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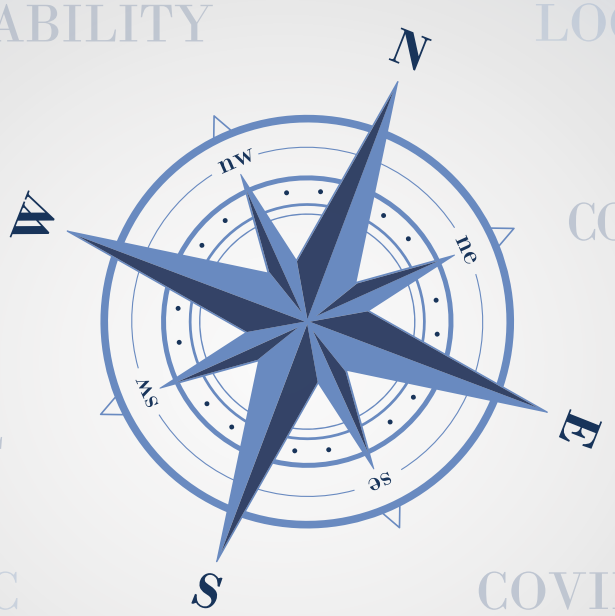
Italian Maritime Economy

The impact of Covid-19 on maritime transport: strategic routes and global scenarios

Intermodality and sustainability as keys to the Italian recovery

7th Annual Report

2020



SUSTAINABILITY
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“Joins the sea that separates the countries”
Alexander Pope

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Acknowledgements and notes

The 2020 Annual Report on *Italian Maritime Economy* is part of a broader research project launched by SRM and called 'Permanent Observatory on the Economy of Maritime Transport and Logistics', from which the specialized website www.srm-maritimeconomy.com was born. This has the primary aim of monitoring and analysing the dynamics and economic impact of the sector in the economy of the country with a European and Meterranean scope.

We wish to thank all the **supporting partners** of the project: Assoporti (Italian Ports Association), Port Network Authority of the Ionian Sea, Port Network Authority of the Central Tyrrhenian Sea, Port Network Authority of the Sardinian Sea, Port Network Authority of the Central North Adriatic Sea, Confetra, Contship Italia, Federagenti, Fedespedi, Grimaldi Group, Lotras, Morandi Group, MSC CROCIERE, Unione Industriali Napoli.

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Chapters VIII-IX-X-XI are part of a broader research on the Arctic Maritime Route carried out by Intesa Sanpaolo and SRM with the collaboration of the University of Antwerp and the Shanghai International Shipping Institute. A special thanks goes to Intesa Sanpaolo President Gian Maria GROS-PIETRO for the support provided in the design and promotion of this study. We would also like to thank Giovanna PALADINO, Head of the Technical Secretariat of the Presidency, who was amongst the promoters and coordinators of this work.

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This work was possible thanks to some significant scientific missions SRM carried out and which made it possible to sign agreements with prestigious centres of studies and to gather data, information and documents which resulted in considerable value added to this publication.

During the different missions and through direct visits of the ports, it was possible to comprehend the most interesting port models and maritime phenomena currently affecting the various global situations.

In particular, in February 2020 a mission was carried out in **Antwerp** which made it possible to implement a programme of technical meetings aimed at gaining in-depth knowledge of topics connected to the Arctic Maritime Route. To this end, we wish to thank Prof. Thierry VANELSLANDER of the University of Antwerp for the organizational and operative support provided.

SRM is also a member of the **Global Shipping Think Tank Alliance** forum of international studies specialized in maritime and logistic matters, coordinated by the **SISI-Shanghai International Shipping Institute** and **KMI-Korea Maritime Institute**. Every year, the prestigious meeting is hosted by one of the members and in 2020 this event was delivered in the form of a webinar on 27th of April due to the Covid-19 restrictions on travel.

Finally, a special thanks for their collaboration goes to: Silvia COPPOLINO (Port Network Authoity of the Ionian Sea), Fiorinda CORRADINO (Port Network Authority of the Central Tyrrhenian Sea), Tiziana MURGIA (Assoporti), Teresa PUGLIESE (Mediocredito Italiano), Paola RUSSO (Unione Industriali Napoli), Felicetta STANCO (Unione Industriali Napoli).

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Preface

The Annual "Italian Maritime Economy" Report of 2020 comes out at a particular and delicate moment for our economy: a pandemic of global dimension has had, and is still having, negative impacts on all the main international, economic and financial indicators, with repercussions also on the maritime sector: import - export, added value, port and logistic traffic and many others; and obviously it has had devastating effects on the health systems of various countries, including Italy, one of the first to be affected.

On the one hand, the virus has brought negative numbers and problems of various kinds to be faced, while on the other, it has made Italy more aware of the importance of having an efficient logistics system: logistics has been recognized as an "essential sector" that cannot be stopped; it is the enemy of pandemics as it means digitalization of processes, organization, tracking and smoothness of the passage of goods, all principles that go against the spread of contagion, one of the main problems (if not the main one) that we had to face.

The principle is clear: the more logistically performing a country is and the better it deals with economic shocks, the more efficient and effective its infrastructure is and the better it is able to cushion the impacts of phenomena like this one we are experiencing.

This is the dogma that the report wants to bring to the attention and, to tell the truth, it is the idea that SRM has been highlighting for years now, showing and analysing phenomena such as naval gigantism, strategic naval alliances, the Belt & Road, the North African Ports. All of these can be faced only if we give a great competitive impetus to our ports, our shipping sector and our maritime logistics, the mainstays of our economy.

Unfortunately, I must point out that the publication contains a lot of negative data and analyses with dark considerations for our short-term future, but it also shows that on the horizon we could embark on a new path of growth by creating new port and logistical models and we could also introduce mechanisms that allow us to have a system that is more resilient to shocks of this kind.

The research also proposes and explores in depth what the drivers on which the growth of our ports, first and foremost intermodality, could be based.

It is significant that work on these issues is hosted and authored by the Presidents of the Port Network Authority of the Central Tyrrhenian Sea (ports of Naples, Salerno, Castellammare), the Port Network Authority of the Northern Adriatic Sea (Venice, Chioggia) and the Port Network Authority of the Ionian Sea, as well as the University of Hamburg, which has been collaborating with us for some time in the drafting of the volume.

These players, together with the Observatory's partners who are always present and active, accompany us on our growth path, offering ideas, reflections and analyses and allowing our researchers to carry out important scientific missions during which they can find out more about port models, traffic routes, problems and emerging and prospective maritime phenomena.

SRM's Observatory, therefore, continues its activities whilst constantly and closely monitoring the dynamics and phenomena that characterise the Mediterranean in the global maritime scenario.

The current moment is difficult but we will be able to get out of it because Italy has an industrial system that has its own strength as well as important maritime and logistic infrastructures on which we will have to work, above all for the future, so that emergencies like this do not catch us unprepared but rather reactive and resilient.

A special thanks goes to the Director, to all the researchers, and to the communication staff of SRM who have worked from home overcoming many operational difficulties and who very much wanted the Report to be published ensuring that the quality of the analysis and the development of contents be always up to date and of interest. These contribute to understanding how significant and important this sector is for Italy, as well as protagonist role that Southern Italy can play in this context.

Paolo SCUDIERI

Objectives and structure of the Annual Report

The *Italian Maritime Economy* publication has reached its seventh edition at a time when Italy and the world are facing the spread of Covid-19. The current pandemic, which is affecting all countries in the world after initially hitting China, is a significant phenomenon because it is impacting and will continue to impact aggressively on health care systems as well as on the production activities alongside the whole transport and logistics chain.

The sector we hereby analyse, with all its supply chain, accounts for 9-10% of our country's GDP and involves certain interests represented by the sector of infrastructure (ports, airports, freight villages, logistic platforms, roads, railways) and companies (i.e. terminals, forwarders, maritime agencies, port businesses) all of which have been hit by an unprecedented economic and financial storm.

Within the scope of its research connected to the Observatory on the Economy of the Sea, SRM has decided to pursue a research pathway that has led to the elaboration of a series of analyses aimed at illustrating economic trends and issues linked to the spread of Covid-19 and to the effects of containment measures deployed by the government to fight against the pandemic.

Despite the fact that SRM's research has always attempted to identify the positive aspects of our economy, it cannot be ignored that the current situation is extremely complex with the latest operators' sentiments and data displaying negative trends, in particular with reference to the first semester of this year where Italy experienced the peak of the pandemic. This does not mean that we have given up our customary style of research. In fact, the present study presents itself as an analysis tool that clearly highlights the dimension of the issue whilst outlining proposals alongside certain sector's operators. Ultimately, attempts are made to illustrate possible actions to be implemented in order to favour a gradual recovery.

For the Annual Report 2020 we decided to devote space to this negative event with an approach aimed at highlighting not only data and analyses, but also models of port management and specific drivers that in the future could make our country more resilient to similar economic shocks.

This volume shows figures that are undergoing very rapid evolution, on a weekly and sometimes daily basis, which is why they are to be taken with due caution. They illustrate scenarios that we have in front of us and in any case provide useful indications and food for thought on the sectors that are most affected by the Covid-19 and on those that are showing more resilient trends.

Therefore, we have decided to focus less markedly on the usual phenomena that tend to shape our research such as naval gigantism, the Belt & Road and Free Zones, because we aim to provide more in-depth analyses of the maritime consequences of the pandemic.

The first of these was the drastic drop in the Suez Canal traffic, which after 38 consecutive months of positive trends, in May recorded a -9.6% in terms of tonnage of ships transited, which means smaller cargoes and smaller vessels, which entailed a consequent decrease in goods handled. In addition, many companies, given the low price of oil, have preferred not to cross Suez and circumnavigate the Cape of Good Hope, thus obtaining simultaneous savings on transit tolls. All this despite a massive policy of discounts implemented by the Suez Canal Authority.

Another phenomenon that has affected maritime routes has been that of Blank Sailing (ships that, despite possessing a scheduled departure, have not carried it out or have not docked at any ports of call, due to lack of cargo to be embarked or disembarked). Suffice to say that for the route that most affects our country, the ASIA-Europe, in the period April-June 2020 there were 84 departures not made, compared to a total of 374 scheduled (-22.5%). For the first half of the year, a loss of approximately 7 million TEU in traffic has been estimated.

According to some estimates, this will result in a loss for Italian ports quantifiable in the range of 90-100 million tons of goods. Other problematic sectors are Ro-Ro (Car Carrier ships, did not carry cars due to lockdown) and passenger-cruise ships where losses are expected to exceed 50%.

The lack of handled cargo also coincided with administrative and customs problems for containers arriving with goods destined to companies that were closed as a result of the lockdown, while gridlocks occurred in the distribution of sanitary goods for both imports and exports.

This volume, as mentioned above, tries to offer a vision of the light at the end of the tunnel by analysing the mechanisms that we can define as “enemies of the virus”. Our ports, especially for the future, can be made resilient by acting on certain levers. More logistical efficiency, sustainability, intermodality; this is the concept of the sixth-generation port that we have always promoted.

For two years now, SRM has been developing a survey in collaboration with Contship to emphasise the strengths and weaknesses of our logistics at the service of the manufacturing system. For example, if we consider outsourcing, rail transport, sustainability and the use of fast corridors, these have become more and more strategic imperatives for the country and this report gives these aspects due consideration.

A specific focus is dedicated to a very contemporary topic such as the Arctic Sea Route; this year we have carried out a study in partnership with Intesa Sanpaolo and a scientific mission in Northern Europe, Antwerp, with the University of Antwerp-Department of Transport and Regional Economics, which is one of our research partners. We have tried to understand the future strategic value of this route, as an alternative or as a stand-alone route compared to the existing ones. We have listened to global players such as MSC and the International Association Port and Harbours, to understand if the Arctic could become a competitor for the Mediterranean in a future context of climate change - which will hopefully be distant - or if it will serve certain types of goods and ships, especially those coming from or heading towards the Far East. On this topic, we have also included a contribution from another partner of ours, the Shanghai International Shipping Institute, in order to understand China’s vision of this phenomenon.

It is fundamental, in fact, for our research policy, to remain connected and to work together with Italian and foreign research centres but also with the operators themselves who can add their experiences and testimonies to the report, making it an increasingly significant point of reference in the ports and shipping sector.

As regards the organization of this Report, the following can be said:

The first section has been elaborated by taking a look at the international and national scenario.

In particular, Chapters I and II, written by SRM's researchers Arianna Buonfanti and Olimpia Ferrara respectively, provide an outlook with data and detailed analyses, paying special attention to the way Covid-19 has impacted our ports and logistics with all the repercussions outlined above.

Chapter III, authored by SRM's researcher Dario Ruggiero, takes a closer look at the topic of logistic corridors and the efficiency of our system whilst providing some indications as to certain possible variables that can be adjusted to further improve efficiency of our country in terms of maritime transport, especially containers.

Chapter IV, written by Prof. Sergio Prete who is also president of the Port Network Authority of the Ionian Sea, explores the so-called sixth-generation ports as a possible solution to economic shocks. A port that invests in innovation, Free Zones, sustainability, intermodality and research has the potential to become more modern and competitive.

In the second part of this publication there are a number of specific focus studies on the drivers of recovery.

Chapter V, by Prof. Michele Acciaro of the Kühne Logistics University of Hamburg, aims to clarify the challenge of low carbon shipping that awaits our maritime sector in the next decades. It provides an illustration of actual regulations, new potential regulatory tools which will affect the sector and the consequences and measures necessary to comply with regulations with special reference to operations, decarbonization technologies and alternative forms of propulsion.

In Chapter VI Pino Musolino, president of the Port Network Authority of the Northern Adriatic Sea, commences by stating that the global connectivity system, on which the very structure of world trade and the world economy is based, represents the foundation of our current way of life.

In view of the fact that in their product cycle approximately 90% of goods complete at least one passage on board a ship, it can be said that industrial production and international trade are based on maritime transport.

This in turn makes the 'Port' infrastructure not only central, but also the essential driver and fundamental piece to all phases of production, both upstream for the supply of raw materials and downstream for the distribution and marketing of semi-finished and finished products. Ports, however, due to their historical nature, are located in the centre or near the cities that host them. In many cases, they are the very reason why cities have prospered and grown.

However, times and ways of acting are imposing, with an urgency that is no longer negligible, a significant rethink of business and organizational models. This paper shows how some of the assumptions that have marked the development of the so-called

"globalisation" of logistics and the creation of global value chains need to be reviewed, updated and, even more so, designed with a long-term strategic vision, merging economic growth and sustainability.

Prof. Pietro Spirito, President of the Port Network Authority of the Central Tyrrhenian Sea, in Chapter VII concentrates on intermodality, another asset which, if well-conceived within the logistic strategy of a country, can have very significant impacts in terms of added value and efficiency. The author points out that Italy, when putting this type of mechanisms into practice, has not always considered them in an adequate way and failed to put the infrastructural nodes at its disposal into a system.

The third part of this volume entails three specific focus studies which take a closer look at the Arctic maritime way, a new route expected to grow due to climate change which will shape our planet. Since the times when it was a merely seasonal route, this has gradually gained significant value, especially for certain voyages. In particular, these four chapters have looked at the economic scenario awaiting the route (Chapter VIII by Olimpia Ferrara), port strategies in the Northern Range (Chapter X, University of Antwerp) and the trends and issues related to transit in the sector of Bulk Carriers, in Chapter XI edited by the researchers of the SISI-Shanghai International Shipping Institute.

*****

We wish to conclude this introduction to the volume with a special thanks to SRM's researchers and to the partners of the project who demonstrate their trust in our work and support us in this adventure we have embarked upon. A special thanks goes to all the authors who have contributed to adding to the value of this research.

We hope to have been able to provide factual support to those convinced that the development of the maritime transport economy and logistics is a priority for our entire country, especially in these hard times we are all experiencing.

Massimo DEANDREIS

Part One

Port infrastructures facing the challenging Covid-19 pandemic

Chapter I

The new face of maritime transport in a new-normal economic period shaped by Covid-19

Year 2020 will almost definitely be remembered as the one affected by the Covid-19 pandemic which, without distinctions, has hit all the economies of the world. The situation we are about to analyse here is still marked by uncertainty, with a maritime transport sector that was already changing before the health crisis and is now attempting to enter a new-normal period.

This paper aims to take a detailed look at the dynamics of shipping up to 2019 in order to understand their fundamental components. Secondly, the impact of the Covid-19 pandemic on the sector will be analysed with the aim of identifying some elements that might shape its future development. Additionally, this study will focus on the evolution of shipping in the Mediterranean before moving on to gauging the effects on our country.

1. Global maritime transport and the factors that are shaping the 'new-normal' trend

Even before the pandemic, trends in shipping were the reflection of moderate economic and trade growth, increasingly regionalized supply chains and trade models, a steady rebalance of the Chinese economy with planned investments for the Belt and Road Initiative and a more prominent role for technology and services in the value chains of logistics alongside a more environmentally friendly political agenda.

In addition to the demand side, the new normality also brings about new trends in terms of supply. Oversupply remains the hallmark of all shipping sectors, despite the fact that in 2019 the world fleet grew by 2.75%, the lowest rate in the last decade. Ports, carriers and maritime players in general are increasingly focusing on expanding their activities towards inland logistics. Recent strategic choices by carriers to act as integrated freight transport players as well as the acquisition of regional carriers by some global operators (e.g. the acquisition by CMA CGM of the logistics company Containership or the acquisition of Hamburg Süd by Maersk) could be indicative of the industry's efforts to adapt to changing conditions.

Given the regionalisation of trade flows and the trend of restructuring supply chains, the new normality – despite potential challenges – could generate opportunities, particularly for developing countries seeking to integrate effectively into global trade networks.

In this context, attention should also be paid to the external and internal uncertainties in the sector which present systemic and inherent risks that could have a considerable impact on demand prospects, profitability and port investment over the next 10 years.

Here are a range of factors within the maritime transport and terminal sectors that many operators have already faced: overcapacity and under-utilisation of maritime transport;

instability of alliances which, in terms of risk, is increasing as volume growth slows down; investment in shipping line terminals; pressure from increasingly large vessels; terminal overcapacity in some regions; and finally, potential disruption to the sector by entirely new operators. In this respect, major commercial and logistics companies such as Amazon and Alibaba are increasing their market presence, so pressure is expected to be on them to invest vertically in the distribution chain.

However, there are also external factors: the decrease in globalization as a consequence of increased protectionism; tensions and trade restrictions that impose duties on import-export; Brexit; the ever present role of geopolitics, especially in the liquid bulk sector; growing financial instability since 2009, in the context of which much of the growth since the crisis has been financed by the increase in debt levels; the technological problems posed by 3D printing; finally, the growing importance of sustainability, which port operators must take into account when planning new projects. In this regard, further uncertainty to the sector is created by the implications of the new IMO 2020 regulation imposing a sulphur limit in fuel oil for ships (from 3.50% to 0.50%, that came into force on 1 January 2020). Of course, to these factors must be added the unprecedented economic and social disruption caused by the spread of the Covid-19 outbreak in 2020, the effects of which will be analysed in detail in the next sections of this work.

Given the strong impact of the pandemic on GDP and world trade, early estimates for 2020 illustrate a sharp slowdown, which will also obviously be reflected in shipping which accounts for 90% of global imports and exports.

Annual % change in world GDP, international trade and maritime trade

FIGURE 1 - SOURCE: SRM on IMF and Clarksons Research

As anticipated, given the magnitude of such an unprecedented exogenous shock as the Covid-19 pandemic, to analyse "the fundamentals" of shipping, the study will focus on the period up to 2019.

In 2019, 11.9 billion tonnes were transported by sea, an increase of 1.1%, the lowest in the period analysed. More specifically, 44% is dry bulk (mainly wheat, coal, iron ore), 32% is liquid bulk, namely crude oil and petroleum products, gas, chemicals, 16% is related to the transport on container ships and the remaining 8% is accounted for by other goods.

Quantity (millions of tonnes) and shares of the different types of goods transported by sea in 2019

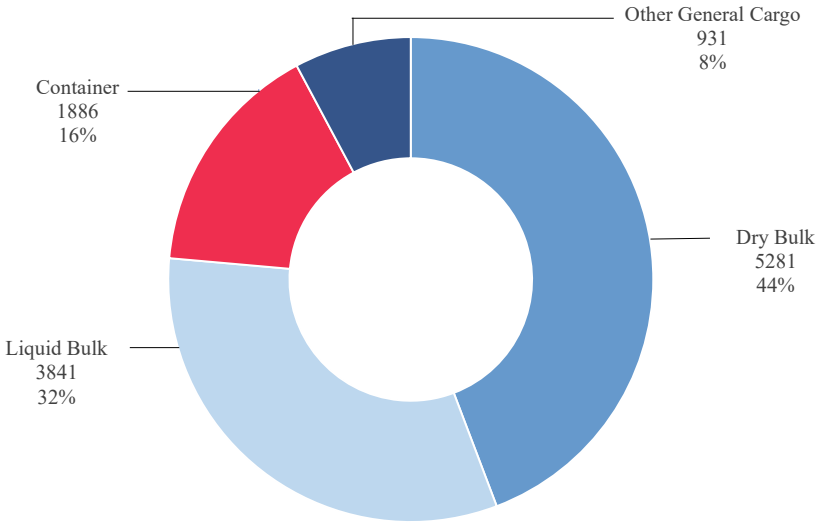


FIGURE 2 - SOURCE: SRM on Clarksons Research

Figure 3 displays the trend in the last six years of goods that have travelled by ship. The last two years, in parallel with economic and trade trends, show a slowdown of growth in all categories.

Dry bulk trade was mainly affected by the reduction in the transport of iron ore, of which China is by far the largest importer (accounting for 71% of global imports of this commodity). This is linked to the increased use of scrap for the steel industry and the use of existing iron ore stocks in China which have limited demand. In fact, the performance of the entire dry bulk sector underlines the central role of China, so any change in its demand, due to endogenous factors but also to the effect of the trade war, has a significant impact.

The liquid bulk sector, which recorded +0.4% in 2019, is usually affected heavily by geopolitical balances: as for crude oil, while transport from the Atlantic basin to Asia has encouraged tanker trade volumes, further downward pressure might be exerted by the sanctions against the Islamic Republic of Iran and the Bolivarian Republic of Venezuela, which have reduced exports, as well as by compliance with the production cuts imposed by OPEC+.

Annual percentage variation (2014-2019) of goods transported by sea

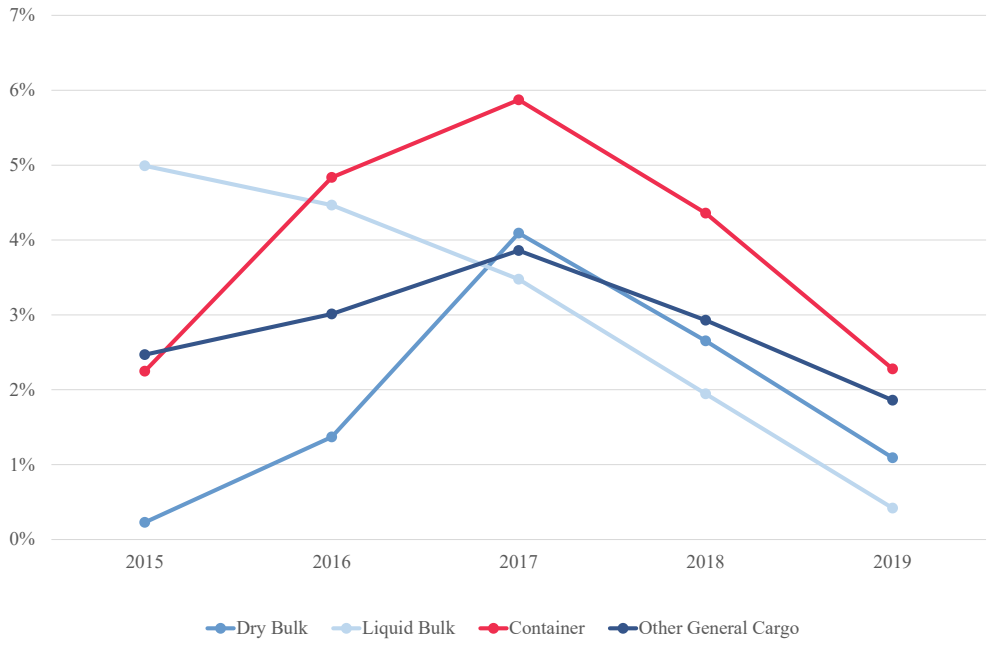


FIGURE 3 - SOURCE: SRM on Clarksons Research

Containerised transport has developed over the last 2 years in a context of great uncertainty, caused by trade tensions, economic rebalancing in China, weak consumer markets and a slowdown in the world economy. As a reaction to this situation, two trends occurred in 2019: consolidation, which involved smaller regional operators, and vertical integration, with carriers aiming to take greater control of internal logistics and to provide integrated services that generate more value. Some of the largest operators, including Maersk and China COSCO Shipping, are planning to expand their presence to inland terminals, warehouses, customs brokerage and logistics to take advantage of additional business opportunities: it has been estimated that if currently up to 80% of Maersk's revenue comes from container shipping, the plan is to achieve a 50:50 split between ocean and non-oceanic services in the coming years[1].

