNG-fuelled ships operating in the Mediterranean (+4 compared to 2022) and 4 bunkering barges used for naval bunkering. It also forecasts that by 2030, cruise ships will be the main type of vessel using LNG with bunkering at the main ports of the Mediterranean.

According to Shell's LNG Outlook 2024, global demand for liquefied natural gas (LNG) will increase by more than 50% by 2040.

The French company CMA CGM recently took delivery of the first of ten LNG-powered container ships, and plans to invest a total of \$15bn to upgrade the fleet.

Container shipping company ZIM announced that, upon completion of ongoing newbuilding investments, one-third of its fleet will be powered by LNG.

In 2023, Baleària deployed the fast ferry Margarita Salas, equipped with four dual-fuel natural gas engines and two electric-powered ferries.

⁴ Biomethane is the fuel obtained from the purification of biogas, which, after proper chemical-physical treatment (purification or upgrading), also performed in a place other than the production site, is suitable for the subsequent compression stage and injection into the natural gas network. This definition also includes fuel produced by processes for converting hydrogen obtained from renewable sources and CO₂ present in biogas intended for biomethane production or produced by biological and fermentation processes.

Regarding *carbon capture*, last September Ecospray, an Italian company that has installed more than 700 scrubbers on ships, presented two new technological solutions, developed in collaboration with the University of Turin, capable of capturing up to 80% of the carbon dioxide emitted by ships en route. These are available on the market from the first quarter of this year. Both systems capture CO₂ through chemical absorption, specifically with amines (organic compounds containing nitrogen) or calcium hydroxide. A third technology, in collaboration with the University of Genoa, using molten carbonate fuel cells (MCFCs), will be on the market in 2025. The different technologies may be applied according to the various needs of ship owners and existing installations.

A study commissioned by the Global Centre for Maritime Decarbonisation (GCMD), a centre established by the Port Authority of Singapore⁵, and conducted in collaboration with Lloyd's Register and the British consultancy ARUP, highlights, among other things, that few ports have the necessary infrastructure to unload liquefied carbon dioxide stored on ships. Additionally, the available facilities are primarily designed to handle food-grade CO₂.

With regard to the possibility of using small modular reactors, Fincantieri, Rina, and Newcleo, which operates in clean nuclear technologies and is active 'in the development of innovative Generation IV reactors using nuclear waste as fuel', have signed an agreement to carry out a feasibility study for applying lead-cooled small modular reactors produced by Newcleo to ship propulsion. According to the manufacturer, 'the mini-reactor would act as a small nuclear battery producing a 30MW electric output. This would require infrequent refuelling (only once every 10-15 years), very limited maintenance and easy replacement at end of life. In the event of an accident, the marine environment would be safeguarded as 'with newcleo's design the liquid lead inside the reactor would solidify as it cools down in contact with the cold water, enclosing the reactor core in a solid casing, and containing all radiation thanks to the shielding properties of lead'.

Regarding shore power, known as cold ironing, which entails supplying electricity⁶ from shore facilities to ships docked in port, Law No. 214 of 30/12/2023⁷ defines it as a 'service of general economic interest provided by the infrastructure manager'. Port authorities are empowered to participate in supply companies and identify forms of economic support in line with European standards. ARERA is not mandated to set a tariff but to offer discounts on tariff components related to system charges.

However, during the approval of the aforementioned law, the proposed amendment, jointly presented by Assarmatori, Assiterminal, Assocostieri, Assologistica, Assomarinas, Assoport, and Confitarma, aimed at including CERPs (Port Renewable Energy Communities) among the managers of cold ironing facilities, was not accepted.

The electrification of quays in all Italian ports will be financed through the €700 million contributions from the Supplementary Fund of the NRRP.

Among the **operational measures to reduce consumption**, worth mentioning is the installation of a wind turbine on the Ro-Ro pax ship GNV Bridge, built by Cantiere Navale Visentini, on the basis of an experimental project carried out in collaboration with Naos of Trieste. As stated by the company, 'the project aims to validate a technology for wind-assisted naval propulsion (WASP) by evaluating the Wind Sail Module (WSM) in operational conditions. The WSM utilizes wind energy to decrease thrust on ship propellers, thereby reducing fuel consumption for propulsion.

⁵ Together with BHP, BW, DNV Foundation, Eastern Pacific Shipping, Ocean Network Express and Sembcorp Marine.

⁶ From renewable sources.

⁷ 2022 Annual law for the market and competition.

The anticipated outcome is to diminish the environmental footprint, including greenhouse gas emissions and other pollutants generated by ships. This initiative seeks to foster an ecologically sustainable maritime transport system while also lowering operational costs’.

The Spanish company Bound4blue will install a 22-meter eSail system on board the ship ‘Na Pae e Hiro,’ currently under construction and scheduled for delivery in 2026. The eSail system consists of a ‘suction sail’ that harnesses the energy of the wind to propel the ship, significantly reducing the load on the main engines, resulting in fuel savings and reduced emissions. In addition to the eSail, the ship will be equipped with engines capable of running on biofuel or electric fuel. Bound4blue has also announced that it has signed commercial agreements with Louis Dreyfus Company to install 4 eSails on four more ships.

In the Turkish Gelibolu Shipyard, a cargo ship outfitted with the Econowind VentiFoil system was launched on behalf of the Dutch shipping company Conoship International. This innovative system harnesses wind power for propulsion, potentially reducing annual fuel consumption and CO₂ emissions by approximately 10%, contingent upon the specific shipping route.

Meanwhile, at the Turkish shipyard Rmk Marine, construction began on a new sailing vessel dubbed ‘Neoliner Origin,’ commissioned by Neoline Armateur and with Corsica Ferries as a vested party. This vessel boasts lanes accommodating 1,200 linear meters or 265 20-TEU containers, along with space for up to twelve passengers. Scheduled for delivery in June 2025, it will ply routes connecting the ports of Saint-Nazaire, Saint-Pierre-et-Miquelon, Baltimore, and Halifax. Outfitted with sails spanning approximately 3,000 sq m and supported by two carbon masts, the ship is projected to maintain a commercial speed of 11 knots. Anticipated fuel savings of 80% to 90% herald a significant reduction in greenhouse gas emissions.