Although the combination of these factors slowed down its performance compared to previous years, the sector nevertheless continued to grow, registering +2.3% in terms of tonnes, but some trade balances changed. The main routes remain East-West (Asia-Europe, Trans-Pacific and Transatlantic) whose volumes remained constant in 2019, equal to 30% of global traffic in terms of TEU, but there was a change in weight within them. Trans-Pacific remained the busiest, with 26 million TEUs, but as a result of the trade war it contracted by 1% in the North America-Far East direction and by 2% in the opposite one.

[1] UNCTAD, *Review of Maritime Transport 2019.*

This benefited the Asia-Europe route which, with 25 million TEU, recorded +8% in the Europe-Far East direction and +3% in the opposite one. The Transatlantic route also grew, and with 8 million TEU it showed an increase of 3% in the Europe-North America direction and 4% in the North America-Europe. 70% of containerized traffic is distributed in the many secondary routes involving trade in developing countries which are becoming increasingly important. Of these, intra-regional flows characterised by intra-Asian movements and South-South trade routes (Oceania, West Asia, East Asia, Sub-Saharan Africa and Latin America) account for the largest share (43%), followed by North-South routes, i.e. trade between Oceania, Sub-Saharan Africa and Latin America with Europe and North America. With 32 million TEU, these account for 16% of the total, while secondary East-West trade (e.g. West Asia and Indian Subcontinent with Europe) accounts for 10%, amounting to 20 million TEU.

The central role of Asia in trade and shipping is also highlighted by the global activity of container ports due to the fact that the primary ones are located in Asia.

The routes of global containerised trade. Years 2015-2019

			2015	2016	2017	2018	2019	% Chg 19/18	10 year CAGR
Trans-Pacific	Eastbound	East Asia-North America	16	17	18	19	19	-2%	3%
	Westbound	North America - East Asia	7	8	8	8	7	-1%	0%
	Trans-Pacific		23	25	26	27	26	-1%	
Asia-Europe	Eastbound	Northern Europe and Mediterranean to East Asia	7	7	8	8	8	8%	4%
	Westbound	East Asia to Northern Europe and Mediterranean	15	15	16	16	17	3%	2%
	Asia-Europe		22	22	24	24	25	5%	
Transatlantic	Eastbound	North America to Northern Europe and Mediterranean	3	3	3	3	3	4%	2%
	Westbound	Northern Europe and Mediterranean to North America	4	4	5	5	5	3%	6%
	Transatlantic		7	7	8	8	8	3%	
Non Mainline East-West			18	19	20	20	20	0%	5%
North-South			28	29	31	32	32	0%	4%
Intra-Regional / Other			69	73	78	82	86	4%	6%
Total			**168**	**176**	**186**	**194**	**198**	**2%**	**4%**
y-o-y change			2%	5%	6%	4%	2%		

TABLE 1 - SOURCE: SRM on Clarksons Research

Top 10 container ports. 2015-2019

Rank	Port	Country	2015	2016	2017	2018	2019	Var.% 19/18
1	Shanghai	China	36,537,000	37,133,000	40,230,000	42,010,000	43,300,000	3%
2	Singapore	Singapore	30,922,400	30,903,644	33,666,556	36,600,000	37,200,000	2%
3	Ningbo-Zhoushan	China	20,627,000	21,561,000	24,610,000	26,520,000	27,530,000	4%
4	Shenzhen	China	24,205,000	23,979,000	25,210,000	25,736,000	25,800,000	0%
5	Guangzhou	China	17,624,900	18,857,700	20,370,000	21,890,000	22,800,000	4%
6	Busan	South Korea	19,468,725	19,456,291	20,493,475	21,670,000	21,900,000	1%
7	Qingdao	China	17,436,000	18,050,000	18,300,000	19,320,000	21,000,000	9%
8	Hong Kong	China	20,073,000	19,813,000	20,760,000	19,640,000	18,340,000	-7%
9	Tianjin	China	14,111,000	14,519,000	15,070,000	15,972,000	17,300,000	8%
10	Rotterdam	Netherlands	12,234,535	12,385,168	13,734,334	14,480,000	14,810,804	2%
Global throughput			**684,000,000**	**700,000,000**	**743,500,000**	**784,000,000**	**801,000,000**	**2%**

TABLE 2 - SOURCE: SRM on data from Port Network Authorities and Drewry Shipping Consultants

2. THE GROWING ROLE OF THE MEDITERRANEAN AND OF ITS PORTS IN GLOBAL SHIPPING

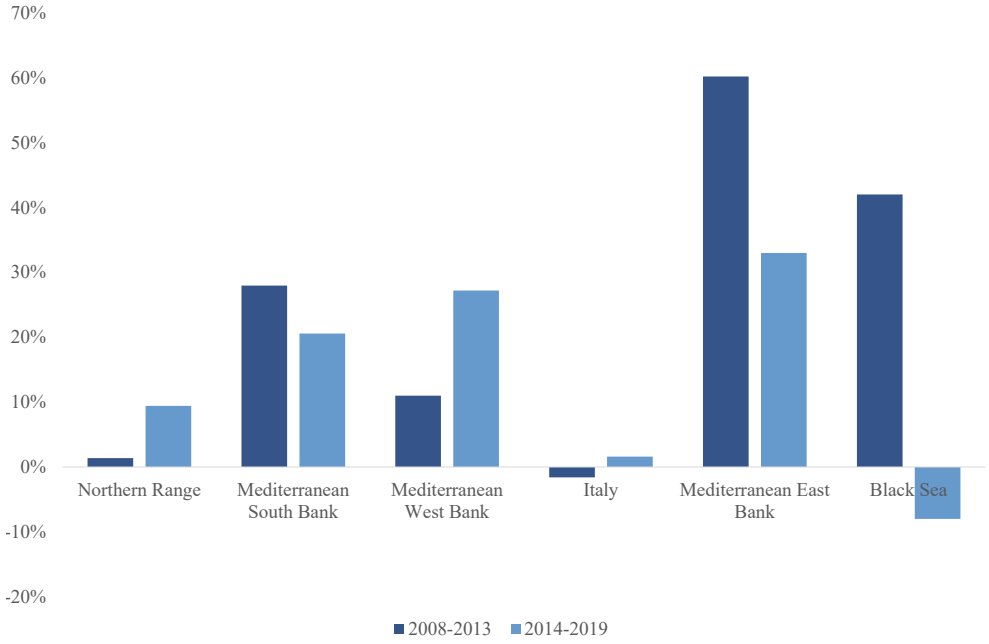
The centrality of the Mediterranean today is mainly linked to the maritime dimension of trade routes. It represents a privileged route for container traffic, concentrating 27% of the world's scheduled services, and short sea shipping between its shores. The growth of goods in transit confirms the importance of the Suez Canal as a crucial route for the passage of all types of cargo. The greater concentration of scheduled services in the Mediterranean facilitated by the Egyptian Channel, which, following its enlargement, places virtually no limits on the size of ships in transit, is an undoubted benefit for the ports bordering its shores, which gain a further advantage from their position. Not only can they strengthen their role as hubs for goods coming from the Far East heading towards North America, but they become the potential gateway for territorial production towards transoceanic markets.

With the increase in traffic and routes and the consequent importance of the Mediterranean basin in maritime transport and logistics, and with the development of major global strategies, starting with the Chinese Belt and Road Initiative, the intensity of competition between the shores of the Mediterranean increases whilst simultaneously creating important investment opportunities for countries able to offer a modern and integrated network of port and hinterland infrastructure. The ports on the Southern and Eastern shores (North Africa and Turkey) are pursuing important policies for the development of their port systems and are aware that this represents a fundamental factor

for the economy, development and foreign outreach of an area. Not only are we witnessing a new design in world trade by sea, but also a change in the rules of competitiveness of ports, which currently cannot base their growth only on infrastructural, material and immaterial endowment, but must be able to innovate and offer value-added services, back port areas where manufacturing and logistic activities can settle in favourable environments both from the fiscal and bureaucratic point of view.

Figure 4 shows how the Mediterranean port systems, as well as the Northern Range benchmark, have shown increasingly higher growth variations compared to our country, both in the period of the financial crisis and in the last 6 years.

*Comparison of growth in the periods 2008-2013 and 2014-2019 between port areas in the Mediterranean and in the Black Sea (TEU)**



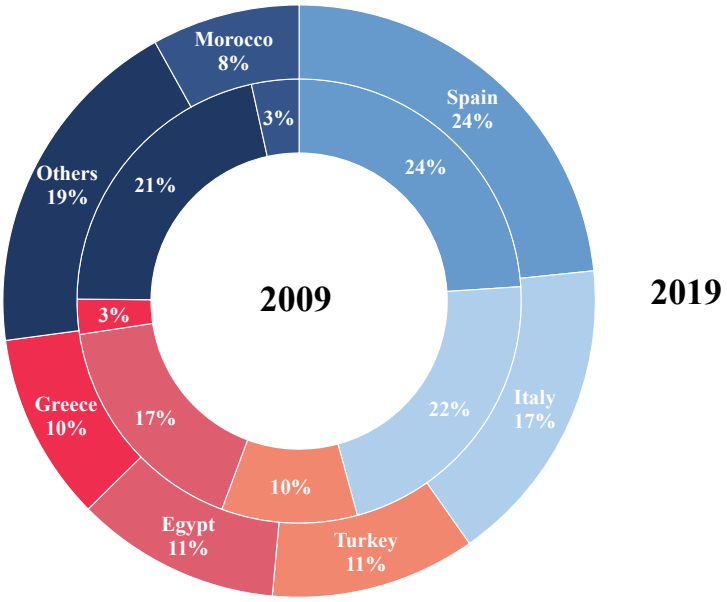
* Ports with a 2019 handling capacity higher than 1 million TEU have been considered.

Figure 4 - Source: SRM on Port Authorities

The Northern Range handled more than 45 million TEUs in 2019 and despite high volumes, it has accelerated its growth over the last 6 years, recording +9.4%. It must be underlined that the traffic in this area is very concentrated because the system is made up only of 6 container ports. This represents an element of greater attractiveness for many European markets, in the face of a greater fragmentation of the port reality in the Mediterranean, still evident in Italy even after the reform. Our Country has not been able to take advantage of the increase in the flow of goods in the Mediterranean: its weight has passed from 22% in 2009 to 17% in 2019. Spain has confirmed its importance with an incidence of 23% and the port of Piraeus alone has increased its incidence from 2% to 10%.

Figure 5, designed considering the first 30 ports of the Med and Black Sea by TEU moved in 2019, depicts the weight of each country and highlights the variation compared to 2009.

*Percentage share of ports on the handling of containers in the Med and in the Black Sea (TEU)**



* Spain: Valencia, Algeciras, Barcelona
Italy: Genoa, Gioia Tauro, La Spezia, Livorno, Trieste, Venice, Naples, Salerno, Ravenna
Turkey: Ambarli, Mersin, Izmir
Egypt: Port Said, Alexandria, Damietta
Greece: Piraeus, Thessaloníki
Morocco: Tanger Med.
FIGURE 5 - SOURCE: SRM on Port Authorities

The success factors of the competing ports analysed vary. The growth of investments (public and private, as well as foreign direct investments) in ports generates new services and new activities: the prime example of this is Piraeus, whose operations are managed by the Chinese COSCO, which in 2019 became the first Mediterranean port with 5.65 million TEU. Important in other cases has been the construction of back ports where industrial and manufacturing activities have been established alongside numerous value logistics functions in the ZES environment (special economic zones - i.e. with lower or no taxes paid for export or re-export and import flows). Therefore, in the next decade Italian ports will face an increasingly competitive scenario, in which the growth of average ship size continues, generating risks and opportunities for the shipbuilding industry cycle, a strategic sector for Italy.

In 2020-30, it will also be possible to gauge the impact of the SEZs and their ability to attract international investment, in collaboration with the Italian diplomatic network, and to act as catalysts for business investment thanks to their simplified bureaucratic procedures. SRM has estimated that these areas can increase overall exports by up to 40% over 10 years.

The impact of an increasingly concentrated, consolidated and gigantism-oriented container market significantly affects terminal infrastructure, with ports at risk of losing great shares of their business if they are unable to rapidly upgrade their equipment. Mega-vessels load and unload increasingly significant volumes in a single port of call; as a result, intermodal connection networks must be able to effectively manage increasing volumes in a limited amount of time, to avoid generating costly and inefficient bottlenecks along the supply chain. Thus, port services have become a decisive factor to the competitiveness of a country's traffic. Every hour of time in port saved by ships translates into lower port infrastructure expenditures for seaports, capital costs of ships for carriers and stockpiling expenditures for shippers.

The complexity and dynamism of the aforementioned political and economic changes has led to the exploration of new international routes, as well as the search for new markets alongside the creation of new trade flows between the Far East, Europe and North America which has ultimately benefited the Mediterranean as a preferred choice to traditional routes.

3. The performance of the Italian port system

Italy holds a privileged position in the Mediterranean, and in particular along the Asia-Europe route which continues to be one of the pillars of the international traffic of goods.

In this context our national port system in 2019 showed traffic figures that can now be considered satisfactory and stable, especially when compared to the trend of the last five years. This seems to prove that the regulatory reform and capital invested (albeit not considerable in quantity) have had effects mainly in terms of improved organization and rationalization of traffic.

In fact, at the moment ports are still trying to emphasise the scarce attention devoted to the definition of a national port strategy in our country. This means that we cannot improve our position in the international rankings of logistic and maritime competitiveness where we are still far from our main competitors.

Looking at LPI and LSCI, the indicators show a ranking that improves year after year and that places Italy in the top 10 positions in Europe. However, there is still a big difference with the large ports of Northern Range, Spain, the U.S. and the Far East that have implemented models aimed at integrating traffic with other assets and improving them over time.

Italy's position in international maritime and port indicators

Indicator	Source	Italy's ranking	Difference compared to first
Liner Shipping Connectivity Index (LSCI)	UNCTAD = Port connected with the world through liner services	13th in the world 2nd in the Mediterranean 6th in Europe	**79.12** points from China
Logistics Performance Index (LPI)	World Bank = Port Connected and integrated with the logistic chain	19th in the world 3rd in the Mediterranean 10th in Europe	**0.46** points from Germany
Quality of Port Infrastructure (QPI)	World Economic Forum = Quality of port infrastructure	60th in the world 12th in the Mediterranean 21st in Europe	**0.46** points from the Netherlands

TABLE 3 - SOURCE: SRM on sources listed in the table

Traffic data supplied in 2019 by Assoporti confirm the notable figure of 479.2 million tons (-2.2% on 2018) and confirm the structure of our port system as being better suited to the traffic of liquid bulk (37.5%), followed by container and Ro-Ro, with 23.2% and 22.2% respectively and, last but not least, dry bulk with 12.3% of the total; the percentage of various (or other) goods was marginal/minimal with approximately 5%.

Nevertheless, the major effects of the global pandemic have significantly altered the forecasts.

Performance of Port Network Authorities in 2019 by type of goods

Port Network Authority	Liquid Bulk (tonnes)	Dry Bulk (tonnes)	Container (tonnes)	Ro-Ro (tonnes)	Other General Cargo (tonnes)	Total Throughput (tonnes)	Var 2019-2018	TEU	Var 2019-2018
West Ligurian Sea	21,661,585	5,047,941	25,202,782	13,940,401	1,299,224	67,151,934	-2.9%	2,669,917	-0.2%
East Ligurian Sea	2,132,635	1,047,253	14,473,876	693,372	535,713	18,882,849	3.3%	1,490,537	-3.4%
North Tyrrhenian Sea	9,107,837	3,183,965	9,142,346	21,782,019	1,757,059	44,973,226	2.0%	789,833	5.6%
Central North Tyrrhenian Sea	5,239,421	2,791,220	1,003,461	5,561,631	5,504	14,601,237	-11.1%	112,249	3.5%
Central Tyrrhenian Sea	5,489,264	1,228,864	11,839,099	13,373,668	946,376	32,877,271	0.9%	1,095,156	5.7%
Sea of Sardinia	27,873,750	4,098,151	669,861	10,922,066	2,686,610	46,250,438	-2.9%	151,405	-47.6%
P.A. Gioia Tauro	88,328	639,908	28,821,390	213,042	0	29,762,668	0.3%	2,522,876	8.4%

Port Network Authority	Liquid Bulk (tonnes)	Dry Bulk (tonnes)	Container (tonnes)	Ro-Ro (tonnes)	Other General Cargo (tonnes)	Total Throughput (tonnes)	Var 2019-2018	TEU	Var 2019-2018
Messina Strait	17,856,829	138,850	0	6,299,542	11	24,295,221	-0.6%	-	-
Eastern Sea of Sicily	20,465,954	1,330,647	583,430	7,495,395	535	29,875,961	-8.9%	63,179	5.7%
Western Sea of Sicily	427,081	308,287	176,334	5,571,540	-	6,483,242	4.8%	14,124	-11.5%
East Adriatic Sea	43,349,423	4,666,505	9,224,722	6,769,495	2,080,725	66,090,870	-1.7%	790,542	8.8%
Northern Adriatic Sea	9,019,622	6,946,458	5,688,389	1,763,717	2,817,919	26,236,105	-4.6%	593,126	-6.2%
Central North Adriatic Sea	4,643,362	11,167,726	2,388,268	1,630,737	6,426,155	26,256,248	-1.6%	218,138	0.8%
Central Adriatic Sea	4,909,474	943,222	1,252,197	4,699,951	-	11,804,844	-0.2%	176,193	10.8%
Southern Adriatic Sea	2,942,443	6,048,893	671,485	5,666,420	204,997	15,534,238	2.6%	82,742	21.2%
Ionian Sea	4,344,056	9,170,869	-	-	4,610,246	18,125,171	-11.3%	-	-
Italy	**179,551,068**	**58,758,759**	**111,137,640**	**106,383,036**	**23,371,074**	**479,201,523**	**-2.2%**	**10,770,017**	**1.5%**

TABLE 4 - SOURCE: SRM on Assoporti

Types of goods handled by Italian ports in 2019 in tonnes and percentage variation on 2016

Traffic	Tonnes	Var. on 2016%
Liquid Bulk	179,551,064	▼ -1.2%
Dry Bulk	58,758,759	▼ -13.6%
Container	111,137,640	▼ -5.4%
Ro-Ro	106,382,996	▲ +7.8%
Other General Cargo	23,371,063	▲ +3.5%
Total	**479,201,522**	**▼ -1.9%**

TABLE 5 - SOURCE: SRM on 2019 Assoporti data

4. The impact of the Covid-19 pandemic on international maritime transport

In the scenario just described, the COVID-19 pandemic has been disruptive, representing an unprecedented shock to the world economy and trade, causing production and consumption to shrink everywhere which, of course, is negatively affecting global shipping demand for 2020. The speed of the spread of the virus makes it difficult to ascertain all the consequences, but what is clear is that none of the players or sectors of shipping will be immune. Past experiences show that container and dry bulk transport tend to be the most affected sectors, while liquid bulk is generally influenced not only by demand, but also by the geopolitical situation.

GDP and international trade estimates for 2020 show an unprecedented recession, even greater than the 2008-09 financial crisis. The International Monetary Fund in its June outlook indicates a reduction in world GDP of 4.9%, with the greatest weight falling on the most developed economies, in particular the Eurozone which is expected to have a reduction of 10.2% and, unfortunately, the most negative performance is estimated for Italy and Spain for which it is estimated -12.8%. The OECD in its June "Global Outlook" forecasts an even stronger decline, and predicts 2 possible scenarios. In the first, more optimistic, it assumes that the pandemic will end in 2020; in the second, it predicts that there may be a second wave of contagion. At a global level, estimates indicate a drop in GDP of 6% or 7.6% respectively; for Italy this ranges between -11.3% and -14%.

As regards world trade, the IMF forecasts a collapse in 2020 of 11.9%, with a rebound in 2021 of 8%. UNCTAD estimates an even stronger impact of the pandemic on international trade volumes with a decrease of about 20% for the year 2020 in line with the WTO, which found a 3% decrease for the first quarter and assesses the reduction for the second quarter at -18.5%.

Hence the forecasts of a drastic reduction in demand also for shipping which, according to the analysis company Clarksons, is expected to decrease by 5.4% in 2020.

The final figures for the first 3 months of the year show a 5% reduction in the value of world trade of goods compared to the previous quarter with a forecast of -27% for the period April-June[2]. Considering the month of April alone, UNCTAD reported that many of the most developed economies have seen declines of more than 20% due to the measures taken to contain the coronavirus pandemic. UNCTAD specified that trade has been particularly reduced in the automotive, energy, machinery and equipment sectors with a significant decrease in demand, while a less significant impact has been experienced by the computer and computer accessories sectors, as well as medical equipment and pharmaceuticals[3].

No part of the world has been spared by the decline in international trade. However, the East Asian and Pacific regions appear to have performed better than the others, containing the decline to single figures, both in the first quarter of 2020 and in April. Although only preliminary, April's figures suggest a sharp decline in all other regions with a drop of up to 40% for South Asia and the Middle East.

[2] UNCTAD, Committee for the Coordination of Statistical Activities (May 2020), *How Covid-19 is changing the world: a statistical perspective.*

[3] UNCTAD (June 2020), *Global Trade Update*.

World Trade Trend by sector. Performance as of 1st Quarter of 2020 and April 2020 (year-over-year percentage change)

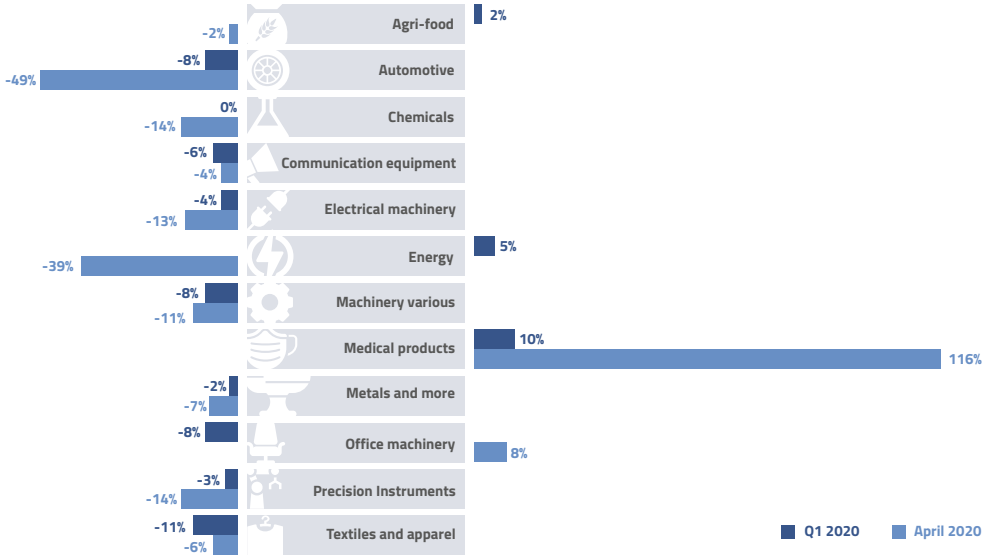


FIGURE 6 - SOURCE: SRM on UNCTAD

World Trade trend by area. Performance as of 1st Quarter 2020 and April 2020 (year-over-year percentage change)

Region	Q1 2020		April 2020	
	Imp	Exp	Imp	Exp
North America	-5%	-2%	-24%	-32%
Central and South America	-7%	-6%	-30%	-20%
Europe	-10%	-7%	-14%	-14%
Africa	-2%	4%	-21%	-36%
Middle East and Southern Asia	-3%	-6%	-23%	-40%
Central-Western Asia	-5%	-11%	-18%	-27%
South-Eastern Asia	-3%	-7%	-2%	-4%
Oceania	-4%	0%	-9%	0%

TABLE 6 - SOURCE: SRM on UNCTAD

It is therefore difficult to evaluate the effects of the pandemic on the maritime transport of goods because future events will depend very much on what will occur in terms of the reorganisation of the industrial sector, not only in individual countries but on an international scale.

The OECD, based on preliminary data of trade relating to May, has found an improvement of the situation due to the fact that some economies have started to show moderate growth while others have demonstrated a slowdown in their negative trend[4].

This is also confirmed by the results achieved by Chinese ports in May. In the period January-April 2020 the total traffic of the goods moved from Chinese sea ports was 2.84 billion tons (-2.5%), of which 1.25 billion tons of exchanges with foreign countries (+1.2%), while the traffic of containers was equal to 75.8 million TEU (-7.8%). Chinese industrial production in the same period decreased by 4.9% compared to the previous year[5]. According to data from the Shanghai International Shipping Institute, this has led to a reduction in capacity utilization in the major Chinese ports which fell between 20% and 50%. In the month of May, however, there was a new monthly peak of goods moved from the sea ports of the nation (807.1 million tons, +2.0%), with international traffic alone amounting to 331.6 million tons (+1.2%), yet another record broken in the month of May.

The performance of the international maritime sector is strongly influenced by China, where the virus started at the end of December, which is an important trading partner for several countries and the leader in shipbuilding.

The pandemic with its disruptive impact is already having an effect on shipping routes. Low oil prices, rising tonnage surpluses and falling demand for goods have prompted carriers to redirect part of their Asia-Europe tonnage from the Suez Canal corridor to the Cape of Good Hope route (adding 3,000 nautical miles). As a consequence, the Suez Canal Authority has introduced a 17% toll discount for southbound containerships[6] and a 60-75% cut of tolls for the route US East Coast-South East Asia[7]. This was done in order to offset the decision of some carriers to cut costs by avoiding such tolls. According to data available at the end of May, the total number of containerships that have avoided the Egyptian canal since March 2020 was 32[8].

[4] OECD (June 2020), *International Trade Pulse.*

[5] National Bureau of Statistics of China.

[6] The amendment to 30 April 2020 of Directive 3/2020 of 31 March provides that container ships "from north-west European ports (and the port of Tangier) to the port of Algeciras and directed to Port Klang and ports east of it in South-East Asia and the Far East will benefit from a discount of 17% on the normal Suez Canal toll (this discount does not include the surcharge levied for the levels of containers carried on the upper deck of the ship). The discount is provided on condition that the ship does not make any intermediate calls during its commercial voyage between the port of origin and the port of destination. This circular is valid until 30 June 2020.

[7] The amendment to 30 April 2020 of Directive 2/2016 provides that the containerships "coming from the port of Norfolk and north of it and directed towards Port Klang and the ports east of it" will benefit from a 60% discount on the normal toll of the Suez Canal; the containerships "coming from the ports south of Norfolk and directed towards Port Klang and the ports east of this one" will benefit from a discount of 75%; the containerships "coming from the ports south of Norfolk and directed towards the port of Colombo the ports east of this one until Port Klang" will benefit from a discount of 65%. The discount is provided on condition that the ship does not make any intermediate calls during its commercial voyage between the port of origin and the port of destination. This directive is valid until 30 June 2020.

[8] Alphaliner (2020), *Weekly Newsletter*, Volume 2020 Issue 21.

The Panama Canal is also dealing with the effects of the epidemic, with a decline in the number of ships passing through it, and is preparing for a different future with a long-term vision in which it will be affected more by regional trade than by global trade. The Panama Canal Authority does not have the autonomy of Suez to reduce tolls, given the high costs associated with the operation of the locks, and must seek the approval of the Panamanian Government. A new toll structure was introduced as of 1 April, which includes lower tariffs for container ships participating in a "loyalty programme". In addition, in the short term, the port authority is temporarily authorising carriers to pay booking fees for transit together with other fees, rather than requiring payments to be made weeks in advance as used to be the case. At this time, technical requirements have priority, given that the reduction in rainfall in four of the last six years has forced the channel to impose draught restrictions, reducing the loads that larger container ships can carry. In order to cope with potential changes in demand, the Panama Canal must first of all ensure sufficient water depth to allow transits for containerships. Short-term action has been taken to better ensure water supply, but a longer-term approach is needed, which could cost the same as the $5.25 billion expansion completed in 2016. New locks that allow ships of up to 14,500 TEU to pass through are useless if full draught cannot be guaranteed.

The spread of the epidemic has also affected the BRI strategy because most projects depend heavily on China: human resources, equipment, machinery and funding come from there. With the social distancing measures set in place to contain the epidemic, together with supply chain disruptions due first to closure and then to reduced activity of Chinese factories, the Belt and Road is slowing down: among others, the China-Pakistan economic corridor, the Sihanoukville Special Economic Zone in Cambodia, the Payra power plant in Bangladesh and projects in Indonesia, Myanmar and Malaysia are at a standstill. There are dozens of Belt and Road projects that remain inactive throughout the world, so it will most likely be necessary to renegotiate loan repayments, and currently the future of many projects seems uncertain given the extremely limited resources available as a result of the epidemic[9]. The Health Silk Road (HSR) initiative, through which China has duplicated its efforts to establish itself as a responsible global health leader by launching a widespread public diplomacy campaign and sending medical aid around the world, has become much more relevant to the BRI in the aftermath of the pandemic. The Chinese government is providing medical assistance and advice on a bilateral basis, often provided directly by local Chinese embassies such as those in Malaysia, the Philippines and Greece. The BRI, starting with this pandemic, could then take a new shape because if China wants to keep its global project active and aims to strengthen its role in global health governance, a redistribution of capital, which has become more limited in the meantime, will be necessary to cope with public health projects together with ambitious infrastructure projects.

The HSR is also not immune to geopolitical competition. The US State Department has launched the US-ASEAN Health Futures initiative to compete with China in Southeast Asia.

[9] Shepard W. (27 March 2020), "China's 'Health Silk Road' Gets A Boost From COVID-19", in *Forbes*.

Given this scenario, despite the difficulties of making forecasts on individual sectors, on the basis of economic and maritime transport trends in the first months of the year it is possible to make some considerations for 2020 in order to pin down some of the uncertainties that have emerged.

Liquid Bulk

As regards liquid bulk, the geopolitical tensions of March 2020 resulted in the collapse of OPEC+[10] and then pushed the market of crude oil transport on tankers with a subsequent increase in freight rates. The events that have followed the crisis, namely a new agreement on cuts to production, have contributed to shaping a sector that in 2020 seems to be posing several issues mainly as a consequence of the marked economic downturn linked to the Covid-19 pandemic which has produced a declining trend in oil demand.

According to the latest IEA estimates, in the second quarter of 2020 bunkering demand for ships will be 8% lower than the same period of last year. As for the yearly estimate, the decline is less marked, at 5% less than the annual 2019 figure. This rise is due to the fact that forecasts for the second part of this year show a less severe decrease of the demand for naval bunkering in the third quarter (-5%) and in the fourth (-3%).

Dry Bulk

The decline in demand that has taken place so far will impact performance throughout the year, as China, which accounts for 35% of all dry bulk imports, reduced its purchases as a result of the pandemic. In the short term, demand from China is still weak, but import (-5%) and export (-9%) data for the first 4 months of 2020 show that the coronavirus has had a less marked impact on import volumes than was initially feared. Imports of the main goods relevant to shipping, including coal (+27.8%), soybeans (+9.8%) and iron ore (+5.3%) increased in the first 4 months of 2020 compared to the same period of 2019. Chinese steel production held up well during the same period, growing by 1.3% year-on-year. In the medium term, increased demand from China is translating into a positive but very moderate outlook as Europe and North America are at the epicentre of the pandemic. The most recent (April 2020) dry bulk demand forecasts have been significantly revised downwards (-4%), weakening the outlook for 2020.

Dry bulk ship freight rates are negatively affected by substantially lower demand: the Baltic Dry Index (BDI) in May fell below 400 points for the first time in four years.

Containers

Containerised transport is the one most closely linked to economic trends, so with demand volumes negatively affected for the whole year, a reduction is expected for the sector. Given the magnitude of the impact of the pandemic, uncertainty has led to a multitude of forecasts, which however agree on estimating a strong recovery in 2021.

[10] OPEC+ is the alliance born at the end of 2016 between the 14 OPEC countries and the 10 non-OPEC ones led by Russia with the aim of bringing oil prices back up.

The benefits expected from the *Phase 1 agreement* on tariffs reached by China and the US in January 2020[11] will therefore be reversed.

The research and analysis firm Clarksons has estimated that the impact of the Coronavirus pandemic will weigh on demand for container shipping by 11% in 2020 and has highlighted that it expects a significant rebound in volumes transported in 2021 of 10%.

The drop in overall trade at the end of the year will be 10%, according to SeaIntelligence forecasts.

Impact of Covid-19 on the container sector and risk assessment

Period	Global Economy	Container Shipping	Global port handling
1st Quarter 2020	• GDP fall of 1% • Widespread lockdown measures and travel restrictions • Rapid growth of unemployment • Significant government aid • Collapse of stock and oil markets	• Firstly, halt to production in China • Secondly, widespread demand shock • Reduction of capacity (blank sailings) • Operational ports and terminals • Issues with availability of equipment • Delays in the transfer of personnel • Stable freight rates	Estimated: **-5%**
Rest of 2020	• Very uncertain but consensus on -3% of GDP • Recovery expected in the second half if lockdown measures are lifted	• Extreme reduction of volumes in the 2nd Quarter (about 20%) • Slow recovery of demand in the second semester • Lower rates as bunkering prices decline • More service disruptions • Negative margins for carriers • Government aid for some liners • Carriers investment on hold	Baseline scenario: **-9%** **from 2nd Quarter onwards**
2021	Estimates may vary according to: • Containment of Virus and development of vaccine • Effectiveness of measures deployed by governments • Impact on consumer behaviour • Public debt control measures • GDP estimates ranging from +6% to -2%	**Positive GDP Scenario** • Potential V shaped rebound of demand • Quick return of latent capacity • Higher freight rates • Positive revenues for operators • Recovery of carriers' investment • More diversified supply	**Approximately +13%**
		Negative GDP Scenario • Further collapse of demand • Prolonged reduction of freight rates • Growth of idle fleet and ship-breaking • Heavy losses for carriers / higher risk of bankruptcy	**Approximately -6%**

TABLE 7 - SOURCE: Drewry Maritime Research

[11] The agreement includes technology transfers, intellectual property, food and agricultural products, financial services and trade expansion. Under this agreement China will purchase US goods and services for $200 billion over the next 2 years. The U.S. will withdraw the risk of new 15% tariffs that would have been triggered on December 15 on nearly $160 billion worth of products made in China, but will not eliminate the 25% tariffs on $250 billion of Chinese imports that will remain as they are, while the tariffs on much of the rest will be reduced to 7.5%, for a total estimated of $120 billion worth of Chinese products.

Drewry's estimates have been repeatedly revised downwards, with the May 2020 update[12] envisaging a reduction of world ports handling of 8% (compared to -3% of March), which is equal to a drop of 737 million TEU, the worst performance since the 2009 financial crisis.

In addition, to a certain extent, there is a confirmation of the fact that the main East-West routes are suffering with the weakening of demand but the Transpacific one is the most affected by the reduction of trade volumes.

Container traffic forecasts along the major East-West routes (thousands of TEUs)

Route		2019	2020	2021
Transpacific	Eastbound	20251	17675	20221
	Variation	*-1.3%*	*-12.7%*	*14.4%*
	Westbound	7419	7302	7604
	Variation	*0.3%*	*-1.6%*	*4.1%*
Asia-North Europe	Eastbound	5453	5035	5254
	Variation	*8.6%*	*-7.7%*	*4.4%*
	Westbound	10483	9455	10416
	Variation	*-2.0%*	*-9.8%*	*10.2%*
Asia-Med	Eastbound	2380	2349	2539
	Variation	*1.5%*	*-1.3%*	*8.1%*
	Westbound	5717	5122	5742
	Variation	*2.0%*	*-10.4%*	*12.1%*
Transatlantic	Eastbound	2123	2031	2079
	Variation	*3.5%*	*-4.3%*	*2.4%*
	Westbound	3410	3041	3367
	Variation	*3.2%*	*-10.8%*	*10.7%*

TABLE 8 - SOURCE: SRM on Drewry Shipping Consultants, 2020

These forecasts are partly confirmed by data available for the first months of 2020. Container Trade Statistics has in fact calculated that the decline in demand for container shipping in April was -16.9% compared to the same month in 2019. In absolute value this means a loss of global demand equal to 2.4 million TEU in the fourth month of the year and a loss of 4.4 million TEU from 1 January to 30 April (-8.1% with respect to the same period of 2019).

[12] DREWRY MARITIME RESEARCH (May 2020), *Container Forecaster Quarter 1 update*.

As for the individual areas of the world, Drewry assumes: a) for Asia a reduction in container handling of 8% for 2020 with a rebound of 13.5% in 2021; b) for Europe a reduction of 10% and c) for North America a decrease of 17% in the second and third quarters of 2020 and 5.6% in the fourth.

The carriers' response to the drop in demand was prompt because they managed the emergency in the best possible way, rapidly removing hold capacity from the market with repeated blank sailings, i.e. the cancellation of certain departures, and thus ensuring that transport tariffs did not collapse. A very evident consequence of this strategy is the record amount of idle fleet capacity that reached 2.72 million TEU at the end of May, exceeding the previous peak of 2.46 million TEU recorded at the beginning of March 2020, a level already higher than that caused by the financial crisis. Inactive fleet accounts for 11.6% of the total capacity of the container fleet[13].

Blank Sailing on the main East-West routes

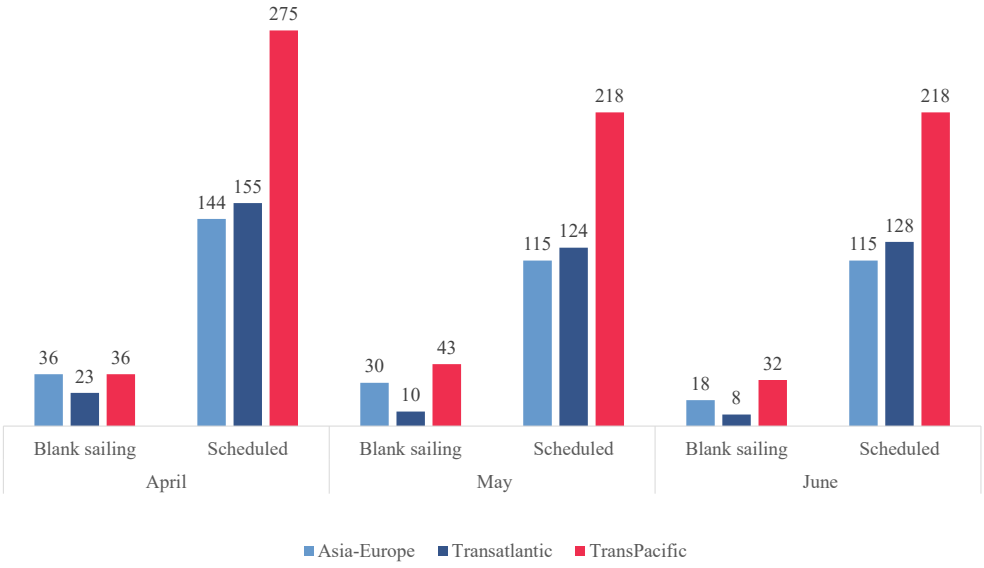


Figure 7 - Source: SRM on Drewry Maritime Research, 2020

This carrier defence strategy is proving its worth considering that freight rates on the main routes are holding. This is also confirmed by Drewry's World Container Index, which 'systematises' fares on the 8 main world routes between the United States, Europe and Asia. On average, compared to the first week of June 2019, the increase was 23% and the average composite index for the current year is $1,603 for a 40-foot container, or $218 higher than the average of the last 5 years, $1,384 per FEU (Forty Equivalent Unit).

[13] Alphaliner (2020), *Weekly Newsletter*, Volume 2020 Issue 22.

On the transpacific routes, fares on the Shanghai-Los Angeles route have thus increased by 26% on a weekly basis (a change of $435) and by 45% on an annual basis, by 11% on the reverse route on a weekly basis with no significant change in the calculation year by year. Rates on the Shanghai-New York route also rose (+4% for the week and +8% for the year). The only decrease on an annual basis – merely 1% – has been recorded on the New York-Rotterdam route. No weekly change for the Shanghai-Genoa route, where you spend $1,907 to ship a 40-foot container. On an annual basis, however, the increase was 24%, a considerable figure but still far from the 84% increase recorded between Rotterdam and Shanghai.

This strategy has so far rewarded the profitability of carriers. Against an average reduction of 4.6% in the number of containers transported in the first quarter calculated by Seaintelligence Consulting, the analysis of the financial results of the 10 main carriers carried out by Alphaliner shows that the majority of them recorded positive profits for the first quarter and the average operating margin reached 2.6%, an improvement compared to the 1.7% margin recorded in the same period last year[14].

Despite a positive start to the year, carriers' profits are likely to take a heavy hit in the second quarter, with more marked volume reductions expected on all trade routes. Transport tariffs have remained relatively resilient, supported by the strict management of capacity implemented by the shipping companies, but the effectiveness of the blank sailing strategy in the medium to long term will need to be assessed as it will not fully offset the impact of the pandemic. Keeping ships idle saves money, but there are still fixed costs. The recovery of containerised traffic to pre-coronavirus levels will not happen before 2021.

In fact, containers are used to transport products that are among the consumer goods most affected by the restrictions put in place by various countries, and it cannot be ruled out that lower consumer spending power than in the past may persist for a long time.

Another strategy adopted by shipping companies to better balance supply and demand is to offer container storage services at various transhipment hubs in Asia, the Middle East, Europe and America. For example, MSC offers a 'Suspension Of Transit' (SOT) service to its customers exporting from China, allowing them to bring their cargo closer to their final destinations. This service is also designed to limit negative impacts on supply chains once restrictive policies adopted in response to the pandemic are mitigated.

While it is true that carriers have more levers to focus on in order to protect profitability margins, the same cannot be said for port terminals, which in these first months of 2020 are suffering from a drop in volumes handled. According to Drewry, many of them will be forced to contain costs if they want to survive this downturn.

5. The Italian Shipping Scenario in the shadow of the Covid-19 crisis

If we take a closer look at the Italian context, it seems clear that the novel Coronavirus is significantly impacting traffic trends as well as logistic and port needs in our country, with rapidly evolving figures and data whose fluctuation is also dependent on government

[14] Alphaliner (2020), *Weekly Newsletter*, Volume 2020 Issue 23.

containment measures. The Prime Minister's Decree of 22 March established that **the sector of transport and logistics is essential for the country and as such it cannot halt its activities**. Despite not having completely stopped, this sector has still been suffering significantly with turnover reduction due to a noticeable decrease in the quantity of goods moved both nationally and in import-export, with obvious repercussions on the maritime traffic of all kinds of goods.

In the first two months of 2020, Confetra[15] has estimated a reduction of volumes handled of 35-45% on the previous year.

The dynamics of international traffic will be difficult to control because, even though our country is gradually loosening its grip on lockdown, the attitude of other countries in dealing with the contagion that has spread on different and progressive dates must also be taken into consideration.

According to Assiterminal estimates, the losses of national maritime traffic resulting from the Coronavirus crisis for the whole of 2020 are 150 million tons and 3 million TEUs. According to the data available for the first months of 2020, the Ro-Ro sector is also suffering with the interruption of the motorways of the sea between Mediterranean countries and the crisis in the automotive sector.

The data relative to the period January-March 2020 of almost all the Italian ports already display the signs of the slowdown, recording a decrease in the total handling of goods equal to 7.5%, particularly marked in the sector of dry bulk (-19.4%), in RO-RO (-5%), in liquid bulk (-4.1%). The container sector bucked the trend, which in the first 3 months of 2020 recorded +11% in terms of TEUs handled. The slowdown is emphasised in the month of April as, based on available information, the contraction of the volumes moved in the ports has reached an average of 9%, while the trend of containers has remained positive with a +7% on the first 4 months of 2019. This data is mainly attributable to the brilliant performance of Gioia Tauro which has become one of the hubs of reference for MSC in the Mediterranean, since the company has acquired 100% of the Medcenter Container Terminal. MSC has also decided to include this Calabrian port of call among those of reference for the 'Suspension of transit' programme: a section of Gioia Tauro's port areas will therefore be used for the temporary storage of containers that cannot reach their destination due to lockdown measures. With this new functionality, implemented after the production lockdown due to the spread of the pandemic, Gioia Tauro will be able to attract further traffic.

The better performance of the Calabrian hub is also reflected in the data concerning the connectivity of ports in the Mediterranean, which shows that Gioia Tauro is the only Italian port that has improved its ranking.

In particular, according to the last data of the Liner Shipping Connectivity Index (LSCI) elaborated by MDS Transmodal (MDST) in collaboration with UNCTAD updated in May 2020 (used as proxy for the second quarter of 2020) Gioia Tauro is the first-placed Italian port in the ranking of Mediterranean ports, in 7th place, an improvement compared to the 9th place it held in the second quarter of 2019. The port has seen its index increase from 47 to 57 points in 2020.

[15] Confetra (4 April 2020), *Covid-19, Trasporto Merci e Logistica: Flash Congiunturale. Gli effetti sul Settore del primo mese di emergenza.*

The connectivity of Med Ports.
Comparison of Med Rankings, 2nd Quarter 2020 and 2019

Port	Country	Port LSCI2Q 2020	Rank 2Q 2020	Rank 2Q 2019
Valencia	Spain	68	1	3
Algeciras	Spain	67	2	2
Barcelona	Spain	65	3	4
Tanger Med	Morocco	65	4	5
Piraeus	Greece	61	5	1
Port Said	Egypt	60	6	6
Gioia Tauro	**Italy**	**57**	**7**	**9**
Ambarli	Turkey	50	8	8
Genoa	**Italy**	**48**	**9**	**7**
Marsaxlokk	Malta	44	10	10
Izmit Korfezi	Turkey	44	11	15
Fos	France	41	12	12
Tekirdag	Turkey	41	13	17
Mersin	Turkey	41	14	11
Haifa	Israel	41	15	13
La Spezia	**Italy**	**38**	**16**	**14**
Aliaga (Nemrut)	Turkey	38	17	19
Ashdod	Israel	36	18	16
Koper	Slovenia	35	19	20
Damietta	Egypt	35	20	18

TABLE 9 - SOURCE: SRM on MDST and UNCTAD

If we enlarge the scope of the analysis to the European area, there is no change compared to the second quarter of 2019 for the first three places in the European and Mediterranean ranking on port connectivity. Noticeably, Rotterdam, Antwerp and Hamburg confirm their top positions.

With reference to Italian ports, we would like to mention Vado Ligure, which is among the top 10 thanks to the opening of its new container terminal, Vado Gateway, on 12 December 2019. The terminal, which has been managed by APM Terminal management for 50 years, aims to increase the competitiveness of the Ligurian and Italian port system, allowing it to be a gateway for goods moving in the northern part of the country, as well as possibly in markets located north of the Alps, such as Switzerland, Germany and south-eastern France. Conversely, Venice has seen the most significant drop in its LSCI, down from 19 to 11 over the past year.

The decline is mainly due to the cancellation of the Ocean Alliance's direct maritime service to the Far East, while Trieste is now the only Italian port in the rotation.

The connectivity indexes for the other Italian container ports are generally stable or decreasing, with negative performances mainly due to the reduction in the number of maritime services and a decrease in the number of direct connections for Italian ports, as shown in the following table.

Connectivity of the top 10 Italian container ports. Comparison 2nd Quarter 2020 and 2019

Port	LSCI 2Q 2020	LSCI 2Q 2019	Global ranking	Rank 2Q 2019
Gioia Tauro	57	47	34	3
Genoa	48	50	49	2
La Spezia	38	39	81	4
Trieste	33	34	107	5
Livorno	27	26	144	1
Naples	25	25	153	6
Vado Ligure	21	7	176	9
Civitavecchia	21	21	180	8
Salerno	15	17	234	7
Venice	11	19	291	10

TABLE 10 - SOURCE: SRM on MDST and UNCTAD

6. CONCLUSIONS

The pandemic has highlighted the fragility of the modern supply chain and the strength of the recovery will depend on the effectiveness of the economic rescue packages introduced by governments and consumer spending capacity.

In the short term, the outcome of the lockdown on the economy, trade and global investment has been unquestionable, with demand collapsing, GDP falling sharply and income falling across the board.