As for other **alternative fuels**, it is worth mentioning that the Croatian state-owned company Jadrolinija will acquire a new hydrogen-powered ferry as part of the €18.9 million ZEAS (Zero-Emission Adriatic Ship) project. This initiative, funded with €13.5 million from the European Union’s ‘Horizon Europe’ programme, aims to facilitate sailing in the Adriatic Sea. The announcement came from the Croatian branch of the German Lürssen Design Center Kvarner, leader of a consortium of 14 partners from several European countries, including Jadrolinija, in building the ferry. The vessel will incorporate advanced technologies for hydrogen storage, distribution, and utilization, along with the installation of a hydrogen refuelling station on land.

In addition, last December the first hydrogen-powered tugboat in the world was launched at the Spanish shipyard Armon. This ‘Hydrotug’ was commissioned by the port of Antwerp alongside CMB TECH, a company belonging to the group Compagnie Maritime Belge specialised in the design and building of hydrogen or ammonia vessels as well as in the supply of such fuels. The tugboat will be dual fuel as it will also be able to run on traditional fuel.

Swedish company Gotlandsbolaget, operating maritime connections between the island of Gotland and continental Sweden, has started the ‘Gotland Horizon’ project for the development of an innovative ro-pax hydrogen-powered catamaran, thanks to the signing of a memorandum of understanding with Australian firm Austal.

The yachting world, which is sensitive to environmental issues, is also strongly interested in the use of hydrogen, and NatPowerH – a division of the NatPower Group, operating in the field of renewable energy – is currently working on a project to set up hydrogen filling stations in marinas. The €100 million project, which boasts among its partners the San Lorenzo and Baglietto shipyards, will kick off in Venice and it will aim at building about one-hundred filling stations across Italy, Greece, France and Spain over the next six years.

NatPowerH has also signed a partnership agreement with Bluegame from Sanlorenzo Yacht group, which is currently building hydrogen-powered support and assistance vessels for the US and French America's Cup teams. In addition to being a sponsor of the manufacturer, the company will be involved in the refuelling of the boats.

Hydrogen is the most abundantly available chemical element in the universe. Therefore, it holds potential as the fuel of the future, playing a key role in the energy transition especially in hard-to-abate sectors such as maritime transport. The main issues linked to using hydrogen derive from the fact that it is almost always bound to other elements such as oxygen in water or carbon in hydrocarbons. Separating it from these other chemicals is a very energy-intensive and therefore costly process.

IRENA (International Renewable Energy Agency), an intergovernmental organization whose aim is to facilitate the energy transition, maintains that by 2050 two thirds of hydrogen output will be 'green', or produced from renewable sources, differently from blue or grey hydrogen which are produced from fossil fuels. Indeed, IRENA forecasts signal a reduction of cost and thus of prices in the medium to long term, thanks to technological innovation and economies of scale. The colours of hydrogen mainly designate the way it is produced, as this element is colourless in nature. One of the ways to make hydrogen is electrolysis which divides hydrogen from oxygen in water through the use of electricity. If this energy comes from renewable sources, the hydrogen is defined as green. Currently, the most common form of hydrogen is the grey one, produced mainly thanks to natural gas and with high CO₂ emissions. When carbon capture and storage systems are employed, the hydrogen is defined as blue. Finally, if the production process uses energy from nuclear or coal plants or oil, the hydrogen produced is purple.

At Korea's Hyundai Mipo Dockyards, two gas carriers also propelled by ammonia are under construction for Exmar LPG, a joint venture between Exmar and Seapek, whose fuel system will be supplied by Wärtsilä Gas Solutions.

The Naples-based Grimaldi Group has ordered ten new ammonia-ready car carriers from the China Merchants Industry shipyard, potentially ready for the future use of ammonia as a clean fuel.

As part of the European project 'Gamma' (Green Ammonia and Biomethanol fuel Maritime Vessels), an initiative began last January with a financing of about €17 million. The project involves several Italian and European companies, along with the Politecnico of Milan. They are collaborating to convert a 60,000 dwt merchant ship by substituting the auxiliary generators with an e-fuel system.

Once the initial testing phase is concluded, the plan is to replace the main engines too. Here is how it works: ammonia and green methanol are loaded onto the ship, then transformed into hydrogen through a cracking and reforming plant. This hydrogen gets purified and converted into electricity using a fuel cell. That electricity powers the ship, replacing the need for auxiliary generators fuelled by fossil fuels. Also, to make things even greener, part of the energy required for the hydrogen conversion comes from renewable sources like photovoltaic panels.

The Politecnico of Turin will coordinate the Soffhice project (Sofc Hybridization with Internal Combustion Engine fuelled by Natural gas for maritime applications), in which the Universities of Genoa and Bologna will also participate and which is financed by the PRINPNRR initiative for a 24-month period. The project focuses on the possible coupling of a solid oxide fuel cell (Sofc) with an internal combustion engine (Ice), to then develop highly efficient and emission-free propulsion systems fuelled by natural gas, hydrogen, methanol and ammonia. These can be applied to existing ships and, in particular, to ferries on short routes including lagoon navigation or connections with smaller islands) to reduce nitrogen oxide, sulphur and particulate matter emissions.

As far as the dry bulk sector is concerned, Eastern Pacific has ordered four 200,000-dwt ammonia-ready vessels with scheduled delivery in 2028.

The shipping sector is showing growing interest in methanol, despite persistent issues related to production capacity and distribution infrastructure. Alongside Hania, JP Morgan has commissioned two 50,000-dwt MR Tankers from the Chinese shipyard Guangzhou Shipbuilding International. These vessels are equipped with dual methanol power and will be leased to Totalenergies.

It is noteworthy that 'traditional' methanol is produced with fossil fuels while green or renewable methanol is defined by the Methanol Institute as 'an ultra-low carbon chemical produced from sustainable biomass, often called bio-methanol, or from carbon dioxide and hydrogen produced from renewable electricity'.

The use of green methanol, according to Offshore Energy, reduces sulphur oxides (SOx) and particulate matter (PM) emissions, decreases nitrogen oxides (NOx) emissions by 60%, and nearly eliminates carbon dioxide (CO₂) emissions.

Smyril Line, a company from the Faroe Islands, has commissioned the Chinese shipyard CIMC Raffles to build 2 Ro-Ro ships, to be delivered in 2026, for use on the route between the Faroe Islands, Norway, and Iceland. The ferries will be equipped with batteries and technology for shore power supply in port waters, powered by green methanol.