However, this situation has provided some food for thought: this disruptive, unpredictable event, whose resolution is still completely uncertain, has made it clear that we need to design smarter, stronger and more diversified supply chains.

Multiple sources of supply and digitalisation will be key to building a global business and investment network that can withstand future turmoil and ensure a sustainable recovery. Digitalisation will also help to reshape supply chains because it will allow for the identification and recruitment of new suppliers in a much more rapid way. With technologies such as Artificial Intelligence and the Internet of Things, supply chains could quickly switch to alternative suppliers when regular suppliers experience problems.

This pandemic has caught ports around the world unprepared with an unprecedented reduction in demand volumes. The critical situation linked to the pandemic has highlighted the need to support the digitalisation of port processes as well. Following the provisions of the Covid-19 epidemic containment measures, port authorities and port cluster operators (road hauliers, freight forwarders, port terminals) were faced with the need for complete digitalisation of import-export procedures. The aim is to contain the spread of the coronavirus within the port by limiting personal contact between supply chain operators whilst simplifying procedures and making the port logistics cycle more efficient, ultimately facilitating delivery and collection of goods to and from port terminals.

What seems certain is that post coronavirus the economy will never be the same again. The slowdown in globalisation could be even more noticeable than that seen following the 2008 financial crisis. At the moment, the only certainty seems to be uncertainty: it cannot be ruled out that increasingly strong protectionist measures could be implemented in the event that nations need to defend themselves against the vulnerability resulting from the health crisis. It is possible that some productions will find their relocation to countries with more advanced industrialisation, reducing the degrees of dependence linked to the choices typical of the intense globalisation of the past decades. This trend has grown in parallel with automation and the production of small batches, which have become so cheap that a number of countries have begun to move parts of their supply chain back home.

Global and regional supply chains will be reviewed, and some will change: a number of these changes will benefit shipping demand, while others will not. Less integration of global trade could affect levels of maritime connectivity, which could be particularly detrimental to developing countries. A reduction in shipping services offered by shipping lines, in order to adapt to declining trade flows, is likely to affect the connectivity of direct maritime transport to supply countries in terms of both intercontinental and intra-regional services. This could make economic development more difficult for these economies. And it is precisely the system of maritime connections that will be one of the key players in future competitiveness.

In logistics, as can be seen from the data for the first few months of 2020, we will see the more accelerated growth of e-commerce, which will put the large organised distribution sector under intense pressure.

In the medium-long term, therefore, the effects of this situation are numerous, as are the consequences of the economic stimulus packages that countries have put in place to guarantee the purchasing power of consumers and businesses, but which will in any case contribute to increasing public debt.

STATISTICAL APPENDIX

DEEP SEA SHIPPING MARITIME TRAFFIC

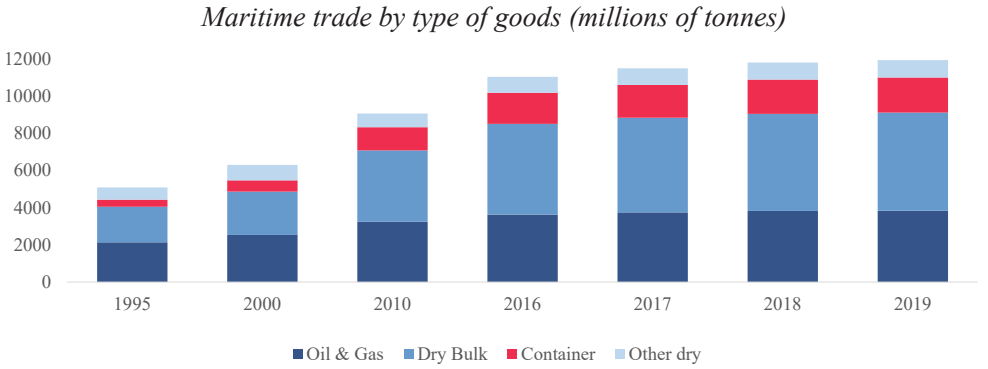


FIGURE 8 - SOURCE: SRM on Clarksons Research, 2020

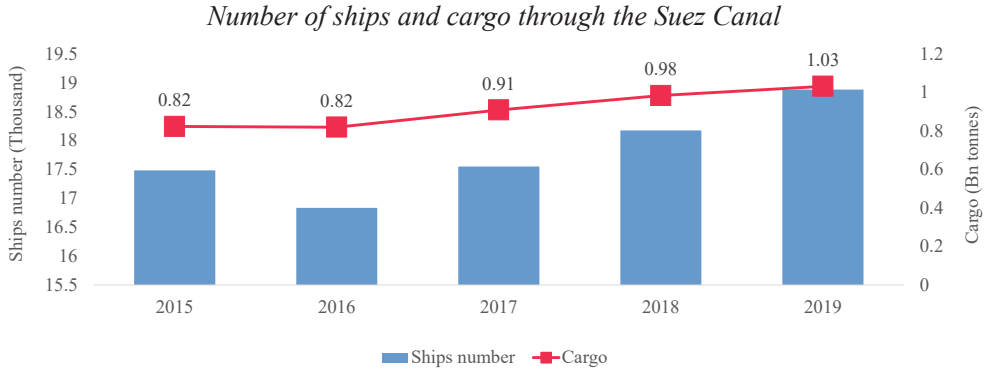


FIGURE 9 - SOURCE: SRM on Suez Canal Authority, 2020

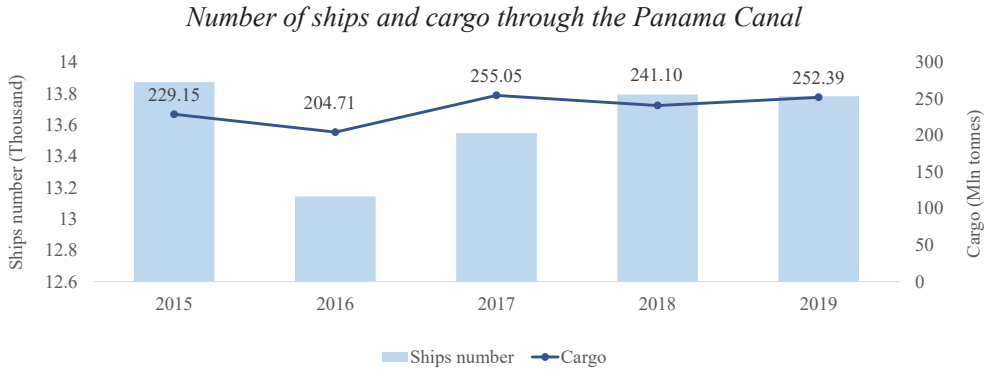


FIGURE 10 - SOURCE: SRM on Panama Canal Authority, 2020

Containership fleet sizes. Top 30 global carriers. June 2020

		Total		Owned		Chartered			Orderbook		
Rnk	Operator	TEU	Ships	TEU	Ships	TEU	Ships	% Chart	TEU	Ships	% existing
1	APM-Maersk	3,956,363	654	2,364,356	315	1,592,007	339	40.2%	34,252	15	0.9%
2	Mediterranean Shg Co	3,712,594	556	947,622	136	2,764,972	420	74.5%	187,500	11	5.1%
3	COSCO Group	2,899,315	474	1,555,755	174	1,343,560	300	46.3%	115,000	5	4.0%
4	CMA CGM Group	2,706,211	500	971,405	122	1,734,806	378	64.1%	449,640	27	16.6%
5	Hapag-Lloyd	1,706,735	235	1,052,321	112	654,414	123	38.3%			
6	ONE (Ocean Network Express)	1,560,259	214	514,170	71	1,046,089	143	67.0%			
7	Evergreen Line	1,231,740	192	580,640	108	651,100	84	52.9%	523,987	61	42.5%
8	Yang Ming Marine Transport Corp.	599,068	91	187,275	42	411,793	49	68.7%	193,800	22	32.4%
9	HMM Co Ltd	562,996	66	251,156	20	311,840	46	55.4%	287,060	15	51.0%
10	PIL (Pacific Int. Line)	352,424	112	152,249	66	200,175	46	56.8%			
11	Zim	293,717	61	4,992	1	288,725	60	98.3%			
12	Wan Hai Lines	244,687	94	164,888	67	79,799	27	32.6%	48,744	20	19.9%
13	Zhonggu Logistics Corp.	168,581	115	101,689	38	66,892	77	39.7%	1,140	1	0.7%
14	KMTC	153,894	65	63,332	26	90,562	39	58.8%	12,500	5	8.1%
15	IRISL Group	152,419	48	94,387	44	58,032	4	38.1%			
16	Antong Holdings (QASC)	144,376	114	114,353	61	30,023	53	20.8%	14,780	9	10.2%
17	SITC	124,620	86	91,366	65	33,254	21	26.7%	12,900	5	10.4%
18	X-Press Feeders Group	102,500	71	45,676	27	56,824	44	55.4%	5,564	2	5.4%
19	UniFeeder	101,458	65			101,458	65	100.0%			
20	TS Lines	96,922	43	22,647	12	74,275	31	76.6%	6,496	3	6.7%
21	Sinokor Merchant Marine	86,877	69	37,463	36	49,414	33	56.9%	30,498	22	35.1%
22	Global Feeder Shipping LLC	69,075	21	9,841	3	59,234	18	85.8%			
23	Matson	66,563	29	39,529	20	27,034	9	40.6%	2,750	1	4.1%
24	Arkas Line / EMES	60,429	35	56,179	34	4,250	1	7.0%	12,400	4	20.5%
25	Sinotrans	60,150	37	27,703	17	32,447	20	53.9%	1,140	1	1.9%
26	RCL (Regional Container L.)	53,471	29	28,726	23	24,745	6	46.3%			
27	Salam Pacific Indonesia Lines	51,105	51	51,105	51				558	1	1.1%
28	SM Line Corp.	42,103	10	29,070	7	13,033	3	31.0%			
29	Grimaldi (Naples)	40,556	39	40,556	39				3,600	12	8.9%
30	Swire Shipping	39,817	24	29,476	17	10,341	7	26.0%	18,263	7	45.9%

TABLE 11 - SOURCE: SRM on Alphaliner, 2020

Top 30 ports in EU and the Med (TEU). Years 2015 and 2019

Rank	Port	2015	2019	
1	Rotterdam	12,234,535	14,810,804	—
2	Antwerp	9,653,511	11,870,000	—
3	Hamburg	8,821,481	9,257,683	—
4	Piraeus	3,339,293	5,648,030	▲
5	Valencia	4,615,196	5,439,827	—
6	Algeciras	4,511,322	5,125,385	—
7	Bremen	5,546,657	4,856,873	▼
8	Tanger Med	2,961,837	4,801,713	▲
9	Felixstowe	4,043,000	3,781,000	▼
10	Port Said	3,462,400	3,658,159	▼
11	Barcelona	1,953,282	3,324,196	▲
12	Ambarli	3,091,026	3,110,000	▼
13	Le Havre	2,559,000	2,786,000	▲
14	Marsaxlokk	3,064,005	2,720,000	▼
15	**Genoa**	**2,242,902**	**2,615,375**	—
16	**Gioia Tauro**	**2,550,000**	**2,522,874**	▼
17	St. Petersburg	1,715,139	2,221,724	▲
18	Gdansk	1,091,202	2,073,215	▲
19	Southampton	1,954,000	*1,970,000*	▼
20	Mersin	1,466,199	1,939,029	▲
21	Alexandria	1,661,917	1,814,950	▼
22	Zeebrugge	1,568,938	1,710,000	▼
23	London	1,185,041	*1,680,000*	▲
24	Izmir	656,000	*1,600,000*	▲
25	Ashdod	1,307,000	1,538,000	▼
26	Marseille	1,223,173	1,454,621	▼
27	Sines PSA	1,332,200	1,423,213	▼
28	**La Spezia**	**1,300,442**	**1,409,381**	▼
29	Haifa	1,220,000	1,379,000	▼
30	Beirut	1,130,284	1,229,081	▼

In italics estimates for 2019.

TABLE 12 - SOURCE: SRM on on Port Authorities

SHORT SEA SHIPPING MARITIME TRAFFIC

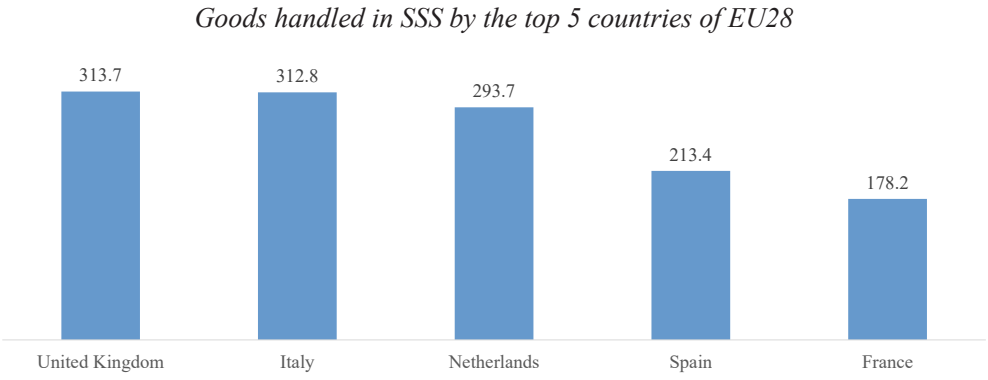


FIGURE 12 - SOURCE: SRM on Eurostat, 2020 – data relative to 2018

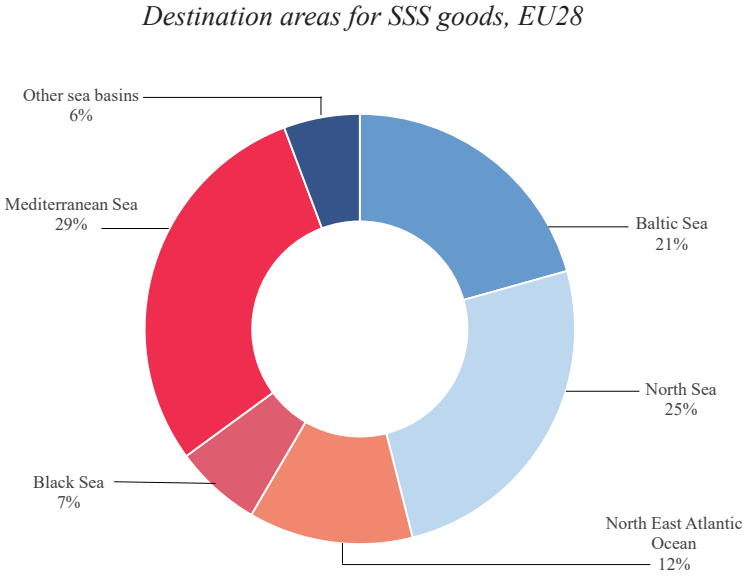


FIGURE 12 - SOURCE: SRM on Eurostat, 2020 – data relative to 2018

Top 10 ports of EU28 by handling of goods in SSS (thousands of goods)

Rank	Port	SSS
1	Rotterdam	206,813
2	Antwerpen	96,803
3	Hamburg	49,997
4	Marseille	47,922
5	Amsterdam	45,978
6	**Trieste**	**44,614**
7	**Genoa**	**43,924**
8	Algeciras	43,066
9	Göteborg	35,030
10	Piraeus	33,045

TABLE 13 - SOURCE: SRM on Eurostat, 2020 – data relative to 2018

INTERNATIONAL TRADE RELATIONS

Trend of maritime import-export of Italy. 2015-2019

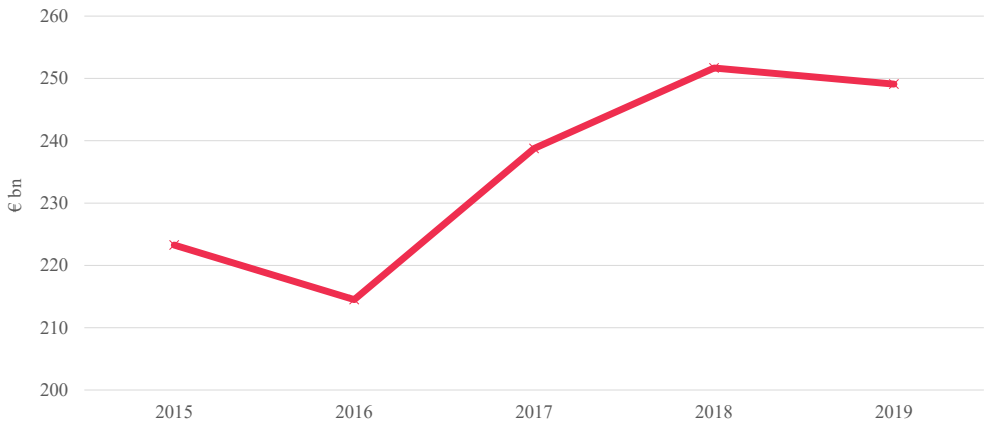
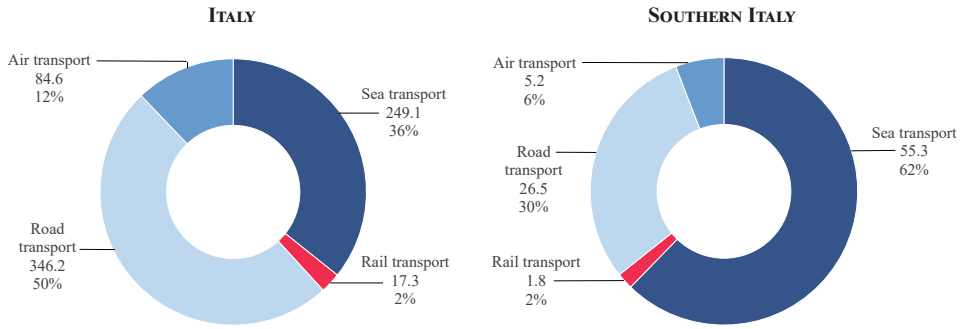


FIGURE 13 - SOURCE: SRM on ISTAT-Coeweb, 2020

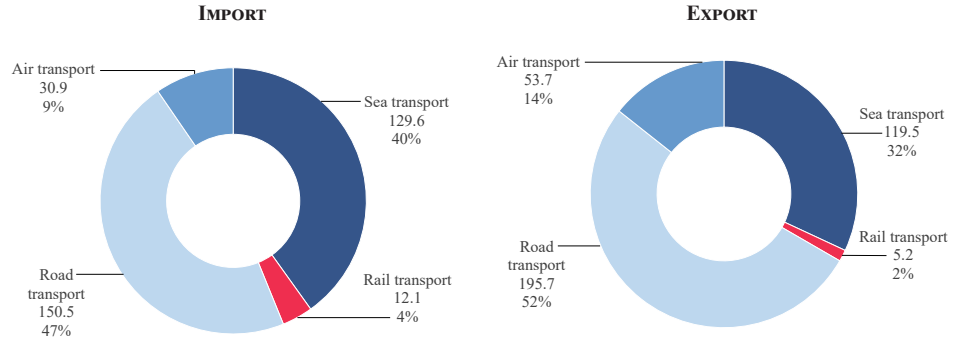
Transport mode of trade exchanges (data in € billion and %). Year 2019



Note: only statistically identified transport modes have been considered. 'not declared' and 'other modes of transport' have been left out.

FIGURE 14 - SOURCE: SRM on ISTAT-Coeweb, 2020

Italian import and export by mode of transport (data in € billion and %). Year 2019



Note: only statistically identified transport modes have been considered. 'not declared' and 'other modes of transport' have been left out.

FIGURE 15 - SOURCE: SRM on ISTAT-Coeweb, 2020

Italian Maritime Trade: the top 10 world partners. Year 2019

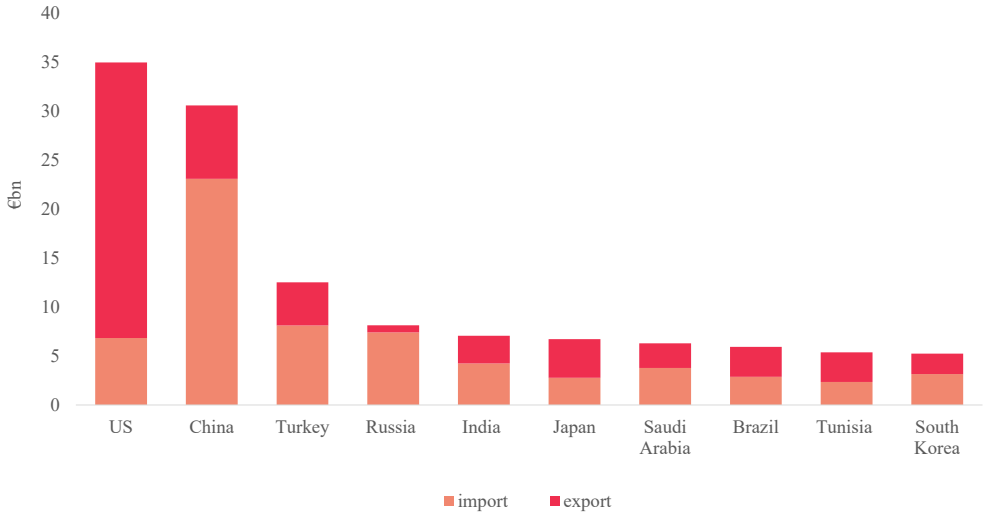


FIGURE 16 - SOURCE: SRM ON ISTAT-Coeweb, 2020

Italian Maritime Trade: top 10 goods exchanged in 2019 (€ billion)

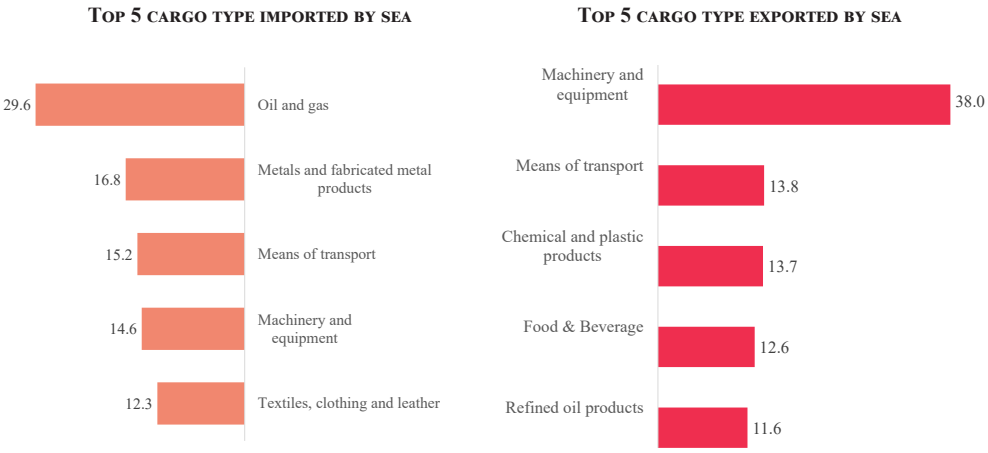


FIGURE 17 - SOURCE: SRM ON ISTAT-Coeweb, 2020

COMPANIES OF THE ITALIAN MARITIME CLUSTER

Categories of companies in the maritime cluster by sector of activities as of 31st March 2020 (number and percentage)

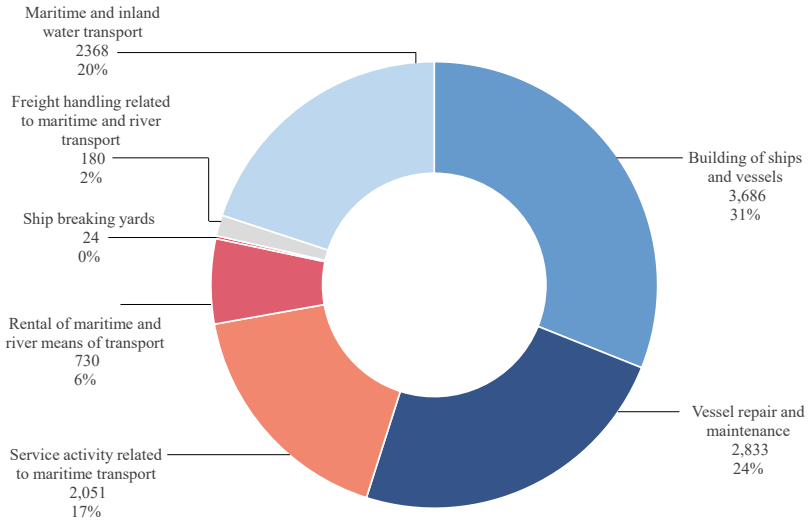


FIGURE 18 - SOURCE: SRM on Database from Camera di Commercio delle Marche Region

Companies of the Maritime cluster by region (number)

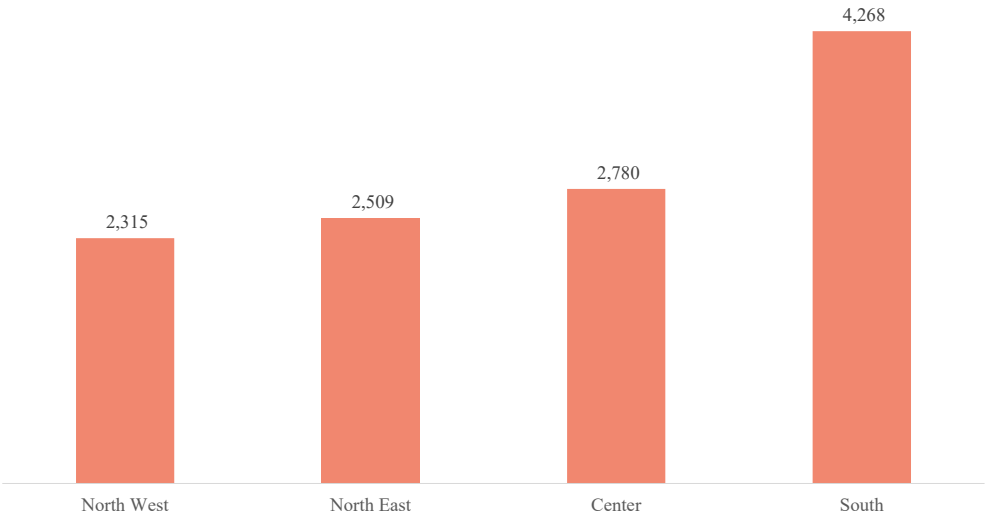


FIGURE 19 - SOURCE: SRM on Database from Camera di Commercio of Marche Region

ITALIAN PORTS PERFORMANCE

Types of goods handled by Italian ports. Years 2015-2019

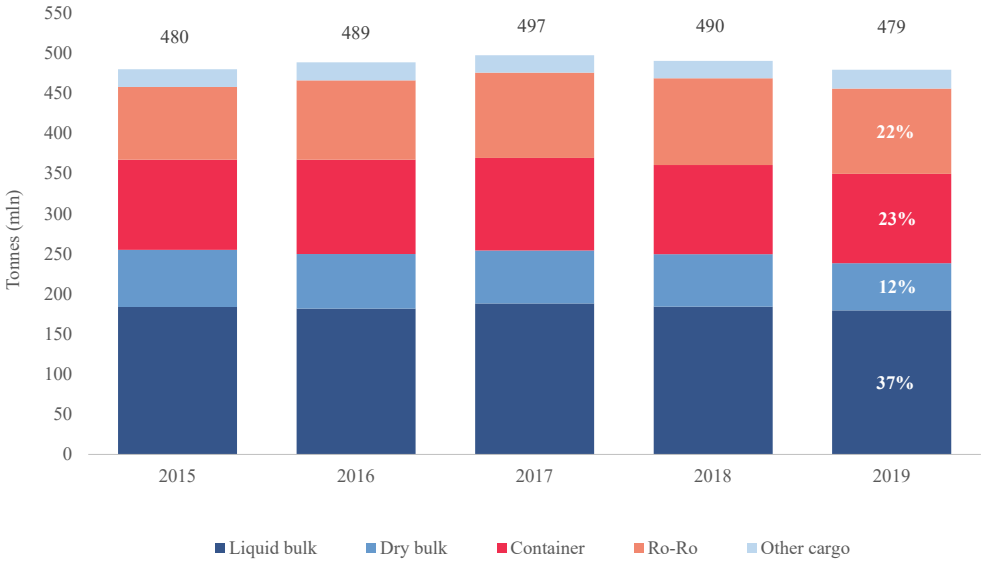


FIGURE 20 - SOURCE: SRM on Assoporti 2020

Overall goods handling by region. Years 2018-2019 (millions of tonnes)

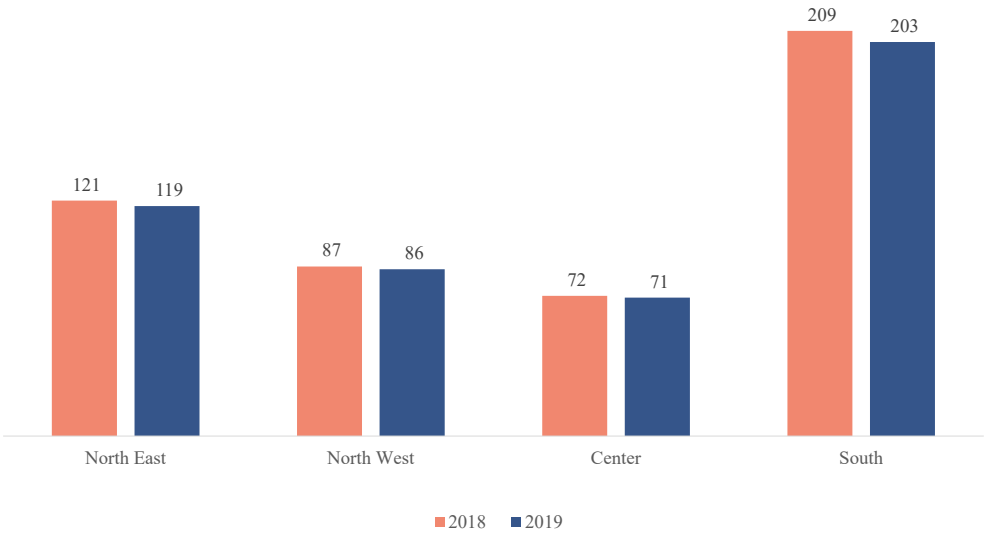


FIGURE 21 - SOURCE: SRM on Assoporti 2020

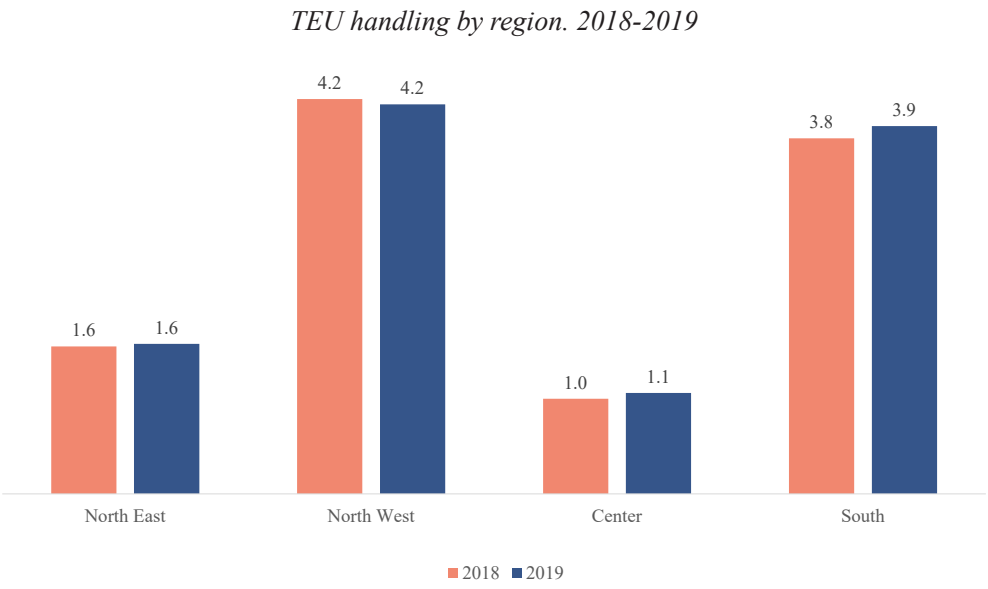


FIGURE 22 - SOURCE: SRM on Assoporti 2020

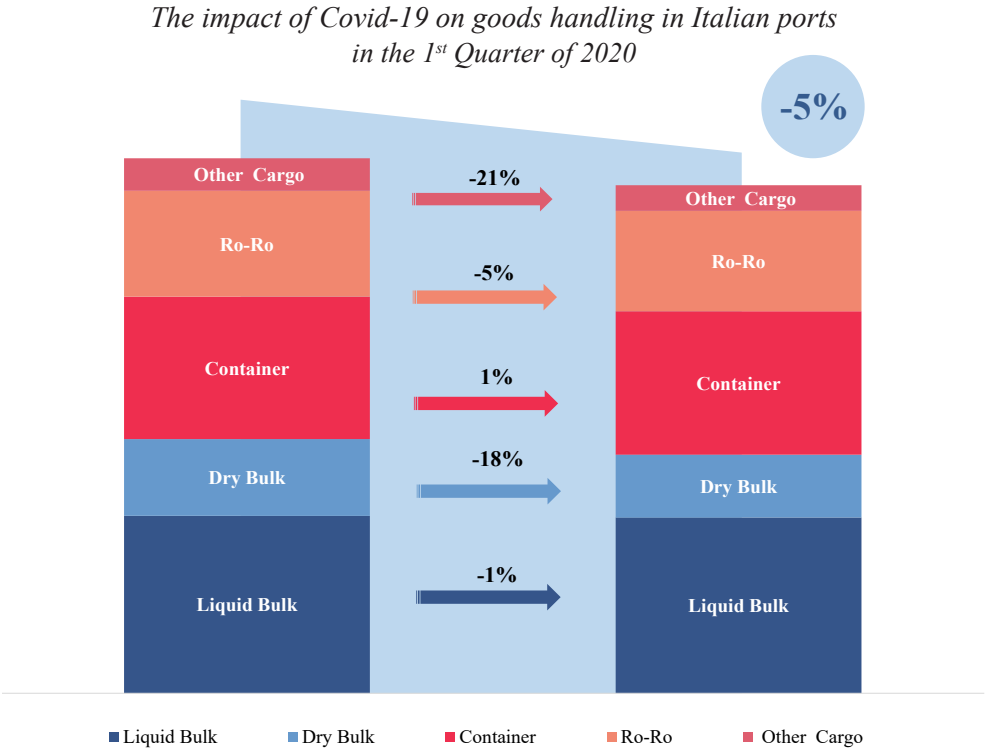


FIGURE 23 - SOURCE: SRM on Port Network Authorities 2020

The impact of Covid-19 on container handling in Italian ports in the 1st Quarter of 2020 (million TEU)

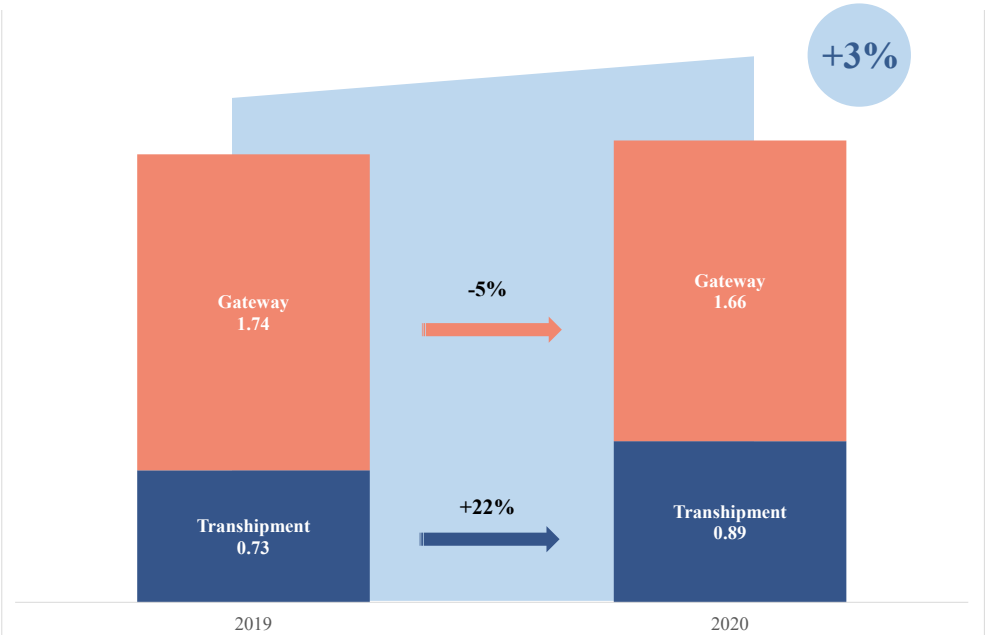


FIGURE 24 - SOURCE: SRM on Port Network Authorities 2020

The impact of Covid-19 on movements of goods and containers in Italian ports in the period January-April 2020 (percentages relative to variation Jan-Apr 2019 of the tonnes moved)

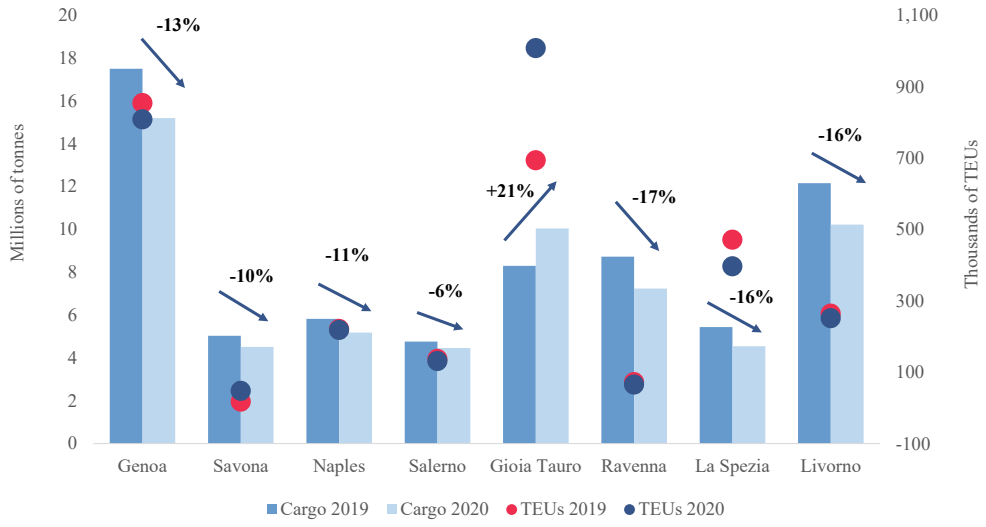


FIGURE 25 - SOURCE: SRM on Port Network Authorities 2020

Chapter II

Results of an impact analysis of Covid-19 on maritime containerised import-export in Italy and in the Mezzogiorno[1]

This chapter will illustrate an analysis of forecasts for the import-export of containerised maritime traffic in Italy[2] in the year 2020 with special reference to the potential handling of gateway ports. The present study highlights that this sector is strategic in this emergency period.

This sector potentially accounts for approximately 20% of Italian overall trade value (including energy) and for over 70% of total maritime, with figures showing a value of over €190 billion, 85 of which in imports and 106 in exports, and therefore with a positive trade balance.

This analysis also shows the full extent of this sector's contribution which, in these hard times of health emergency, plays a vital role in supplying and supporting activities in our country.

1. The reference framework for Italy

Much has changed with regard to the estimates of the trend of container maritime import-export; in the first few months of the year there was a shift from a hypothetical 2% annual growth in 2020 to a clear downturn due to the spread of the pandemic; what is not yet measurable is the intensity of the contraction. This in fact, is an element of exogenous shock never experienced by the economy before.

The positive aspect is that as such it does not affect the economic fundamentals; it is not a degeneration of the economic system or the container sector even if the latter suffers and will suffer the consequences of such an event.

Moreover, since it is a pandemic, the impact has not been limited and will not be limited to Italy, but has already spread worldwide like a wave and therefore even the analysis of the period of spread of the virus becomes difficult to pinpoint.

What can be said is that it will be a year of uncertainties in which there will be extreme volatility, linked to some fundamental aspects which, as they affect the supply side of products, influence also container transport.

However, these elements are also affecting demand. In fact, a surge in demand for some products (e.g. drugs and medical equipment) corresponds to a production halt for others (automotive and components).

[1] This chapter was written during the critical phase of Covid-19 with data available at the end of May 2020.

[2] As we do not have definite data on this cross-section to define the sector (import-export maritime container), some Ateco codes (categories of economic activities) have been specifically considered in terms of their potential to be containerisable).

There is widespread awareness that the virus will cause a temporary shock both to the economy and to maritime transport but, in assessing its economic impact, there are several elements of uncertainty, which include both internal and external elements to Italy, which all have an impact on container transport due to its global nature.

As regards some of the main factors abroad, which in any case have an impact on national trade, it must be said that it is not known whether the virus will affect all countries in the same way and this will also influence import-export. As the disease progresses, some ports will slow down or even stop their activity, while others may continue to operate. First of all, Chinese ports have been blocked, and the spread of the virus in Europe has led to a slowdown in ports on our continent. Due to the different level of virus incidence some countries are currently ready to produce while others are not prepared to receive goods at full capacity because they are still in a state of emergency resulting in a series of negative consequences in shipping and transport. In addition, some important connection lines have been cancelled and blank sailing rounds have been announced (as also specified in the previous chapter).

The cause is always the drop in transport demand due to the effects of the Covid-19 pandemic. The number of inactive container ships increases.

As a result of the cancellation of departures and liner services, the fleet of idle containerships rose to a record level of more than 2.7 million TEU, equal to 11.6% of the total[3].

As far as the internal elements affecting trade are concerned, it has to be taken into consideration that the development of the shipping container industry, as a global sector, closely follows the virus and is inevitably affected by it.

It is now clear that Covid-19 has been and will continue to be for some time a limiting factor not only for the life and sociality of citizens but also for the world economy in general and the national economy in particular. The contagion curve seems to have reached its peak but let us not forget that this shows a decline in contagion, not that the virus has disappeared.

It should be noted that following the outbreak of the epidemic and the restrictions that have been introduced, in order to protect the health of citizens and at the same time ensure their subsistence, the Prime Ministerial Decree of 22 March 2020 in Annex 1 which was amended to the Decree of 25 March, has specified which were the essential activities of the country's economy which therefore had to keep operating. The list of permitted activities is included in a rather extensive list, which mainly concerns the food chain, pharmaceuticals and parts of machinery[4].The lockdown was extended on 10 April with a new Prime Minister's Decree until 3 May, which extended the list to include the wood supply chain.

[3] Alphaliner Issue n. 22 - 6/2020.

[4] On the basis of the Ateco codes (categories of economic activities) indicated in the annex to the Prime Ministerial Decree of 22 March 2020, amended by decree of 25 March, starting from their impact on the total goods traded, estimates have been made in order to define the perimeter of "essential production" also for the container sector. In terms of exports, the volume of such "production" in the basic confinement period (March, April, May) is estimated to be 10% of the total traded during the year and 50-60% of the period. This percentage has also been maintained for the analysis of the container sector.

With the Prime Ministerial Decree of 17 May 2020, all production activities are expected to resume from 18 May. From 3 June onwards, travel between regions is also possible.

These measures have formed the basis for the calculation of estimates of the trend in the import-export of containers handled by sea, making it possible to identify "essential production" especially during the period of isolation.

Based on these assumptions, it is estimated that during the lockdown period container shipping ran at 50 to 60% of its usual capacity. Each additional week of trade block of certain production would have cost the sector €1.5 billion.

Uncertainty surrounding the estimates remains highly dependent on government decisions on the duration of the lockdown.

2. The impact of Covid-19 on maritime containerised traffic in Italy and the Mezzogiorno: import-export data

In order to assess the economic impact of the shock, monthly national import-export (containerisable) data for 2019 broken down by sector have been considered, with the possible loss of value that can be expected during the quarantine period in 2020 for each of them.

It should be borne in mind that some sectors have experienced less marked slowdowns (i.e. agri-food) while others have remained inactive (i.e. automotive and textiles).

In a previous work of SRM[5] 3 hypotheses of scenario were made, which are now narrowed down to 2, based on the analysis of data relative to Italian containerized port trend and maritime import export of the first three months of the year. Compared to the previous study, the trends seem to be less pessimistic even though the data are still showing negative values.

In the first 3 months of 2020 the decrease in value of the import-export of containerized traffic was of -5%, concentrated above all in the month of March that has recorded a -17% (March 2020 on March 2019).

The first scenario (*Scenario A*) is based on an "estimated" baseline duration of the lockdown from the beginning of March to 18 May, and its consequent impact on trade. The "working hypothesis" is based on the abovementioned containment measures decided by the Government. Forecasts indicate a reduction of maritime container import-export of 13 / 15% in a non-pessimistic scenario.

This is why exports of this sector are expected to shrink by 12% and imports by 16%. In line with what was highlighted by the Bank of Italy which forecasts a slightly more marked decline of import-export of goods and services[6].

Another hypothesis (*Scenario B*) has been elaborated with the aim of highlighting the possible impact on import-export in case of new lockdown measures.

[5] SRM (April 2020), *Covid-19 Observatory on Maritime Transport and Logistics*.

[6] Bank of Italy (15 May 2020), *The impact of the COVID-19 pandemic on the italian economy: illustrative scenarios*.

The decline in trade seems to be more considerable (-17% / -20%) and effects on the sector can be seen more clearly but when the overall situation is considered, we see a more marked rebound in the third quarter with considerable recovery.

Two scenarios for the impact of Covid-19 on the sector of container transport

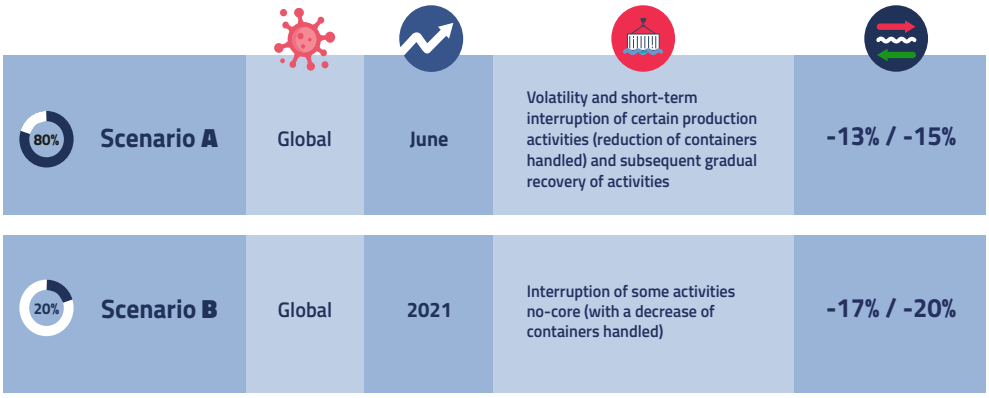


FIGURE 1 - SOURCE: SRM

The result is a series of scenarios that outline a decline in our maritime trade, although to be interpreted with due caution. It is obvious that the types of goods are not the only variable that will shape the phenomenon. In fact, another factor will come from the spread of contagion in the countries that have greater maritime relations with Italy and from their desire to still apply duties and restrictions to trade that were in place even before the Coronavirus and above all from the situation of China which is a player directly involved in many global value chains.

The South of Italy, which concentrates about 20% of Italian gateway container traffic (and 43% of the total traffic of goods handled), is a territory whose development is based on seaborne import-export and which will certainly be affected by the problem. It should be noted that southern ports could be at an advantage due to reduced spread and greater control of the contagion in their territories. Starting from southern ports could be one of the ways to achieve recovery.

As Table 2 below clearly shows, losses for gateway ports in the South of Italy are expected to be less severe than the rest of the country (2 percentage points less) and in particular the port of Gioia Tauro, a transshipment hub, has been showing a positive trend since the first months of 2020 with a 45% growth in April on the first 4 months of 2019. This brilliant result will positively affect the whole Mezzogiorno, Italy and the Mediterranean leading this port to hold a stable position in the top 4 ports of the Mediterranean starting from 2020, as highlighted also by T. Notteboom.

In fact, MSC has decided to include this port in a list of reference points for the programme 'Suspension of transit' which entails a network of hub ports in the world that will offer storage for those containers 'suspended in the global market' which, due to restrictions to traffic, might remain blocked with consequent surge of costs.

A part of the port areas of Gioia Tauro will be used for temporary storage of containers that cannot reach their final destination because of lockdown measures in place. With this new function, Gioia Tauro will be in the position to attract further traffic.