Ethanol is another alternative fuel worthy of mention, provided it is produced without carbon dioxide emissions. Its use results in very low particulate emissions and lower levels of nitrogen oxide compared to traditional fuels, as demonstrated by a study conducted by shipbroker Arnaud Lecoanet and published by Riverlake, a leading naval brokerage firm specialising in the transport of renewable fuels such as FAME (Fatty Acid Methyl Ester), vegetable oils, ethanol, and renewable HVO diesel. Furthermore, ethanol, which is currently blended with traditional fuels, could also be used alone with minimal modifications to ship engines.

Wärtsilä, a leading developer of engines, digital technologies, and propulsion systems for the maritime sector, is also interested in exploring the potential of ethanol as a fuel, capable of significantly reducing CO₂ emissions. To this end, it has entered into a strategic partnership agreement with Raízen, a Brazilian energy company engaged in energy transition and active in the production of ethanol, including second-generation ethanol derived from bagasse from sugar processing and regular ethanol. The agreement entails conducting technological tests with ethanol as fuel in Wärtsilä laboratories and collaborating with Raízen on the interaction with naval designers and shipowners, as well as on regulations for ethanol use.

In conclusion, there are many alternative fuels to reduce greenhouse gas emissions, but important issues remain to be resolved, such as their availability, safety and efficiency, storage infrastructure, cost and, therefore, their competitiveness on the market. Lastly, the adaptation of the propulsion systems of operating ships to the different types of fuel.

Meanwhile, the worldwide orderbook of the maritime fleet at the end of 2023, according to Clarksons, consists of 49% alternative fuel ships, with the largest share represented by LNG and methanol dual fuel units. Hydrogen, ethane and biofuel ships also feature, somewhat less prominently, in the overall order book.

At the CLIA European Summit 2024, cruise lines called for a greater commitment to green policies by European institutions and to allocate part of the resources from the ETS to the development of a global supply chain for alternative fuels. According to CLIA (Cruise Lines International Association), 55 cruise ships will be built globally, about half of which will be built in Italy. Out of all the new vessels, 36 will be LNG-powered and seven will be methanol-powered, i.e. prepared to use it. CLIA has also commissioned Rina to carry out a study to ascertain the current and future status over the next five to ten years of the use of alternative fuels and related infrastructure.

4. The Italian players' viewpoint

To provide a tangible foundation for the analysis conducted, a series of inquiries were conducted with key stakeholders in the Italian shipping industry. These inquiries sought to ascertain their perspectives on two key topics:

1

In light of the implementation of the ETS, what potential alternatives could be considered in the near term to reduce emissions?

2

Which of the alternative fuels (biofuel, methanol, ethanol, hydrogen, etc.) could be considered the most promising in the long term?

The following arguments were presented in response to these inquiries.

Marialaura Dell'Abate, Amoretti Armatori Group

The Amoretti Armatori Group is a prominent player in the Italian and European maritime transport market for chemical and petroleum products, serving the most prestigious energy majors on an international scale. The company's headquarters are in Parma, while its other two logistic locations are in Augusta and Rotterdam. This reflects the traditional operational scope of the fleet, which operates in the Mediterranean and Northern Europe.

1

The EU-ETS legislation represents the most recent piece in a broader course of action that has been underway for years within the maritime sector. The objective of reducing emissions has been guiding the company's strategy for a considerable period of time. Over the past ten years, numerous transactions have been pursued, including two newbuildings that are already in operation. This approach has been taken in order to maintain a young and technologically advanced fleet. This allows us to achieve environmental standards that an older vessel could not provide. The challenge today is to incorporate a series of solutions and technologies that, operating in parallel, allow the ship to emit as little as possible.

2

It is challenging to provide a definitive answer to this question, particularly in light of the varying interpretations of the term "future". If we consider the "NET ZERO" IMO 2050 targets, it will be necessary to use fuels with a very low emission factor. However, at present, it is difficult to identify a single fuel that can be considered the most suitable for all applications. Instead, it is possible to assume that different fuels will be used, selected according to the size and characteristics of individual ships.

Domenico Ievoli, Marnavi S.p.A.

The Group, founded in 1910, operates in the global market for the transport of chemicals and foodstuffs, managing, among other things, transport contracts with major petrochemical companies. It is also active in the anti-pollution and offshore sectors. Its offices are in Naples, Milan and London.

1

The aspect of emissions has been a matter in the spotlight for some time. Indeed, in the context of the numerous technical regulations that impose compliance with and/or monitoring of certain indices, such as energy efficiency (EEXI) or CO₂ emissions (CII), we have been attempting for several years to adopt all possible solutions to reduce emissions. This aspect will undoubtedly become increasingly present in shipowners' choices. The measures range from substantial refitting (e.g. refitting bulbs or optimising propellers or installing air bubble systems to reduce friction) to more detailed measures (such as programmes for optimising ship trim, applications for optimising flows, adopting the latest generation of antifouling). Of particular interest is the carbon capture system, which is currently still being studied for optimisation, although some manufacturers have already proposed solutions on the market.

2

In the short term, the adoption of biofuel could be a viable solution. Its impact is less invasive, as the engines do not require any particular modifications. The supply network is already in place, and the on-board containment arrangements can be easily converted. Furthermore, the performance of the engines with biofuel is virtually unchanged. Conversely, methanol, hydrogen or ethanol, given the significant modifications required on board to satisfy the aforementioned criteria, are alternatives that are still far from the level of sustainability and reliability that can guarantee the day-to-day operation of ships. It is therefore imperative that we continue to pursue the study of these alternative fuels in order to have more and more prospects of reducing and/or eliminating CO₂ emissions into the atmosphere.

Carlo Visentini, Visentini Attilio Group

The Visentini Group has been active since 1964 in the construction and management of Ro-Ro and Ro-Ro pax ships, an activity still prevalent today for the Group. Over the years, Cantiere Navale Visentini has built several vessels, ranking seventh among the world's top twenty shipyards for the construction of Ro-Ro and Ro-Ro pax ships by orderbook. It is based in Porto Viro - Rovigo.

1

- *Service rescheduling (reducing time in port and speed at sea). We have, in fact, noticed that above 20 knots, consumption rises more than proportionally to the increase in power, so optimising loading operations ashore/port allows significant savings in terms of speed at sea, consumption and CO₂ emissions.*
- *Installation, as far as possible, of energy recovery systems (ORC, Heat Recovery/Carbon Capture). On our new vessels, we are, in fact, evaluating the installation of systems that allow us to recover heat but also any energy dispersion. Studies show, in fact, that each application allows some improvement in terms of consumption and CO₂.*
- *Wind energy (WPS): on the C235 we are evaluating the installation of at least two wind turbines, which must be retractable to avoid interfering with loading operations when using cranes from the ground.*

2

Viable fuel in the short term: methanol (the C236 will be Methanol Ready, while we are working so that the C235 can be Full Methanol). All the other fuels present a number of problems related to the distribution network, storage and general management.