The impact of Covid-19 on the sector of container import-export in the Mezzogiorno and Italy (Scenario A)

Italy	**2019 bn €**	**var % 2018-2019**	**Var % 2019-2020 (estimated)**
Export Container	106.4	2%	-12%
Import Container	84.7	-1%	-16%
Trade	191.1	1%	-13%
Mezzogiorno	**2019 bn €**	**var % 2018-2019**	**Var % 2019-2020 (estimated)**
Export Container	12.6	1%	-11%
Import Container	9.8	3%	-11%
Trade	22.4	1.4%	-11%

TABLE 1 - SOURCE: SRM

Chapter III

The different "approaches" of manufacturing firms: corridors and logistic efficiency, "enemies" of Covid-19

1. Foreword

This year has been a difficult one for all those entities, which produce, distribute and consume industrial goods. If we look at the economic estimates, the most recent ones by the International Monetary Fund indicate -3% for global GDP and -9% for Italy's GDP, with a rebound in 2020 of 5.8% and 4.8% respectively.

Yet, in this scenario, a rather clear evidence emerged. For both the individual company (in any sector) and the community of companies, an efficient logistics system is a win-factor: it is a connecting factor and allows companies to reach their customers even in lockdown events such as the one we have just experienced (due to Covid-19), with high levels of performance in terms of timing and quality of service. It can be even more strategic for any company and any country, with the emergence of new models of consumption.

However, it is not just a question of coping with emergency shocks (and growing in resilience) as happened in 2020, nor just adapting to new needs. The challenge is far bigger, and the future of the next generations is at stake. Today more than ever, the planet is calling for "sustainability". This is confirmed by the various reports published by the IPCC (Intergovernmental Panel on Climate Change), and by the WWF (World Wide Fund), just to name a few. The United Nations has established 17 Sustainable Development Goals (SDG), asking its Country-members to give their maximum effort to improve in sustainability, and, in particular, in the most relevant SDGs in their contest. It is clear: a more efficient and "cleaner" (or rather "greener") logistics system is a must for any country which wants to make its manufacturing system more competitive and bring it at the forefront of the emerging future. At the same time, it is a must to significantly contribute to meeting the global need for sustainability.

It is for this reason that SRM (a research center connected to Intesa Sanpaolo Group), together with Contship Italia (one of the main terminal operators in Italy), has decided to study in-depth the needs and perceptions of Italian manufacturing companies. It is to understand what are the weaknesses, the strengths, and the factors to work on to build "efficiency", "technology", "innovation" and "sustainability" in our logistics system. It is the second edition, and both "Surveys" have been read with enthusiasm and active participation by many operators. The 2020 study[1] is based on a survey conducted on 400 manufacturing companies located in Lombardy, Veneto, and Emilia Romagna, which export and/or import goods by sea using the container.

[1] The survey was conducted in 2019 and its results published in 2020. The survey published in 2019 was carried out in 2018. In the following paragraphs we will refer to these surveys respectively as 2019 and 2018 survey.

The survey of 2020 has innovated some of its contents if compared with the one of 2019, introducing an in-depth analysis on *sustainability*, and a specific analysis on the companies in the *Prosecco district of Conegliano Valdobbiadene in Veneto*, one of the best performing in Italy, as emerged from the surveys on Italian districts conducted by the Research Department of Intesa Sanpaolo Group.

Besides, this second edition gave voice to the main actors of the sector. SRM and Contship, with the support of Intesa Sanpaolo, identified and brought together, in the first months of 2019, shippers, freight forwarders, logistic operators and researchers, in a focus group so as to collect thoughts and ideas to perfect the questionnaire.

The survey "Corridors and logistic efficiency of the territories" is an extremely important tool for structuring a cutting-edge logistics system able of withstanding the most significant shocks such as the one occurred in the first two quarters of 2020 and building the pillars to better support the Italian production system, starting from the needs of manufacturing companies.

2. Efficiency in logistic corridors: a step to pursue

Before starting this paragraph and providing the most interesting results of the survey, let us give you some information on the economics of the three regions object of the analysis.

Lombardy, Emilia Romagna, and Veneto are the three main Italian regions in terms of trade with foreign countries. In total, in 2019 they achieved €478 billion of import/export (53.2% of the Italian trade with foreign countries), +0.7% compared with 2018. More specifically, Lombardy covers 29.1% (€261 billion in 2019) of Italian foreign trade, Veneto 12.6% (€113 billion), and Emilia Romagna 11.5% (€104 billion).

These three regions accounts for a large part of the Italian GDP (40.7%): Lombardy (22.2%); Veneto (9.4%); Emilia Romagna over (9%).

The maritime trade is an important component (second only to road transport) of the foreign trade of these regions: giving 100 to the sum of the four modes of transport (thus excluding the component "not specified" in the Italian national statistics database - Istat), sea trade represents 27.5% for Lombardy, 30.8% for Veneto, 37.5% for Emilia Romagna (to be compared with 35.7% for Italy).

The survey begins with giving some info on the characteristics of the sample of companies interviewed in terms of maritime transport. Given that these are manufacturing companies, the container is an important means of transport in their business. It's worthwhile to say that the Italian business community (and therefore also of the regions targeted by the Survey), made up of small and medium-sized entities influences the intensity of the use of containers: most companies "use, on average, no more than 1 container per week", both in export and import activities. The companies that make more than 50 containers per year in export are 8% of the total (down from 11% in the previous survey).

In the title of the chapter we emphasized the word "enemies" of Covid-19. Well, the first element of efficiency and resilience consists of choosing the right "logistic corridor", starting with an understanding of the main way of connecting ports and industrial

systems. In the second, as well as in the first edition of the survey, companies continue to prefer road transport for the last part of the route. In the investigated area, intermodal transportation remains a choice adopted by only 17% of companies (compared to 19% in 2018). Of the three regions, while Veneto sees a significant increase in the share of companies opting for intermodal transport, this percentage has dropped significantly in Lombardy. Besides, companies choosing the intermodal option were asked about the three main drivers behind this choice. The survey showed that the most significant shares of companies – over 85% – occur for two reasons: a) the convenience of the service and b) the frequency of the service.

It is obvious: if we want to talk about resilience and the ability to deal with a shock like the one which occurred in 2020 as a result of the lockdown, the logistics factor cannot be neglected and it is clear that the intermodal system is preferable. This is also true if we take into account the pollution factor, for which the rail mode is preferable to the road one. Besides, companies should increasingly have to take into account the "quality" factor in logistics to preserve their business even in the presence of economic and social turbulence.

Mode of connection between the port and the company: Intermodal vs road transport (% of companies)

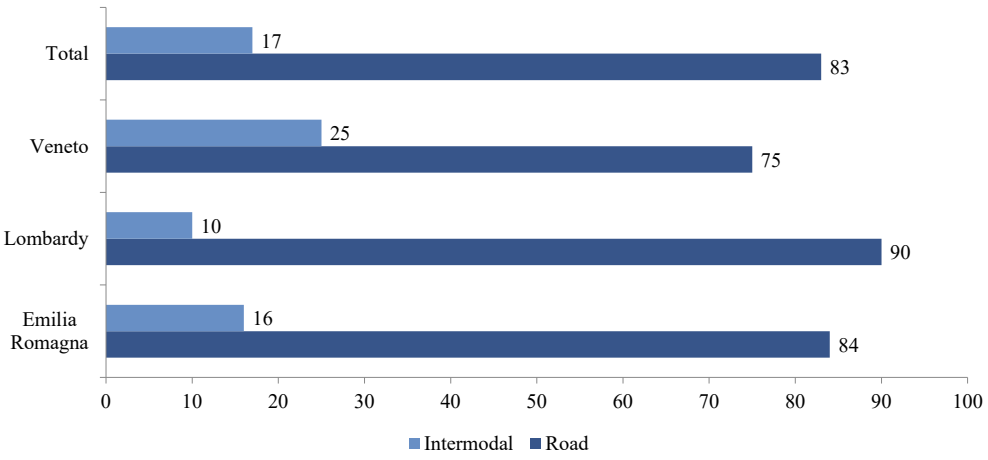


FIGURE 1 - SOURCE: SRM/Contship 2020

Having a clear idea of the logistics corridors used by companies in their production process and market delivery helps better understand the logistics needs of companies when they interface with foreign countries for the supply of production inputs and the sale of finished products. An extremely important issue when it comes to resilience is differentiation in the ports used and the market's destinations. The Covid-experience has taught us that concentrating on a single market, even if in good health, like the Chinese one, can have significant negative effects on your business if there should be a sudden shock as it happened in China at the beginning of 2020.

The same can be said about the choice and the use of Italian ports.

Starting from this element, the Survey shows that Genoa confirms its position as the port used by most companies. Manufacturing companies were asked to indicate "the two ports mainly used for their exports and imports".

The port of Genoa boasts 80% for exports (72% in 2018) and 73% for imports (55% in 2018). La Spezia and Venice are among the two most preferred ports, respectively for 25% and about 20% of companies, both in export and import. The percentage of companies opting for Trieste is growing. It should be noted that the figure for Genoa is higher for companies located in Lombardy: over 90% for both incoming and outgoing goods. It stands at about 70% for exports and 48% for imports in Veneto, while it exceeds 75% for both exports and imports in the case of companies in Emilia Romagna.

A higher percentage of Venetian companies choose Venice (49% in exports and 55% in imports) and Trieste (15% in exports and 28% in imports) as two of the main ports of reference.

The port of La Spezia shows good performances among Lombard companies: it is one of the 2 most used alternatives for 41% of companies in exports and imports (30% in the Emilia Romagna region). Livorno is one of the two choices for exports by 29% of companies in Emilian Romagna.

Then follows the analysis of the foreign points of landing (for exported goods) and departure (for imported goods): where the goods we export go and where the goods we import come from. It should be noted that although the basic trend expressed in the following graphs is interesting and true, it is partly affected by the sectoral reshaping of the sample in 2019 compared to 2018. Asia is between the two main markets for 37% of companies, Europe for 50% (vs. 12% in 2018). For imports, Asia is among the main supply markets for 50% of companies, Europe for 39%.

Main ports in export
(% of companies that declared that port among the first two options for their export)

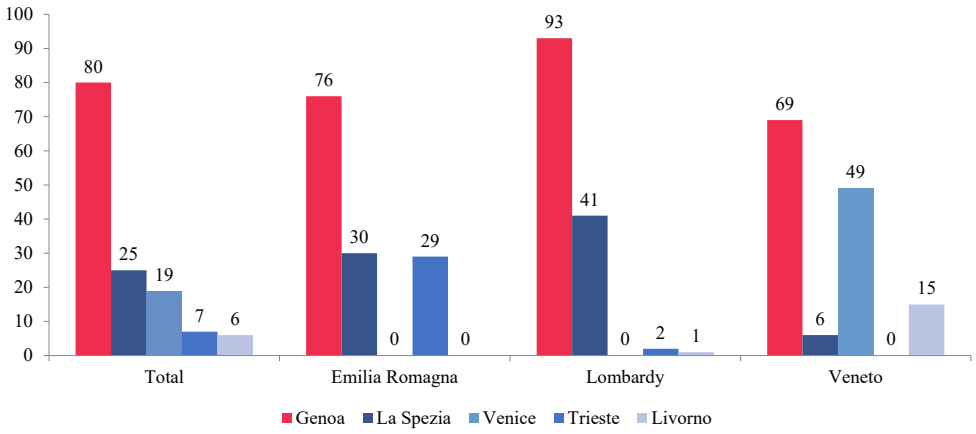


FIGURE 2 - SOURCE: SRM/Contship 2020

Main ports in import
(% of companies that declared that port among the first two options for their imports)

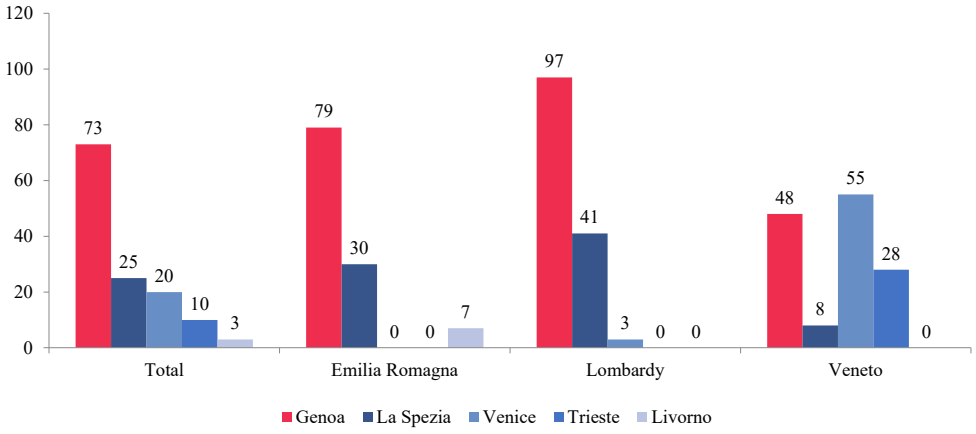


FIGURE 3 - SOURCE: SRM/Contship 2020

Export areas
(% of companies that declared
that area among the top two destinations for their exports)

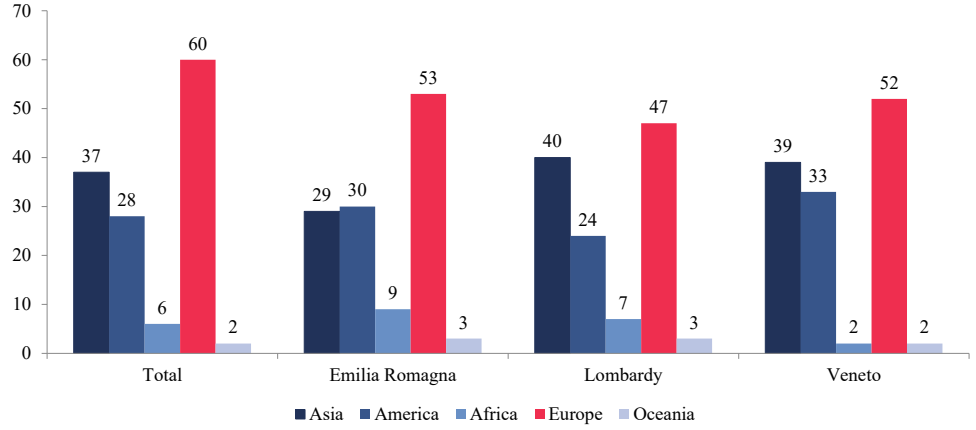


FIGURE 4 - SOURCE: SRM/Contship 2020

Import areas
(% of companies that declared that area between the first two origins for their imports)

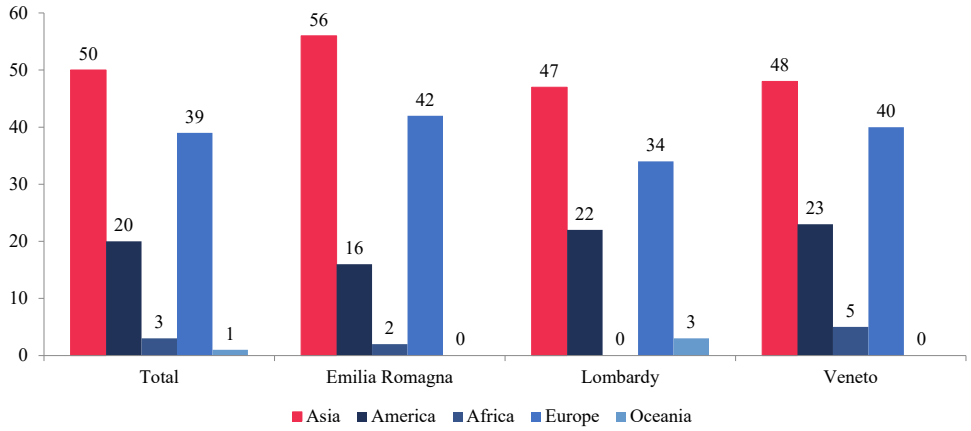


FIGURE 5 - SOURCE: SRM/Contship 2020

3. LOGISTICS PROCESS MANAGEMENT

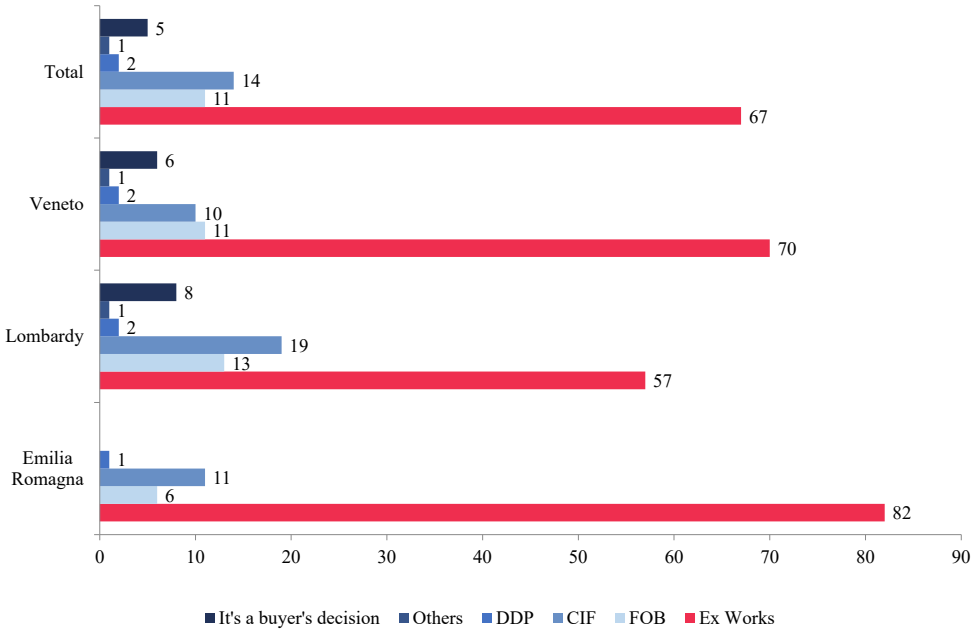
In the previous paragraph we focused on the journey that goods make to get to Italian companies (in the case of imports) or to reach the market destination (in the case of exports). Now the focus moves to how the logistic process is managed. One of the questions is "whether the outsourcing of the logistics process prevails or not."

Also in this case, it can be relevant in the event of a shock to preserve at least part of the decisions regarding logistics while relying on professional operators who can help make the best choices. How many companies (in sectoral lockdown or not) have lost part of the business because they are not well-equipped from a logistical point of view?

Coming to what emerged from the survey, the results confirm (albeit with lower percentages compared to the 2018 survey) the general tendency of companies to outsource the logistics process (69% of exporting companies and 49% of importing companies). There are no major regional differences with reference to exports: in all three regions, the percentage of companies that outsource the logistics process exceeds 65%. When we talk about imports instead, the percentage of companies in Emilia Romagna that outsource logistics is less than in other regions. Outsourcing brings several economic advantages: the reduction of operating costs, better use of stock in warehouses, and, in general, better competitiveness on the market. But the greatest advantage is the absence of capital invested in buildings, installations, facilities, and personnel, thus reducing a fixed cost that becomes variable, albeit not totally. Outsourcing the logistics of goods is a positive choice as long as manufacturing companies are able to preserve a dialogue with logistics operators in order to optimize and better manage the entire supply chain.

An important topic to take into consideration is the choice of contractual terms (Incoterms) when we come to the delivery of goods.

Among the Incoterms, the Ex Works clause prevails
(% of companies that choose the contractual clause in their export transactions)



FOB – Free on Board
CIF – Cost, Insurance and Freight
DDP – Delivery Duty Paid

FIGURE 6 - SOURCE: SRM/Contship 2020

These determine who (seller or buyer) is to bear the costs and/or risks of transport. It has been asked to companies which contractual term they prevalently use in their dealings with foreign countries. The results of this survey confirm what already emerged in 2018, i.e. a wide use of the clause "delivered Ex Works" in the case of exports: 67% of enterprises use it (64% in the 2018 survey). So, Italian companies tend to cede the cost and risk of transport to the buyer. To the mentioned 67% we could add 11% more companies, which resort to the FOB (Free on Board) clause. In this case it is established that the risks related to the placement of the goods on board the ship at the port of departure, as well as all related expenses, are borne by the seller. The buyer, on the other hand, assumes the costs and risks relating to the transport of the goods once they have been placed on the ship. Therefore, a tremendous 78% assumes logistic costs and risks up until, and no further than, the shipment of the goods. Some differences emerge at a regional level: Ex Works is the most used clause by 82% of companies in Emilia Romagna, 70% in Veneto and 57% in Lombardy. For imports, the percentage of Italian companies which buy "under Ex Works" is much lower (24% of companies, down from 46% in 2018).

In summary, Italian sellers tend to transfer transport costs and responsibilities to the foreign counterpart. Therefore, it has been asked to companies, which are the underlying reasons behind this choice. The answer is very clear: 62% of companies states that it is an effective way of "keeping the price of their products low", by avoiding the transport costs. In this regard, a strategic consideration can be made: logistics and transport processes are still considered a "cost" and not a "value". This is an issue that needs to be dealt with by the industry and the main associations of logistics operators which are called upon to make a very important commitment in terms of communication and enhancement for the future.

Reasons underlying the choice of the Ex Works clause
(% of companies that stated that reason)

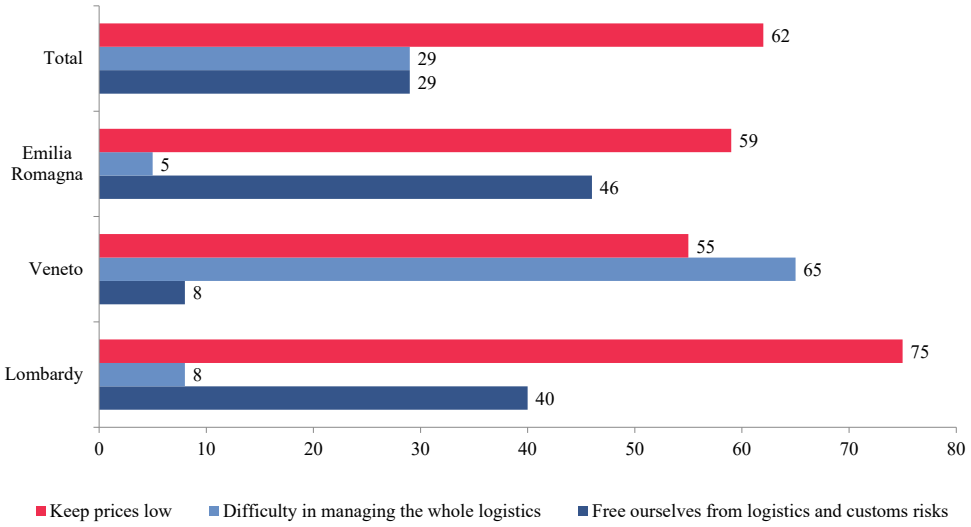


FIGURE 7 - SOURCE: SRM/Contship 2020

4. THE DEMAND FOR SUSTAINABILITY IN LOGISTICS BY MANUFACTURING COMPANIES[2]

Sustainability is one of the hottest topics in recent years. An IPCC study shows that logistics contributes to 14% of greenhouse gas emissions, without forgetting that an efficient and transparent transport system can bring to the consumer goods which are produced, distributed, and therefore consumed according to sustainability (ecological, social, and economics) principles. The theme of sustainability was therefore a must to be investigated in the present edition of the survey "Corridors and logistic efficiency of the territories". It is particularly relevant for understanding "what is emerging".

[2] For further information on the topic of sustainability in logistics, it is possible to consult SOS-LOG website, an association for sustainable logistics [https://www.sos-logistica.org/].

The companies were asked a series of questions aimed at evaluating their approach to sustainability. One of the first elements analysed is the value of sustainability for companies: how it represents an important part of the developmental process, also at the organizational level. Only 16% of the companies interviewed states that they manage sustainability through a specific model of internal governance and engagement with stakeholders. In particular, more than half have done it since the company was born.

Then companies were asked whether they use Key Performance Indicators (KPIs) to improve sustainability and if so, what are these KPIs. Only 8% of the sample uses parameters related to environmental sustainability. Therefore, many manufacturing companies have not yet understood how strategic the issue of sustainability is, and, among other things, that for legislative, market and cultural reasons, sustainability could become an indispensable condition for companies to operate in the future. The survey went beyond the quantification of sustainability in enterprises, trying also, to some extent, "qualify" it. The 8% were then asked about the main KPIs used. It turns out that as many as 50% of companies consider "the choice of materials and the sustainability of packaging" among the main performance indicators.

In the previous part of this paragraph, it has been analyzed how sustainability is considered and treated by manufacturing companies (sustainability supply); but the survey has also analyzed the demand for sustainability from customers and the end-consumers, as it is perceived by the manufacturing companies interviewed. These companies were asked to indicate on a scale of 0 to 10, to what degree they consider their customers to be sensitive to sustainability (environmental, social, and economic). 18% of the sample believe that customers are highly sensitive to the issue of environmental sustainability. This percentage rises to 36% when the question is asked with reference to the next two years.

The demand for sustainability
(% of companies that declare that customers are highly sensitive to the issue of sustainability)

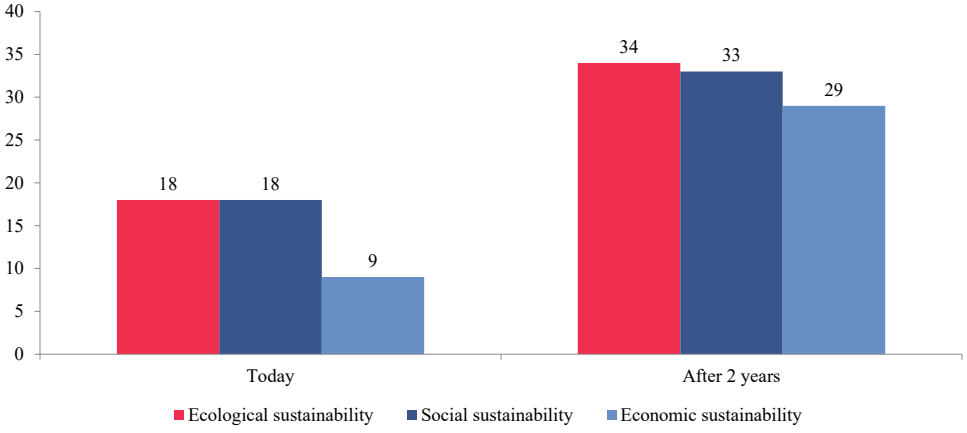


FIGURE 8 - SOURCE: SRM/Contship 2020

Although companies feel there will be a growth in consumer demand for sustainability, this still does not push them to invest adequately into this competitiveness driver. Only 4% of companies claim to have ongoing projects to improve sustainability in the field of logistics and transport. The reason for that can be found in a public policy that is still not very sensitive to the issue of sustainability. Again, more than 53% of these companies are investing mainly in "materials and packaging."

5. Logistical challenges and Quality Logistics Italian Index (QLI²)

One of the strengths of this survey which provides additional information for building resilient logistic corridors and resilient production systems is the analysis of the *sentiment* of companies to the theme of logistics, and the identification of their needs. The maximum expression of this type of analysis in this survey comes out with the *Quality Logistics Italian Index* (QLI²), an indicator developed by SRM and Contship that allows you to immediately understand the assessment Italian manufacturing companies gives to their reference logistics system. This indicator (which is an assessment of i *satisfaction*), is accompanied by an assessment of the importance these companies give to each of the variables used to calculate the QLI². These two indicators (the QLI²) and the assessment of importance) are an average of the assessments given to 12 variables that belong to the Services, Costs, Infrastructures, and Sustainability categories, which can affect the satisfaction of manufacturing companies with regard to the logistics system they use.

Companies were asked to give a score from 1 to 10 in relation to the importance each of these variables has in determining the overall efficiency of the logistics system. The average importance remains quite high (8.4 on a scale of 1 to 10; vs. 8.8 in 2018). The panel gave slightly greater importance to the variables of service and cost.

In addition to the level of importance, the survey has analyzed the level of satisfaction. Each respondent has been asked to give a degree of satisfaction to the logistics of the 2 most used ports for each of the variables considered. The average satisfaction index (the *Quality Logistics Italian Index* – QLI²) is 7.59 for the three regions (satisfaction level: more than suffi¬cient), slightly higher than in 2018.

The most important information that comes out of this analysis is the gap between satisfaction (7.59) and importance (8.4) of the logistic system which needs to be bridged. Satisfaction levels are rather homoge¬neous in the three regions analyzed: the *Quality Logistics Italian Index* is 7.8 for Lombardy, 7.18 for Veneto, and 7.92 for Emilia Romagna.

Satisfaction of the logistics system and Quality Logistics Italian Index (QLI²)
(Average value of the scores attributed by companies to a set of 12 variables on a scale ranging from 1 to 10)

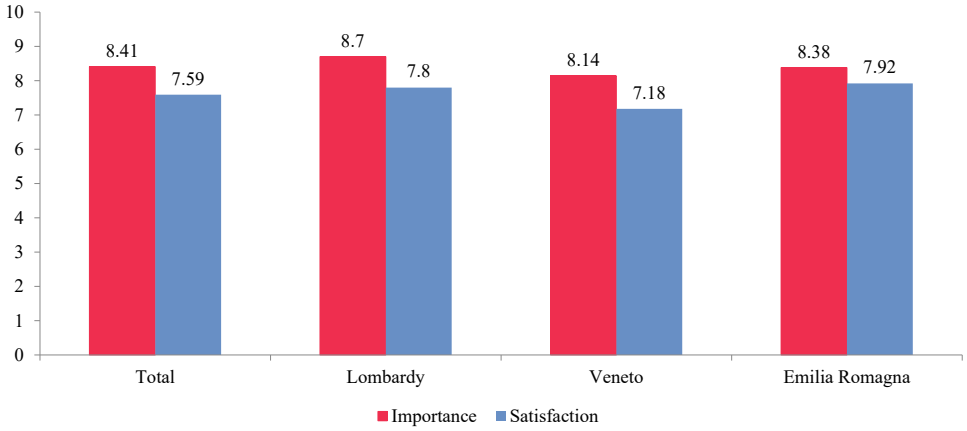


FIGURE 9 - SOURCE: SRM/Contship 2020

By cross-referencing the data on the degree of importance and average satisfaction, it is possible to draw some guidelines and policies. With this type of analysis which we have titled "Strength/priority analysis", it is possible to classify the variables identified in four boxes:

I) *Strengths* (top right corner): there are the variables that are both above average in terms of importance and satisfaction. They represent a positive element in the reference logistics system.

II) *Priority interventions* (upper left corner): there are the variables to which respondents give greater importance, but for which satisfaction levels are below average. In such cases, action is needed to improve the level of satisfaction.

III) *Secondary interventions* (lower-left corner): there are the variables for which both importance and satisfaction levels are below average. In this case, we need interventions to increase satisfaction, but these are of less importance the variables in the second quadrant.

IV) *Potential* (lower-right corner): there are variables for which importance is below average, but satisfaction is above average.

Here the results of the analysis. The speed and regularity of services are among the priority interventions. It is worthwhile splitting sustainability in its three components: there is a demand for greater attention to environmental sustainability (as the level of satisfaction is low), while a relatively higher satisfaction appears for social sustainability. The figure also highlights some strengths, but it is good to remember that also in this case there is a gap between "satisfaction" and "importance", so interventions are also

necessary in these cases, despite that satisfaction is "relatively" higher.

Strength-Priority Analysis
(% of companies that gave 9-10 to importance
and % of companies that gave 8-10 to satisfaction)

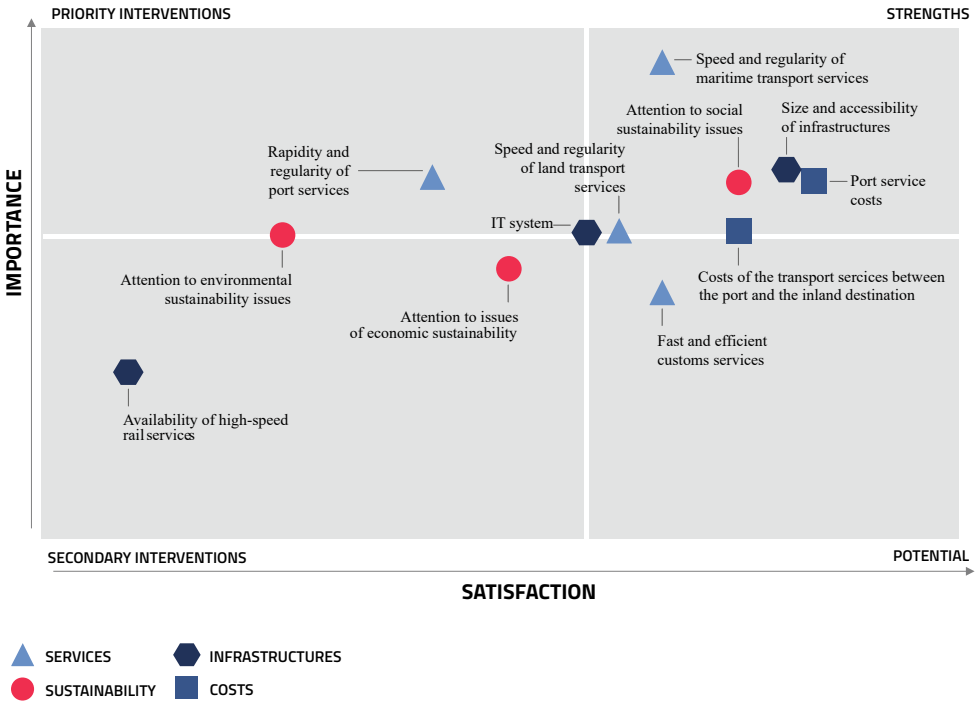


FIGURE 10 - SOURCE: SRM/Contship 2020

6. THE CASE OF THE PROSECCO DISTRICT OF CONEGLIANO VALDOBBIADENE

It is clear that the lockdown from Covid-19 also had some effects on industrial districts, made up mainly of small and medium-sized enterprises. Having a picture of the logistics choices made by manufacturing companies, which operate within a district, is of further help to better understand the added value that logistics can give to the Italian production system both when the economic conditions are normal, and when there is an economic shock.

With the second edition of the Survey "Corridors and logistic efficiency of the territories," SRM and Contship, therefore, felt the need to give voice to companies belonging to an Italian district with high-performance, as it has been identified by Intesa Sanpaolo's Research Department in its publication "Monitor sui Distretti Industriali"

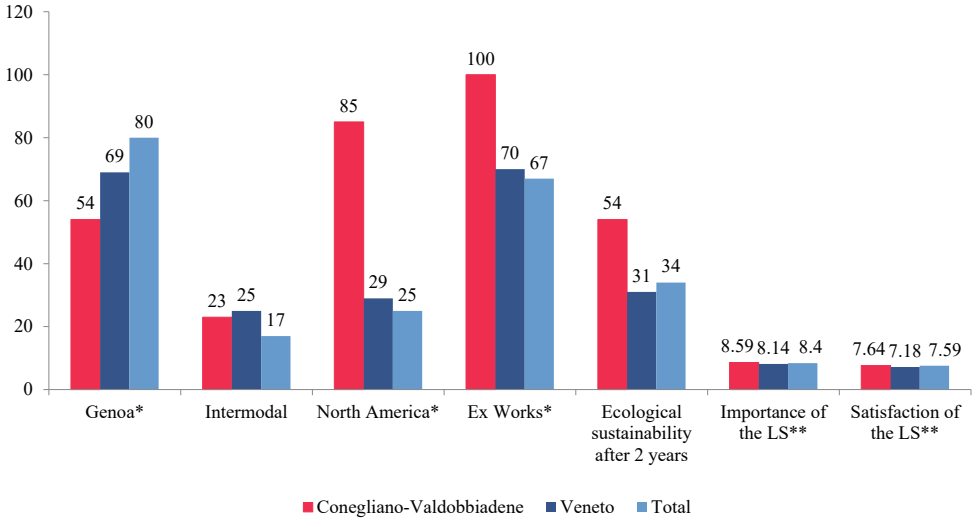
(*Monitoring Industrial Districts*). In this case, the prosecco district of Conegliano Valdobbiadene, in the province of Treviso, was chosen, due to its type of production (typically Italian), and its good international performance in recent years.

When we talk about districts, in the collective imagination we think of small businesses. Although SMEs are the strong core of each district, the SRM/Contship survey shows that even in these particular economic contexts there are some bigger companies: although most of the companies in the district (62%) export no more than 50 containers per year, a good 38% exceed this limit.

Unlike what was found in the sample of Venetian companies, where the port of Venice, although relevant, does not exceed Genoa in the table of ports preferred by companies, in this specific case the following result occurred: the port of Venice is used by the majority of the enterprises (62%), while Genoa is among the first two most used ports for 54% of companies.

Also in this case, road transport is preferred by companies to transport goods from the port to the company and vice versa. More precisely, 77% choose only road transport, and 23% choose intermodal transport. For 100% of the companies, the factors motivating the choice of intermodal transport are the convenience and frequency of the service.

The logistics corridors in the Conegliano-Valdobbiadene district compared with the data emerged in the Veneto region and in the entire area (% of companies and average levels of importance and satisfaction)



*data in export.

**LS: Logistics System.

FIGURE 11 - SOURCE: SRM/Contship 2020

In line with what emerged for the entire sample, there are few companies (8%) in this district that include sustainability in their internal governance. Again, the companies showed positive sentiment towards the "demand" for sustainability. In fact, when asked

"on a scale of 1 to 10, how important is sustainability to customers", 31% felt it was very important (9-10) for environmental and social sustainability; 23% for economic sustainability.

This percentage rises to 54% in all three cases if the question is repeated in relation to a two-year perspective.

The analysis on the importance and satisfaction of the logistics system, based on companies' assessment of 12 variables, was also carried out on the companies in the Conegliano Valdobbiadene district. One of the first interesting elements which arises from this analysis is that, on average, these companies tend to attribute more importance than companies in the Veneto region: for 10 variables out of 12, the percentage of compa¬nies that feel it is very important (9-10) is more than in Veneto. The average importance index is 8.59 (to be compared with the 8.14 recorded for Veneto).

The QLI[2] is also, in this case, significantly lower than the average importance. The gap between the two indicators shows that satisfaction is not high enough, given the level of importance attributed to the logistical dimension.

7. Conclusions

2020 was one of those breaking years for the business world. On one hand, it has been understood that everything cannot be taken for granted, so the normal routine can be broken at any moment. On the other hand, well-digitized companies can better withstand market shocks such as the one which occurred in the first two quarters of 2020. The Survey on the efficiency of logistics corridors by Contship and SRM is an analysis tool, unique in Italy, to better understand the relationship between manufacturing companies and logistics, so that the best choices can be made on a productive, logistical and institutional level.

Logistics is a broad concept that has two main driving factors: the "organization" of the system and the "resilience" of the production structure. Having efficient and effective logistics allows a country to withstand and respond to those extraordinary events that can negatively affect the economy of its territory.

The World Bank's *Logistic Performance Index* (LPI) highlights that the countries with a lower percentage of Covid contagion are precisely those that have a more performing logistics system. For example, Germany is first in the LPI, and it is eighth in the ranking of worldwide contagions among large industrialized countries; Brazil is among the countries with the highest levels of contagion and in the LPI it is only 56th; idem Russia which is third for contagions and 75th for logistical performance.

This does not mean that there is a direct correlation between bad Logistics and Covid-19, but it can be a useful starting point to understand that perhaps the organization and logistics capacity of a country can make their important contribution to both the survival of a society and to restarting an economy.

Chapter IV

New horizons for maritime infrastructure: Ports 6.0 as a possible solution to economic shocks

1. The different generations of port

The functions of seaports and the services they offer have changed considerably over time. Industry publications tend to differentiate ports according to their capacity and production results. However, other criteria should be added such as the management system, and the effectiveness of the port as a logistics centre for value creation and innovation.

The services offered by ports have changed over time with the development of their capacity to handle various types of ships and cargo, with the availability of means of transportation on land, as well as with the development of technological innovation and process automation. The greater the differentiation of the functions undertaken by the port, the more advanced its logistics system is.

In 1990, the United Nations Conference on Trade and Development[1] proposed a theoretical model for the classification of seaports, taking into account port development strategy, the range of services provided and the level of IT integration of the entities operating within the port services market.

According to the UNCTAD classification, which includes three generations of ports, only the world's largest seaports, located at the crossroads of major shipping lanes, are able to function as part of the most advanced global logistic platforms that concentrate most of the flows of loading units.

Until 1960 a port was simply the crossroads of cargo between land and sea transport and in many countries its management was public and static. It was considered to be an emporium with a range of public services.

The port described above identifies the so-called **first-generation port** characterised by isolation from transport and trade activities due to the fact that its function was limited to the transfer of goods from ships to the coast. The port was considered as an 'independent kingdom' with little or no cooperation with local authorities, where the various port activities were separate from one another. It was usually an infrastructure dedicated to bulk cargoes which, taking advantage of a strong position on the local market, often similar to a monopoly, did not perform efficiently because it did not have pressure to meet the demands of users.

Following (the introduction of) UNCTAD's classification[2], **second-generation ports** are integrated with their surrounding environment thanks to their transport, industrial and commercial function.

[1] UNCTAD (1991), *Geneva 1990, Port marketing and the third generation port*, TD/B C.4/AC.7/14, Geneva.

[2] UNCTAD (1992), *Port marketing and the third generation port*, TD/B C.4/AC.7/14.

The considerable increase in maritime traffic and industrial production has led to the specialisation of ports in relation to the prevailing type of traffic, with the increasing use of automation and mechanisation of plants and consequent reduction in the use of manpower. The port was no longer merely a place for the passage of goods but an area full of activities and services, that specialised in various sectors.

Within port areas, industrial parks were created which increased the ease with which raw materials were received, imported and delivered by sea, namely iron ore, steel, crude oil, aluminium, paper pulp, artificial fertilizers, sugar, flour and other agricultural cargoes.

This new generation of ports required a new model of flexible and entrepreneurial management which could allow for the special features of the port as a whole or of parts of it in order to improve its competitiveness. Therefore, the concept of an *emporium port* was replaced by that of an *enterprise port*.

In the 1960s, maritime transport began to make use of huge tankers and bulk carriers, which required an increase in quay depth. The extension of the scope of port operations to industrial and commercial functions created the conditions for an increase in the added value created in ports. The development of the industrial function also linked to improved accessibility to the hinterland, more efficient land transport and the availability of skilled workers and utilities (energy and water). Closer relations with the site were developed and different activities became better integrated within the port organisation.

In addition, **third-generation ports**[3] were established for the first time in the 1980s in a period of rapid development of containerised goods volumes, alongside the creation of a network of intermodal connections and the growth of needs deriving from the development of international trade. These are characterised by a higher level of activity than previous generations, as attractors of goods, and implement a development strategy favouring the creation of integrated logistic centres and platforms supporting international trade. The port is considered as being the pivotal point of international production and distribution networks, the place of convergence of industrial and logistic commercial forces of attraction and economic activities not directly connected to the traditional ones but also located outside the port boundaries and relevant for the surrounding area. From this perspective, and for planning purposes, the port cannot be separated from the community and the territorial authorities and cannot remain dissociated from the whole process of distribution of goods because it holds a greater importance in the transport chain than in the past. The port must be the essential hub of the logistics system underlying integrated transport and must have a weight in the economic policy choices of the territory. Management should be proactive rather than reactive. The distribution service of the third-generation seaport consists of efficient management of the cargo flow and information relating to it, in order to cater for deliveries within the "just in time" system. The high volume of containerised cargo handled in ports requires good quality road and rail connections, connections with modern warehouses and distribution parks, and a complete symbiosis between the port and the city for the rational use of resources and planning of common space.

[3] *Idem*.

The port adds value to the main product. Loading and unloading are certainly value-added activities, as are the above-mentioned industrial and logistic services. The port does not operate on its own but is at the service of users by facilitating their respective activities.

Specification of seaport generations according to UNCTAD

Port characteristics	1st generation	2nd generation	3rd generation
Development period	prior to 1960	1960-1980	after 1980
Main cargo	Semi-bulk cargo	Dry semi-bulk cargo and liquid bulk cargo	Bulk, general, and containerized cargo
Attitude and strategy of port development	Conservative, means of transport change point	Expansive, transport, industrial, and commercial centre	Commercial, logistic-distribution centre for international trade
Scope of operations	[1] Loading, unloading, storage, navigation services	1 + [2] Cargo processing, industrial and commercial services - territorial expansion	1 + 2 + [3] Cargo and information distribution, logistic operations
Organisational features	Independent operations within the port, informal connections between the port and its users	Closer ties between the port and its users. No connections between different types of operations within the port, provisional ties between the port and the city	Unified port community. Port integration with the transport-commercial chain. Close connections between the port and the city. Extensive port organisation.
Specific production features	Cargo flow, simple, single services. No/low added value	Cargo flow, cargo processing. Various services, higher added value	Cargo and information flow. Cargo and information distribution. Wide package of various services. High added value
Deciding factors	Work/capital	Capital	Technology, know- how

TABLE 1 - SOURCE: UNCTAD (1991), *Geneva 1990, Port marketing and the third generation port*, TD/B C.4/AC.7/14, Geneva, p. 23

The three generations of ports are matched by as many historical transport phases[4].

During the period of the first-generation ports, freight transport is mainly carried out by sea because road and rail networks are not reliable. Goods arrive to the port, they are unloaded and transferred to markets adjacent or near the port itself for immediate sale.

Second-generation ports are shaped by the use of containers and naval gigantism; new generation ships need adequate infrastructure for unloading goods.

Finally, as regards third-generation ports, the model is enhanced by the construction of rail, road and air transport systems and networks. We are therefore talking about integrated transport (intermodal or multimodal) which means a single transport from warehouse to warehouse (door to door) carried out by a single operator using not only ships but also trains and lorries.

This evolution of transport has underlined the central role of ports as nodes in the logistics system and pushes operators to look for horizontal and vertical agreements between companies. The port, as a service centre, therefore aims to use logistics, which is closely linked to the loading and unloading of goods, as a competitive factor.

[4] ERRI A. (2012), *Impresa e lavoro nei servizi portuali*, Milan, p. 25.

This new logic, however, presupposes an operational model that integrates the port into an overall global economic fabric.

The competitive profile is therefore determined by services offered, active subjects, levels of specialization, integration with the surrounding territory, and prospects for development.

After inventing the term "third generation port" to indicate those ports where, in addition to cargo handling, other value-added services such as warehousing, packaging and distribution of goods were offered, creating employment opportunities and increased revenue for the port community, in 1999, UNCTAD[5] defined the idea of a **fourth generation port**. This is characterised by the common management of port areas that are physically separate but connected, through the presence of the same operators or the management of a common administration.

Unlike the ports described above, fourth generation ports play an interregional role by creating a hub, i.e. the main port in a large area from which goods are transported by sea to smaller peripheral ports. Port authorities can be interconnected by a common administration (as in the case of the ports of Copenhagen and Malmo) or a common container terminal operator.

UNCTAD highlights that investments in port hubs are usually carried out by the private sector and in particular by renowned international companies specialised in the management of port terminals (mainly container terminals). The case of terminals connected through common operators is more frequent with the expansion of management, brought about by international terminal operators and shipping companies. Global alliances of containership owners have resulted in the use of larger ships, the development of hub port networks and a permanent demand for higher productivity and lower tariffs. The development of the hub and feeder network with its resulting transhipment activities has led to the emergence of multi-port operating companies managing dozens of terminals around the world.

Communication and information technologies enable terminal operators to increase their productivity through better planning as well as a reduction in the time that goods spend in the port. These terminals can be considered as fourth generation ports because they provide standard services or administrative systems with common operation.

In 2012, A. Grzelakowski and M. Matczak[6] identified certain distinctive criteria of fourth generation ports that represent the essence of a modern container port integrated with global logistics chains through a computer network.

This type of port, whose basic development factors are innovation, technology and information, has the following characteristics: containerisation as the main flow of goods, a development strategy based on advanced automation and IT technologies, a variety and efficiency of services, full integration with transport, forwarding and logistics industries, intermodal transport and standardisation of information, a management system focused on globalisation of port operations, human resources management, process management and automation.

[5] UNCTAD (1999), "The Fourth-Generation Port"*, Ports Newsletter*, No. 19, p. 10

[6] Grzelakowski A., Matczak M. (2012), *Współczesne porty morskie. Funkcjonowanie i rozwój*, Publishing House of the Polish Naval Academy, Gdynia, p. 3.

M. Flynn, P. Lee and T. Notteboom proposed to integrate the classification of port generations adopted by UNCTAD with a fifth level of port development. The most significant differences between fourth and fifth generation ports, identified by the two authors, are displayed in the following table.