Chapter 12 | **Special Economic Zones as a tool for territorial development: the case of Dubai and the prospect for the Italian proposal**¹

In a global economic context affected by diverse crises and where Global Value Chains are increasingly longer and more vulnerable at the same time (Xing *et al.*, 2023), it becomes essential for territories to boost their competitiveness and attractiveness to investment. To this end, one of the most common tools used worldwide and especially in emerging countries is Special Economic Zones. Nonetheless, it is complex to assess their impact on local growth and development, as success stories such as the Chinese ones are counterbalanced by unsuccessful cases like the African SEZs.

The Dubai SEZs can be considered among the most successful in the world and are the pivot of the economic expansion and diversification strategy pursued by the Emirate State since 1985, when the Jebeli Ali Free Zone was established. This was then followed by 25 more Free Zones which have contributed to make Dubai a prime Global City.

Italy has also recently decided to implement SEZs as a tool for revamping the Mezzogiorno and so eight SEZs were initially established and then, from 1st January 2024, these were included in the Italian Single SEZ.

In this chapter, we will therefore analyse the SEZ tool in order to assess its effectiveness and the elements that characterise its success, delving into the case of Dubai and trying to draw useful lessons for the proper implementation of the Italian Single SEZ.

1. SEZs as a tool for territorial development: amid successes and failures

SEZs are a widespread phenomenon at global level² with 20% of the world's traded goods coming from SEZs (Mosle, 2019), but they are mainly concentrated in emerging countries. The purpose of SEZs is to attract Foreign Direct Investment, primarily from large multinational corporations (Aggarwal, 2012; Omar & Stoeber, 2008) which are often export-oriented (OECD, 2017), to create jobs and promote regional

¹ This article was selected on the occasion of the "Italian Maritime Economy 2024" call, launched in the context of #Meets4Future, SRM's project dedicated to tomorrow's key players which, to date, includes a community of 15 young graduates from all over Italy.

² According to the latest 2019 UNCTAD survey, there are 5,383 with a 20% rise on 2014.

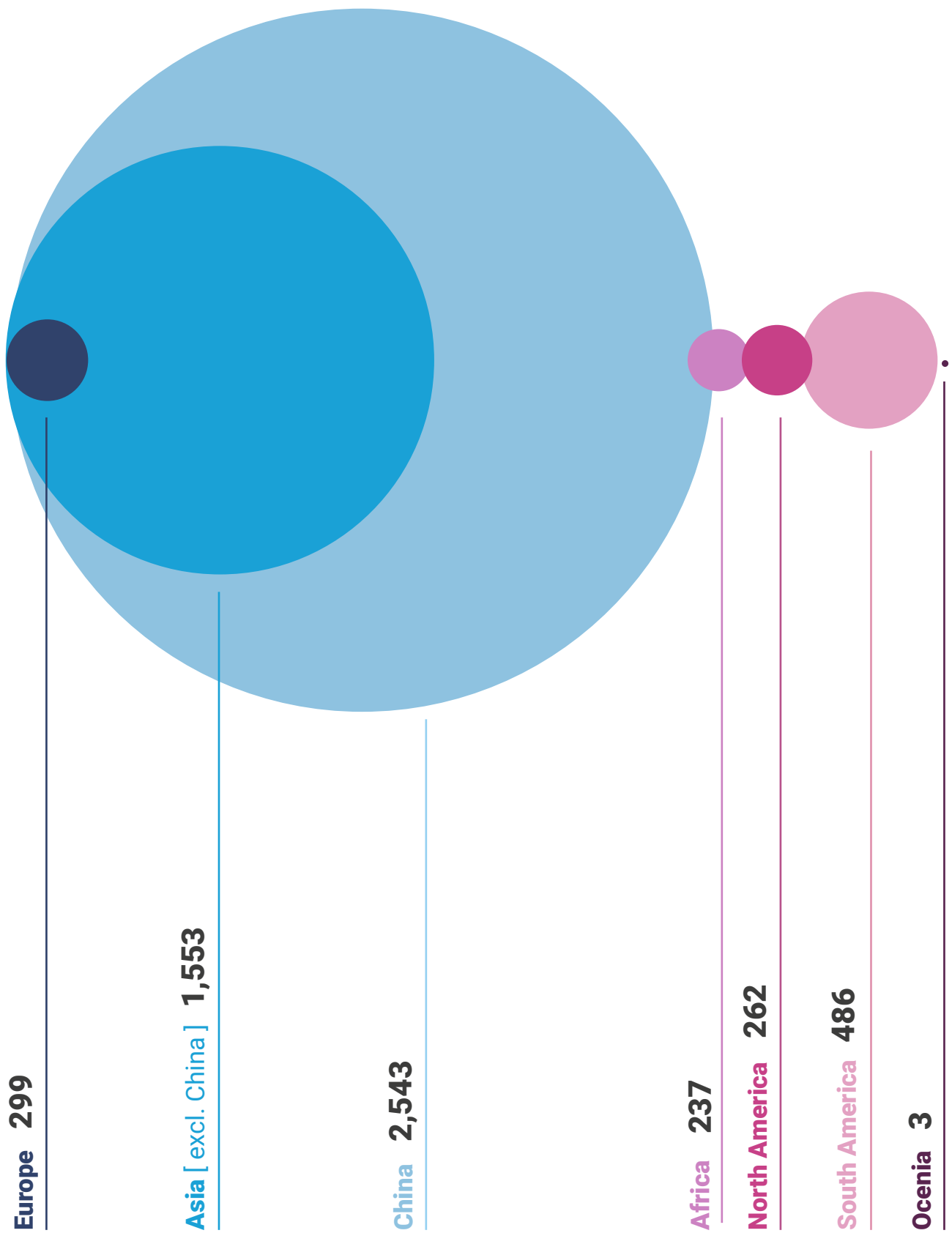


Figure 1 | Source: SRM on author's elaboration. Data from UNCTAD World Investment Report 2019

development, to diversify economic activities, foster knowledge transfer, create innovative hubs and clusters, and to strengthen countries' position in certain global value chains by lowering intermediate costs (UNCTAD, 2019; Aggarwal, 2012; Benevolo *et al.*, 2022; Rubini *et al.*, 2015; Farole, 2011; OECD, 2023; Newman & Page, 2017). SEZs are generally part of an overall development strategy by the countries adopting them (Newman & Page, 2017) and can only be considered successful or unsuccessful by referring to the objectives of the strategic vision of which they represent only a part (Rubini *et al.*, 2015). Specifically, they must aim to address the hindrances to development in certain territories (Mosle, 2019), from which it follows that SEZs in their creation must have a strong component of territorial specificity (Aggarwal, 2017).

To meet these objectives, companies establishing operations in the target areas are offered four types of advantages within the identified SEZs, distinguishing them from the remainder of the national territory (Farole *et al.*, 2013):

1. Infrastructure, services and more easily accessible areas for investment
2. More efficient and deregulated bureaucratic system
3. Facilitated customs regime
4. Attractive Tax Regime.

Evaluating Special Economic Zones (SEZs) is not straightforward, as the literature often focuses on success stories, neglecting failures. This suggests that the effectiveness of SEZs may not be very high (Farole *et al.*, 2013). The literature review indicates that Special Economic Zones (SEZs) are attractive for Foreign Direct Investment (FDI), with a large percentage of FDI in China (80%) and Malaysia (90%) concentrated in these areas (UNCTAD, 2019). SEZs also support exports, especially where trade barriers are low (Davies & Mazhikeyev, 2019), as demonstrated by Costa Rica (50%), Dominican Republic (77%), and United Arab Emirates (40%) (Akinci & Crittle, 2008; UNCTAD, 2019).

Companies operating in SEZs often outperform those outside them. However, the benefits in terms of skilled employment and positive spillovers to surrounding areas are more controversial. Export-oriented SEZs tend to create low-tech employment, and positive spillovers are limited to a radius of about 50 km from the SEZ (Frick & Rodriguez-Pose, 2019).

The overall impact of SEZs on economic growth compared to the rest of the country remains uncertain. Only 19% of SEZs show higher growth than the rest of the country, and in many cases the growth rate tends to decline over time (Frick *et al.*, 2019). SEZs can also lead to negative economic impacts, such as lower tax revenues and high infrastructure costs (Wang & Wei, 2022).

Successful cases certainly include Costa Rica (Monge-Gonzales *et al.*, 2005), China³ and other Southeast Asian countries such as South Korea, Taiwan, Malaysia which have been able, with an incremental process functional to the overall development of their countries, to attract investments in innovative sectors thus generating knowledge spillovers that have enabled the growth of a local productive fabric (Frick & Rodriguez-Pose, 2019; Aggarwal, 2017; Jayanthakumaran, 2003), while in most cases the weakness of local firms, inadequately supported, did not allow integration into value chains within SEZs (Brussevich, 2020). Conclusions on the effectiveness of SEZs are mixed for the Polish case (Ambroziak & Hartwell, 2018; Cizkowicz *et al.*, 2015; Jensen, 2018). Some scholars suggest that SEZs work best in competitive and growing national contexts (Davies & Mazhikeyev, 2019; Zeng, 2021).

³ There are several studies on the Chinese SEZs, including Adlet *et al.* (2016), Wang (2011), Di Tommaso (2009).

2. United Arab Emirates and the Dubai model. Free Zones for diversification and clusterisation

One of the emerging countries that is currently among the most active and attractive for investment is the United Arab Emirates, ranking first among the countries of the GCC, MENA area and Western Asia by incoming FDI flows (Figure 2).

Incoming FDI flows in countries of the Gulf Cooperation Council

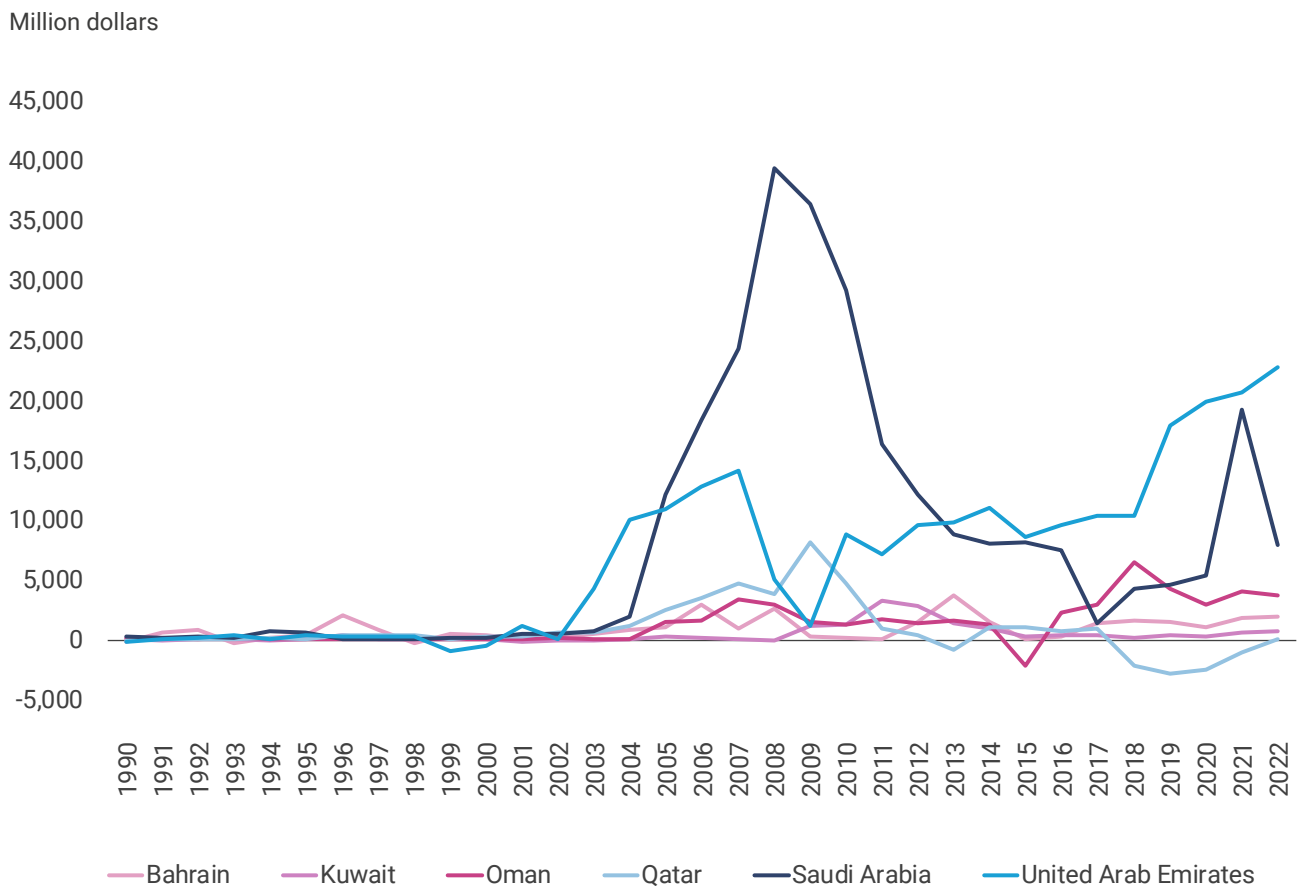


Figure 2 | Source: author’s elaboration on Dubai FDI Monitor

Among the seven Emirate states that make up the group of the UAE, Dubai seems to be the most dynamic and attractive for FDIs (Table 1). The Financial Times’ 2022 FDI Markets annual report has highlighted Dubai’s top position in the world for greenfield investment and for projects on advanced IT which account for the largest share of FDI investment. Dubai now stands at the top of major rankings that measure the competitiveness of the world’s leading cities – 8th in the Global Power City Index 2023 and rated Alpha+ by the Globalization and World Cities Research Network.

Compared to the other emirates, Dubai is characterised by the scarcity of oil resources and consequently by the low weight these have on its economy (Figure 3), a circumstance that has not prevented the small emirate from showing even better growth rates than the overall economy, except for a greater decline as a result of the pandemic caused by its role as a logistics hub (Figure 4).

Overview of FDIs in Dubai, 2015-2023

Year	Number of projects	Total FDI capital (bn US\$)	% of investment in medium-high technologies
2015	341	3.64	73.02
2016	317	4.72	67.51
2017	396	7.37	61.62
2018	550	10.83	45.27
2019	598	17.74	45.32
2020	474	6.60	57.17
2021	620	6.47	65.81
2022	1,185	12.18	63.12
2023	838	5.57	62.05

Table 1 | Source: author's elaboration on Dubai FDI Monitor

Share of oil trade against GDP

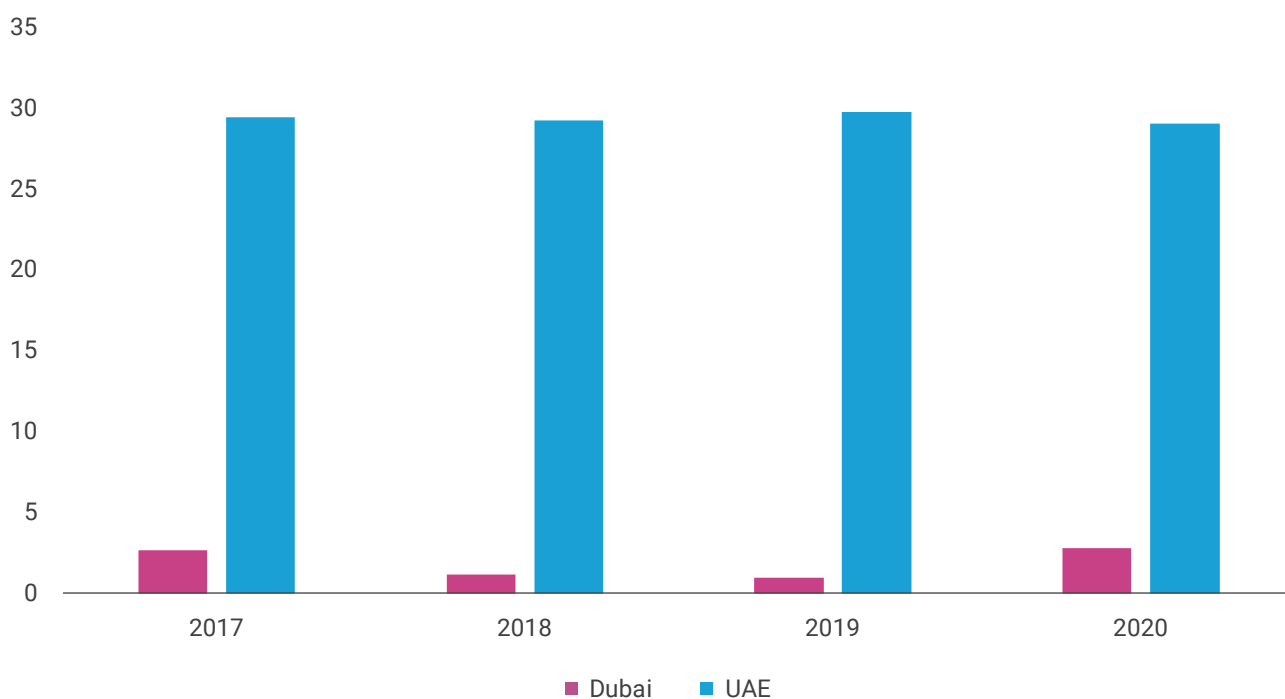


Figure 3 | Source: author's elaboration on Annual Economic Report (UAE) and Dubai Statistics Center (Dubai)

GDP trend

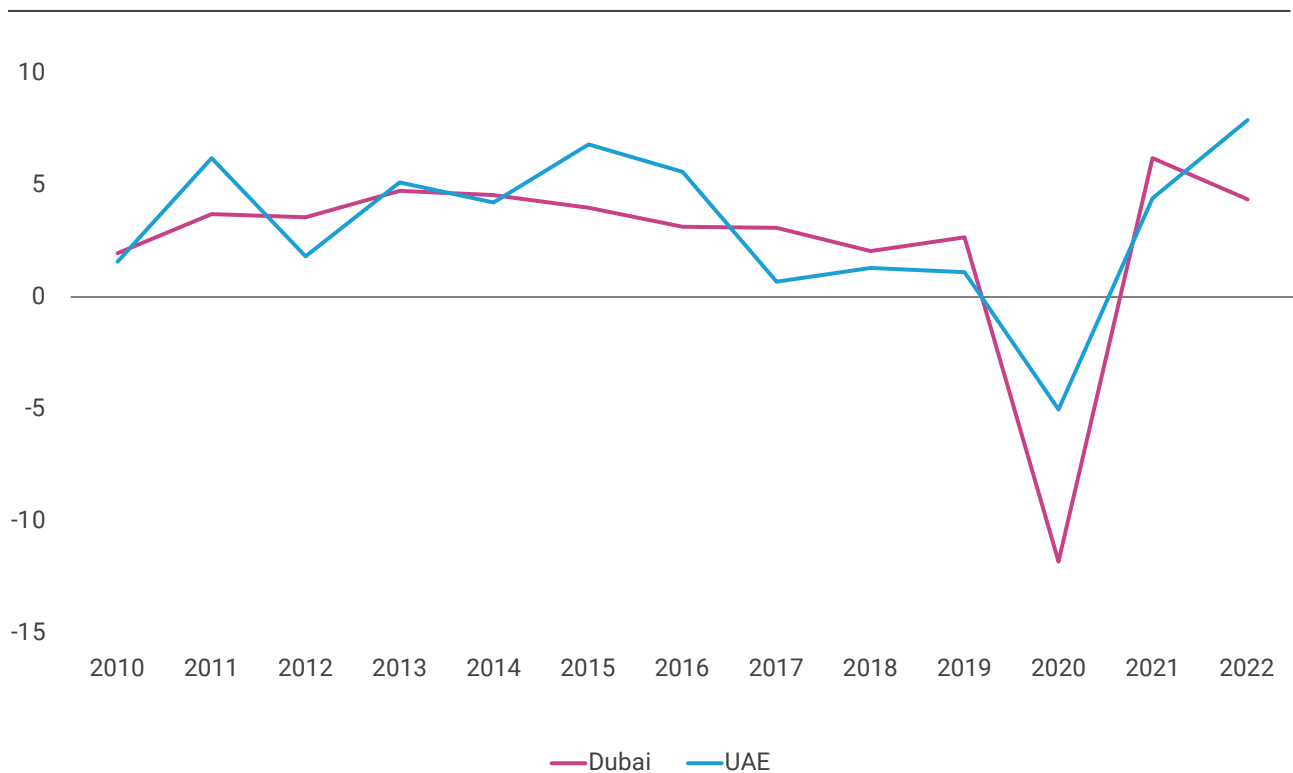


Figure 4 | Source: author's elaboration on World Bank (UAE) and Dubai Statistics Center (Dubai)

The emirate of Dubai has achieved success through its distinctive development and diversification strategy, known as the 'Dubai Model' (Hvidt, 2009). This model is based on the total centralisation of decision-making processes and their rapid implementation at all stages, from planning to execution. Starting from its role as a commercial bridge between East and West, Dubai has built its identity on openness to foreign cultures and regulations, especially in common law, within Free Zones. This attracted foreign capital through Free Zones and fostered the development of sectors such as advanced services, logistics and luxury tourism. The strategy allowed Dubai to gain a foothold in the advanced services and logistics sector, bypassing traditional manufacturing industrialisation (Matly & Dillon, 2007; Hvidt, 2009). As early as the 1960s and 1970s, aware of the limited lifespan of oil resources, Dubai invested the proceeds in the construction of logistical infrastructure, such as the Jebel Ali airport and port in 1979, the largest man-made port in the world (Al-Saleh, 2018). These investments initially aroused scepticism, but the Dubai government's strategy, centred on a long-term vision, focused on anticipating demand, with a focus on the supply of infrastructure and services (Hvidt, 2009).

Within this strategy, aimed at attracting FDI, but also foreign workers, a key role has been played by the FZs. The first one, that of Jebel Ali itself, was followed by 25 others, which according to the Dubai Free Zone Council generated 38% of the Emirate's GDP and 42% of its exports in 2021 (Figure 5).

Dubai Free Zones, whose only limitation is the direct access to the UAE internal market, are competitive because they offer a favourable environment for investment and a series of specific advantages, which can be listed as follows:

1. The potential to have full ownership of companies in Free Zones (unlike outside Free Zones).
2. Tax exemptions applying to both companies and individuals.

3. Capital can be freely moved out of the UAE.
4. Simplified bureaucratic procedures.
5. Low transport costs and advanced connection infrastructure.
6. Legislation and regulations within Free Zones separate from those in the UAE and based on a Western model.
7. Each Free Zone operates with autonomous governance.⁴

Overall value and origin of Dubai exports, 2021

Bn USD

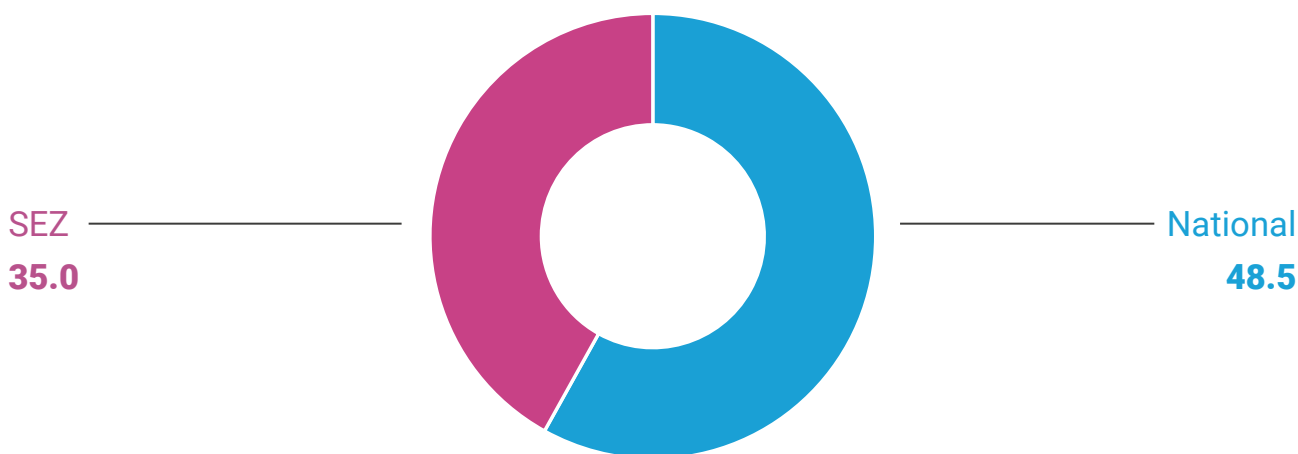


Figure 5 | Source: author's elaboration on Dubai Statistics Center

As noted above, Dubai's first free zone (FZ) project was the Jebel Ali Free Zone (JAFZ), established in 1985 primarily to facilitate warehousing for ships in the port. This initiative marked the beginning of economic diversification and the preservation of economic and political autonomy from Abu Dhabi (Keshavarzian, 2010). Over the years, JAFZ has consolidated its position as the country's leading FZ and one of the most important in the world. In 2023, it was awarded the title of the world's best FZ for non-fiscal incentives, sustainability and industrial excellence by fDi Magazine. With more than 9,000 companies located within its boundaries, the JAFZ generates approximately \$150 billion in trade and \$500 million in revenue, collectively contributing to 21% of Dubai's GDP (Mogielnicki, 2021). Companies operating in JAFZ can count not only on the port, but also on Al-Maktoum Airport and a system of logistics infrastructure for both short and long-term rentals, and above all on advanced business services, including a fintech platform (fDi Magazine, 2023). JAFZ has broadened its scope to include automotive, petrochemical, agribusiness and electronics companies (JAFZ website), but its core business remains logistics, which has made Dubai the world's third largest re-export centre after Singapore and Hong Kong (Matly & Dillon, 2007). The success of the JAFZ prompted Dubai to create other FZs with a sectoral and innovative projection that contributed to the rebranding of Dubai's image from a commercial centre to a logistics, financial, tourism and services hub (Al-Saleh, 2017). In this context, the first sectoral free trade zone not related to physical trade, Dubai Internet City, was created (Delimatsis, 2021), followed by all other sectoral FZs as part of Dubai's industrial strategy to attract more investment in knowledge-intensive sectors.

⁴ The Free Zones of the innovative cluster operate under the supervision of the Dubai Development Authority.

Among these, of particular importance for Dubai's economy is the Dubai International Financial Center (DIFC), established under the direct control of the Emir of Dubai with the aim of making the emirate one of the world's major financial hubs and the leading one in the region between Africa and South-East Asia thanks to Nasdaq Dubai, the emirate's stock exchange, and advanced innovative financial services for businesses⁵. One of the strengths of the DIFC is the transparency of the regulatory system guaranteed by three independent bodies, the DIFC Court, the DIFC Authority (with related subsidiaries) and the Dubai Financial Services Authority, which ensure the application of a common law system separate from that of the emirate (Delimatsis, 2021). The DIFC also stands out for its Innovation Hub for innovative start-ups, especially in the FinTech sector, and its Academy for the training of high-level human capital in the financial, legal and 'Future Skills' sectors (DIFC website).

3. Conclusions: successful aspects of SEZs and lessons for the Italian Single SEZ

The successful case of Dubai, as well as others in the literature, cannot represent an unambiguous model of success, because one of the key factors of a SEZ is the consistency of planning with the country's overall development strategy (Farole, 2011). As highlighted in the literature, tax incentives are no longer an attractive factor for SEZs per se, all the more so in the context of the European Union (van der Berghe, 2022; Benevolo *et al.*, 2022). A competitive SEZ in a competitive environment, needs quality of institutions, governance, independence and financial autonomy, but what matters above all is working on the comparative advantages of a territory or creating new ones, as the DIFC did for Dubai (Rodríguez-Pose *et al.*, 2022; Zeng, 2021), strengthening local value chains (Ambroziak, 2016), providing training, investing in innovation, ensuring quality business services and competitive infrastructure in a clear regulatory scheme that creates a favourable environment for investment, such as in the JAFZ (Rodríguez-Pose *et al.*, 2022). The Italian single SEZ that is being set up, although operating in a potentially competitive context, unlike Dubai cannot count on a financial endowment and autonomous governance, but above all it cannot rely on an overall vision that starts from a national development plan enhancing the innovative clusters of the South (Cersosimo & Viesti, 2012), and above all it does not provide for the necessary complementarity of business services and investments in human capital training. A SEZ is not an end, but a means to achieve the purpose of a territory's development; it can only be an opportunity if it is well planned, otherwise there is a risk of inefficiently distributing insufficient resources for the sole purpose of being able to say that an attempt has been made. The case of Dubai, as well as those of TangerMed or Suez, suggest that territorial development can be planned, with respect to market dynamics, with a precise vision of the competitive and comparative advantages of a territory. After all, the localisation and re-localisation choices of companies no longer depend on competitive wages and tax incentives (UNCTAD, 2019), but on the capacity of territories to offer access to competences in innovative clusters that can and must be the result of a correct application of the SEZ tool.

⁵ The companies operating in the DIFC include, among others, AON, Bank of China Middle East, Barclays, BNP Paribas, Deutsche Bank, Intesa Sanpaolo, Moody's, Morgan Stanley.

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SRM's experience in the field of economic research about port and logistic infrastructure has resulted in the creation of the Permanent Observatory on maritime transport and logistics which is currently a point of reference for the whole cluster in this sector, both nationally and internationally. Research, papers and surveys represent the result of regular and thorough monitoring of the economic dynamics regarding shipping and the main sectors or territories where the maritime economy plays a key role.

SRM also publishes the Annual Report 'Italian Maritime Economy' which collects the most significant analyses and research work carried out by the aforementioned Observatory over an entire year, alongside detailed studies of the typical phenomena shaping the role of the Mediterranean in the global maritime context. Each annual issue includes the contributions of renowned experts and is enriched by the collaboration of prestigious national and foreign institutions who provide further added value to this research endeavour.

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The report, now in its 11th edition, delves into the significant developments shaping maritime transportation, particularly in light of recent events in the Suez Canal, connected to attacks by the Houthis on ships passing through the Red Sea.

This has greatly affected routes, freight rates and the cost of raw materials as well as the fluidity of global supply chains, especially with regard to traffic between the Mediterranean and the Far East.

The present volume also boasts a variety of in-depth analyses sharing a common core made up of three drivers, namely innovation, sustainability and new port models.

These papers have been conducted by SRM's international partners and include special case studies of advanced countries that have successfully invested in the aforementioned drivers.

At the same time, the specialised departments of Intesa Sanpaolo have developed in-depth articles analysing raw materials and the energy transition. Other topics covered in this report include the development of intermodal transport, overseen by the Port Network Authority of the Western Ligurian Sea (AdSP), the Emission Trading System (ETS), and the spread of hydrogen in ports.

A specific essay dedicated to Special Economic Zones (SEZs) was curated by one of the young members of the SRM's #Meets4Future community as an example of analyses and elaborations carried out by emerging researchers.

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