Comparison of UNCTAD fourth generation ports and M. Flynn, T. Notteboom and P. Lee generation five ports

Criteria	4th generation port	5th generation port
Quality of provided services	Compliance with regulatory requirements and general standards	Exceeding the standard of services expected by port stakeholders
Application of IT solutions	Limited to customs clearance and tracking the cargoes in the port	Focusing on the level of quality of services, security, and increasingly better efficiency. Application of computer technology for the provision of port services and to predict events and measure results
Influence on port stakeholders (environment)	Limited to compliance with planning procedures and environmental planning procedures	Active approach towards stakeholders in order to coordinate planning and the process of mutual decision-making
Port cluster	Operated under procedures of port area development	Port services fully integrated with the port's mission and vision. The port authority plays the role of a "cluster leader", contributing to the increase of added value in the port
Maritime cluster	Examined independently of port functions	Closer ties between the port and its users. No connections between different types of operations within the port, provisional ties between the port and the city
Logistic hub	Development of the logistic function, as an expansion of port functions, as well as creating duty-free zones and logistic parks near the ports	Logistics is a part of a maritime supply chain, air transport for valuable cargo and cargo requiring fast delivery. Advanced duty-free zones, as well as logistic parks near ports
Land connection (hinterland)	Development of land connections in result of natural evolution	Ports develop strategies of connections with the hinterland by their pricing policy and constructing a system of economical incentives aimed at securing loaders against such a development of the connection network which would harm the customers' interests

TABLE 2 - SOURCE: FLYNN M., LEE P., NOTTEBOOM T., "The next step on the port generations ladder: customer-centric and community ports", in NOTTEBOOM T. (2011), *Current Issues in Shipping, Ports and Logistics*, University Press Antwerp, Brussels, p. 503

P. Lee e J. Lam[7] have developed the first version of the criteria characterizing fifth-generation ports. This was necessary to obtain more detail to carry out comparisons between the greatest ports like Shanghai, Singapore, Hong Kong or Busan with respect to the special features of a fifth-generation port.

[7] LEE P., LAM J. (2016), "Developing the Fifth Generation Ports Model", in LEE P., CULLINANE K. (ed.), *Dynamic Shipping and Port Development in the Globalized Economy*, Palgrave Macmillan, London, 2016, p. 188.

The criteria set by the two authors can be summarized as follows:

- Efficient management of port users through a 'single-window' IT system providing stakeholders with information regarding environmental and technical-operational indicators.
- Continuous productive exchanges between stakeholders of the port with the aim of planning terminal capacity, in particular for the scheduling of quay development and for the implementation of a system of financial incentives for shipowners who use increasingly sustainable technologies on their vessels.
- A leading role of the port in the port cluster, so that its activities contribute to increasing the quality of logistic services and to creating value added generated by the port itself.
- The introduction of financial incentives aimed at attracting shipowners, forwarders and maritime agents.
- As a logistics hub, there is the necessity to improve relationships with stakeholders of the inland port areas in order to create synergies.
- As regards land connections, a pricing policy is required that attracts clients and aims at improving cooperation, especially with intermodal operators and carriers, with the ultimate aim of reducing overall costs of goods transported.
- As regards maritime connections, it is necessary to aim for the acquisition of containerised transits of goods by gaining a place in international logistic chains so as to modify the nature of the port from a mere gateway to a transshipment centre, more competitive in terms of goods transit.

P. Lee e J. Lam[8] have later categorised the development stages of a port according to two criteria: the creation of economic value added and the complexity of port logistics.

These scholars have identified some distinctions which can be illustrated as follows:

- Level one: simple port operations of loading/unloading.
- Level two: logistic ports providing different services, including storage.
- Level three: ports integrated in the logistic chain through the exchange of bilateral electronic data with clients.
- Level four: global e-ports transferring information on a global scale with global cargo-handling standards.
- Level five: ports focused on clients and the local community characterized by deep integration of IT with stakeholders.

The **fifth-generation port** is characterised by greater complexity and better possibilities for value creation than the ports of previous generations.

Fifth generation seaports should actively cooperate with municipal, regional and national authorities in order to eliminate conflicts whilst working together in the identification of priorities, allowing a smooth exchange of goods between the port and its hinterland, ensuring a high level of safety, the rationalisation of costs and the reduction of external effects on the environment.

It is important for a fifth-generation port to implement the abovementioned strategy and consider the problems of the local community so as to ensure sustainable development.

[8] *Ivi*, pp. 191-192.

T. Notteboom e J. Rodrigue[9] propose an investigation into current and future trends of the development of ports. They take into account trends in the containerised goods market, limits both of the logistics system and of global logistic chains. A key issue is represented by the conflict between the increasingly efficient seaborne transport of containers on megaships and atomized land transport – which in many cases is not capable of handling cargo volumes without external costs, such as port and road congestion – and finally the inefficient rail transport. T. Notteboom e J. Rodrigue[10] argue that in the future an important aspect for maritime ports will be represented by the degree of development of their land transport system. This criterion seems useful for identifying the features of a **sixth-generation port** (A. Kaliszewski). T. Notteboom poses a question on the nature of containerised transport in 2056 (the hundredth anniversary of containerization) and proceeds to analyse the influence, in terms of negotiating weight, of three kinds of factors: economic, technological and logistical. The notion of shortening logistic chains is also considered and regards the scenario where economic powers decide to organize production on a regional scale.

In light of these observations, it might seem that the new sixth-generation ports (6GP) should possess the following three characteristics:

1. An ability to handle 50,000 TEU containerships with a maximum draught of 20 meters.
2. Complete automation of the container terminal thanks to a high amount of loading/unloading operations in a short time and to the significant progress made by information technology in the past 50 years.
3. Management of intermodal connections with inland areas allowing the transport of containerised goods with low external costs – ie congestion-free connections.

According to the author, the identification of a small number of high-level parameters seems to be an opportunity to stabilize the criteria characterizing a sixth generation port over time and at the same time will allow a definition of the size of the largest ports in the world in the next 50 years. To achieve the level of development characteristic of the 6GP, a port must first become a fifth-generation logistics centre.

The handling of megaships will require quays of adequate length and spacious storage areas. T. Bebbington[11] has calculated that a 50,000 TEU vessel will be 470-500 meters long and wide enough to accommodate 32 rows of containers (about 93 meters) with a draught of 20 meters. Such parameters require ports to be equipped with sufficiently long quays. The sixth-generation port would require an even bigger storage area than those belonging to the fifth generation. This increase of capacity might be reached thanks to with the use of innovative solutions to the storage of containers and for the management of port service areas.

[9] Notteboom T., Rodrigue J. (2009), "The future of containerization: perspectives from maritime and inland freight Distribution", in *Geojournal*, vol. 74, No. 1, pp. 7-22.

[10] *Ivi*, p. 18.

[11] Bebbington T. (9 November 2017), "50,000 TEU... the Future or Not?" in *Maritime Executive* [https://maritime-executive.com/editorials/50000-teu-the-future-or-not].

The storage of containers will represent a technical challenge for ports handling 50,000 TEU vessels because even the currently greatest cranes cannot handle half of the containers that these can potentially carry.

Sixth-generation ports can be liable of critique due to the noticeable asymmetry between costs and benefits derived from their impact on port stakeholders.

Shipowner companies would reach a lower level of cost per unit thanks to the distribution of maritime transport costs across a higher number of containers. T. Bebbington[12] acknowledges that there is growing shipowners' demand for infrastructure and supra-structure of container terminals capable of handling 50,000 TEU megaships. All this is extremely costly with the current level of technology. Container terminal operators, both private and public, will bear significant costs for the modernization of a port or for the construction of a floating port with bridges connecting it to the mainland. Shipping liners often change maritime alliances and ports of call for their vessels. In such a scenario, the possible loss of an alliance could mean losing the whole of its loads, consequently increasing risk of investment. This is why there is a need to modify the model of contractual services between ports and shipowners, with the aim of guaranteeing long-term and steady loans for such a conspicuous sizeable investment. External costs might also be generated by limitations derived from the atomization of land transport as mentioned by T. Notteboom and J. Rodriguez which includes pollution, congestion due to a megaship calling at the port as well as land and rail congestion in the whole region. Thus, what is needed are new technical and organizational innovations making Ports 6.0 a reality not only in terms of technique but also of economic and social viability while taking into account environmental requirements (A. Kaliszewski).

2. Functions of port management bodies

When using the term 'port authority' to indicate the management body of a seaport, we mean that this might perform four basic functions[13].

Three of them are traditional, namely that of **land management (landlord)**, **regulator** or **operator** and finally the function of **community manager** that has only recently been recognised. This latter function is intrinsically connected with the changing nature of port communities and stakeholders. Thanks to its role as community manager, the port authority furthers and maintains a good rapport with all the stakeholders both economic and social, with reference to one specific port.

Whatever its right to exert power over the management of areas within the port boundaries, the landlord function consists of a series of common elements, namely management, maintenance and development of the port, supply of infrastructure and services as well as planning and implementing policies and strategies aimed at achieving further development through the use of port areas.

[12] *Ibid.*

[13] Verhoeven P. (2015), *Economic Assessment of Management Reform in European Seaports*, Antwerp.

The landlord function can certainly be considered the most important for a modern port authority.

The regulator function combines a series of duties and responsibilities that can be summarized in the tasks of controlling, surveillance and policing. This is mainly about guaranteeing security of loading and unloading operations within the port, as well as enforcing current laws and regulations in these and other sectors such as environmental protection and labour regulations.

The 'operator' function traditionally covers port services, which can be grouped into three categories: the physical transfer of goods and passengers between sea and land, the provision of technical-nautical services (pilotage, towage and mooring) and a number of other ancillary services. The basic choice for the port authority's operator function in all categories of services is whether or not to provide the service itself.

The traditional functions of port authorities have undergone substantial changes over time. In the larger multi-purpose gateway ports, the current operator function has shifted, at least as far as cargo handling services are concerned, to aspects of the landlord and 'regulator' functions. The main feature of the 'operator' role is currently the concession of the areas and the supervision of the concessions themselves.

By combining the functional profile and the geographical dimension, it is possible to elaborate the three existential options in a hypothetical typology of port authorities. This typology consists of three basic types: the 'conservator', the 'facilitator' and the 'entrepreneur'[14].

A 'conservative' port authority focuses on being a good 'process ruler' and essentially implements a passive and mechanistic implementation of the three traditional functions at a local level. This low-profile conservative attitude could lead port authorities to run the high risk of being marginalised or even removed in the future.

A 'facilitator' port authority stands out as a mediator between economic and social interests, developing the function of manager of the port community. Facilitator port authorities look far beyond the port perimeter and seek to promote strategic regional agreements.

The 'entrepreneur' port authority combines the main aspects of the facilitator with a more direct attitude towards commercial aspects as an investor, service provider and consultant on the three geographical levels (local, regional and national).

Three main port governance traditions have been identified in Europe: 1) the Hanseatic tradition of *local, mainly municipal, governance*, which is dominant in ports around the Baltic Sea and the North Sea; 2) the Latin tradition of *central governance*, which prevails in France and the countries around the Mediterranean; 3) the 'Anglo-Saxon' tradition of *independent governance*, which is characteristic for ports in the United Kingdom and Ireland.

In addition, the fall of the Iron Curtain has led to the appearance of a number of new ports around the Baltic Sea, the Mediterranean and the Black Sea. These ports can be grouped into two further regions: ports in the so-called 'New Hanseatic' countries around the Baltic Sea and "neo-Latin" countries in the eastern Mediterranean and the Black Sea.

[14] Verhoeven P. (2011), *The ESPO Fact – Finding Report*, 2010 Edition.

In this way, port authorities can be classified into five regional groups: 1. Hanse: port authorities of Iceland, Norway, Denmark, Sweden, Finland, Germany, the Netherlands and Belgium; 2. New Hanse: port authorities of Estonia, Latvia, Lithuania and Poland; 3. Anglo-Saxon: port authorities of the United Kingdom and Ireland; 4. Latin: port authorities of France, Portugal, Spain, Malta, Italy, Greece, Cyprus and Israel; 5. New Latin: port authorities of Slovenia, Croatia, Bulgaria and Romania.

3. Functions of the port Network Authority in Italy

The functions of Port Network Authorities have been listed in par. 4 of Article 6 in Law 84/1994, which states that a Port Network Authority performs the following duties: a) the steering, planning, coordination, regulation, promotion and control, including through the territorial port offices in accordance with the provisions of Article 6-bis, paragraph 1, letter c., of port operations and services, of authorisations and concession activities referred to in Articles 16, 17 and 18 and of other commercial and industrial activities carried out in ports and territorial districts.

The port network authority is also granted powers of order, with reference to safety in terms of risks of accidents related to the activities and hygiene conditions at work pursuant to Article 24; b) ordinary and extraordinary maintenance of the common parts of the port, including that for the maintenance of the seabed; c) assignment and control of activities aimed at the provision to port users of services of general interest, not coinciding or closely related to port operations referred to in Article 16, paragraph 1, identified by decree of the Minister of Infrastructure and Transport; d) the coordination of the administrative activities carried out by public bodies and entities within the ports and in the maritime state-owned areas included in the territorial constituency; e) the exclusive administration of the areas and goods of the maritime state-owned property included in its own constituency; f) promoting forms of connection with the back port and inter-port logistic systems.

According to Law No 84 of 1994, the fundamental task of a Port Network Authority is to control and regulate the exercise of economic activities aimed at the production of port operations and services by promoting the regular and profitable use of the facilities that make up the port. The functions originally foreseen are complemented today by those indicated by the 2016 reform and the attribution to PNAs of a key role not only within their own port system but also in the logistic network of reference under the coordination and direction of the Ministry of Transport and Infrastructures. In order to implement the tasks provided for by the abovementioned letter a), the PNA not only plans the different functions of the port system it manages, but it also promotes the port system through the realization of the works necessary for the development of the port, through any type of initiative allowed in particular by law 84 of 1994, with a view to increasing traffic and promoting the development of the related logistics system.

On the contrary, in this regard, in virtue of the new competences attributed to it by the legislative decree n. 169 of 2016 on the subject of coordination and connection, both with other administrations and with port and back port logistic systems, the PNA should not limit itself to acting within the ports on which it has jurisdiction, but along the

entire logistic chain that connects these ports. This might take place through instruments regulated by law, including solutions drawn from the provisions of common law; among these, it is important to highlight the possibility of establishing connections, through forms of public-private participation (PPP), with the private operators of the back port and dryport infrastructures, with a view to promoting and realizing what can be qualified as a port and logistic system of reference[15].

4. Ports 6.0

Putting aside the port generations identified in port literature and the functions of port authorities identified by ESPO or provided for in national legislation, it has recently become apparent that ports, in order to achieve their full potential, need to undertake and develop certain actions. In particular, SRM has defined Ports 6.0 as those port realities characterized by the presence of activities that are certainly instrumental to the conscious pursuit of the functions of modern ports and that cannot be limited to the maximization of traffic or to the control and regulation of economic activities aimed at producing port operations and services, the promotion of port activities, as well as regular profitable use of the structures that make up the port. The six functions identified to define a Port 6.0 are the following: Internationalisation, Intermodality, Training & Academy, Innovation & Start-up, Free Zone & Territorial Marketing and Sustainability.

4.1 Internationalisation

Nei porti è stato sempre necessario conciliare l'appartenenza, quanto meno coIn ports it has always been necessary to reconcile the affiliation, at least as a territorial location, to a specific local or regional community, with the extreme internationality of the activities and subjects involved in the port environment. The location of ports within cities has often created a very strong relationship between these and the port but has also often generated the erroneous assumption that the management of the port infrastructure can be considered equivalent to that of a local or territorial authority.

There are, of course, many aspects on which the port and the local community must necessarily work in full synergy. For instance, urban planning, environmental sustainability, the active participation of local authority representatives in the bodies of port administrations and, therefore, in the regulation and implementation of port management dynamics.

It is equally true, however, that ports have always represented the main intersection of international trade and tourism. This international vocation is not only linked to the passage of goods or people coming from or going abroad, but also and above all, to geopolitical and economic phenomena that inevitably determine traffic flows between States and, therefore, between ports. A localised vision/management of the port would lead to ignore such international phenomena, limiting itself to passively suffering the positive or negative consequences derived from these.

[15]Carbone S.M., Munari F. (2019), *I porti italiani e l'Europa*, Milan, p. 109.

The drivers of Ports 6.0 according to SRM

FIGURE 1 - SOURCE: SRM

The ever-increasing international vocation according to current trends, must lead port management bodies to equip themselves with all the professional skills and services useful and necessary to ensure the possibility of having a consciously proactive role, starting from their individual one, in this global scenario.

4.2 Intermodality

Ports are one of the most important components in a country's transport system, not only as a link between sea and land transport, but often as a centre of logistics activity. As a result of the globalization of production activities and the expansion of world trade, there is an increasing need for an integrated transport system that allows mainly goods, but also passengers, to take full advantage of the special features of various means of transport. The port therefore becomes an intermodal node par excellence where success is no longer guaranteed by the mere movement of goods between land and sea but determined by transport to the inland area, which becomes one of the primary factors[16].

This is because with the development of competition between ports, the efficiency of inland connections becomes one of the battlefields where the most efficient port usually increases its market share. While in the past the port hinterland was dependent on the port, the development of logistic networks, and in particular transport networks, has meant that the port hinterland has expanded to the point where it often overlaps with other ports, sometimes up to hundreds of kilometres away. The hinterland, therefore, thanks to logistical integration, is no longer served only by ports in the vicinity, in an almost dependent relationship (*captive hinterland*), but becomes a disputed area between ports (*contestable hinterland*)[17].

One of the distinguishing features of the port is not only its central position at the intersection of various modes of transport, but also the possibility of developing its function as a centre of direction for intermodal transport and ensuring high levels of efficiency and effectiveness of transport. This is where the capacity of the port to generate value within the logistic chains in which it operates and thus promote the development of productive activities in the hinterland.

In addition, the increasingly urgent environmental imperatives in the port sector, characterised in many contexts by congestion, emissions and other negative externalities, has led to more attention being paid to green logistics and greener modes of transport. European policies aimed at promoting intermodality have long since identified intermodal transport as one of the alternatives to congestion and road-only transport. Ports have a key role to play in promoting intermodality and the shift to greener modes of transport. It is possible that in the not too distant future, the level of sustainability of a port may play a decisive role in the choices of logistics operators and port customers[18].

Over the last few decades, global supply chain management has seen many trends, such as just-in-time arrivals, agility and efficient consumer response, which require

[16] Acciaro M., "The experience in Northern Europe", in SRM (2015), *Italian Maritime Economy. Terminal, logistics and its players: challenges from a pivotal Mediterranean position. 2nd Annual Report*, p. 129.

[17] *Ibid.*

[18] Acciaro M., "The experience in Northern Europe", in SRM (2015), *op. cit.*, p. 130.

faster, more reliable and more flexible transport services. To survive in the highly competitive transport market, intermodal transport has to meet growing customer needs and adapt to the changing business environment by improving flexibility and presenting a more personalised service. This requires new concepts of new operating modes and new arrangements to improve service quality and achieve maximum cost reduction in inland transport.

We are seeing a shift in the emphasis in network development from physical to service connectivity. The synchronisation of service schedules and operations between modes of transport aims to provide uninterrupted operations, leading to a reduction in waiting times and intermediate storage, thereby cutting overall transport costs. Synchronisation or synchronised intermodality can be briefly summarised as a vision of a network of well-synchronised and interconnected transport modes, which together meet aggregate transport demand and can dynamically adapt to the individual and immediate needs of network users. Synchronicity marks the next stage in the development of the port-hinterland network[19].

Given the importance and strategic nature of intermodality, it seems necessary that port authorities are structured and/or organised for the planning and monitoring of infrastructure interventions and market indications, including for planning outside the port. It is no coincidence, among other things, that the national legislation, in art. 6, paragraph 11 of Law 84/1994, allows Port Network Authorities to take minority shareholdings, of a corporate nature, exclusively for initiatives aimed at promoting logistical and intermodal connections, functional to the development of the port system, pursuant to Article 46 of Decree Law n. 201 of 6 December 2011, converted, with amendments, by Law n. 214 of 22 December 2011.

4.3 Training & Academy

A modern port should become, in the medium term, a driving force for innovation linked to the blue economy, acting as a magnet for talent and innovative companies in support of shipping, logistics, sea-related tourism, protection of the marine ecosystem, environmental protection and the development of a heavy industry that is contemporary and sustainable. This vision can be achieved by following various paths, closely connected with the territory, but also aimed at contamination with national and international best practices.

In collaboration with training institutes and universities, the port will be able to promote research and development initiatives that coincide with the themes of the blue economy and the maritime economy, with the threefold aim of: a) encouraging specialist study and research in the thematic areas related to the development of the port and its logistical activities, encouraging the development of professionalism, with distinctive skills immediately employable on a local scale, with important benefits for the areas, in terms of employment, b) contributing to the creation of a local social capital, which provides the port and the companies connected to it with an important pool of experienced and up-to-date human resources that can be drawn on in order to maintain high levels of

[19] Tavasszy L., Behdani B., Konings R. (2018), "Intermodality and Synchromodality", in *Ports and Networks*, New York, p. 251.

competitiveness, c) establishing a network with regional universities that enhances the maritime peculiarities of the territory, through degree courses and research programmes in which universities as well as national and foreign study centres may participate with the help of researchers with a renowned international reputation.

4.4 Innovation & Start-up

Given the technological revolution of recent years, it is necessary to think of a port from a forward-looking perspective as an entity capable of incorporating and developing different technologies while turning them into success factors, thus increasing efficiency and competitiveness compared to other port realities.

Technological innovation is now a constant in every area of society and economy. The maritime-port sector is no exception. Some innovations can be traced back to an internal development logic of the sector in terms of improving operational performance through technological progress.

This category also includes advanced materials, sensors, communication technologies, big data and their analysis, robotics and automation. In the most advanced ports the handling of containers is often entrusted to unmanned service vehicles and projects to extend this automation to the hinterport areas, even remote ones, seem to be entering an implementation phase.

Large ports have to deal with many different activities: the movement of ships, containers and other goods, the loading and unloading of ships and containers, customs activities. In addition to human resources, anchorages, canals, lighters, tugboats and moorings, warehouses and other storage space should also be allocated and made available. The efficient management of a port involves the management of these activities and resources.

The use of digital technologies can improve efficiency by introducing flexible and sustainable modes of operation wilst also enabling creativity and innovation. These objectives can be achieved by measuring activities and monitoring spaces. The Internet of Things vision is an important tool for digital transformation that creates connections between physical spaces and the Internet. Data analysis allows for a better understanding of contexts, situations and people moving within them.

This kind of understanding enables actions that make operations more efficient, optimize resources and improve living and working conditions. Therefore, space is defined as ‘smart’. And, in the same way that we have smart cities, we can also envisage smart ports. A *Smart port* is a relatively new concept. From the point of view of the Internet of Things, smart ports are a context with different machines, different interactions between machines, interactions between machines and people, which can be improved like any other smart space using data that is collected.

Port authorities can also become protagonists of a new business development model involving start-ups, researchers, incubators, private investors and digital operators in the co-creation of innovative solutions for port services as well as for the evolution of the port business model. To achieve this objective, the port authority will have to promote the establishment of a business accelerator for entrepreneurs and innovators in and around the port.

The initiative needs to be carried out in partnership with key players in the world of entrepreneurship and will facilitate market access to innovative start-ups who will support the port and the operators connected to it in the digital transformation and evolution towards the *Port of the Future*. If support is given by investors, banks and local institutions in a proper way, such an initiative would contribute to the economic revival of the area, generating a business-friendly ecosystem able to produce value for stakeholders while simultaneously creating the conditions for the development of a local entrepreneurial mindset connected to the maritime economy.

The implementation of an Innovation Hub will make it possible to provide the port with an important key to access the ICT and digital themes that will have a significant impact on our contemporary reality, and will contribute to generating an ecosystem from which to obtain evolved digital solutions, implementable by the port authority itself and/or by the operators present in the port. At the same time, this Innovation Hub will make the port a pole of attraction of talent and innovative entrepreneurial realities – both on a Mediterranean and international scale – and will help develop a new business model for logistics and port operations, scalable digital solutions and good practices exportable to other realities.

4.5 Free Zone & Territorial Marketing

In order to attract investment, promote economic growth and job creation, many countries have experimented with the introduction of 'advantage zones' for the establishment of new companies. In addition to tax benefits, there are usually financial, infrastructural and logistical support measures, as well as regulatory aspects and procedures that differ from those in force in the rest of the country. The main objective of the Special Economic Zones is to increase the competitiveness of the established companies, to attract direct investments, especially from foreign subjects, to increase exports, to create new jobs and to strengthen the productive fabric in general, through stimuli for industrial growth and innovation. In many areas (Tangier, Spain, Egypt, etc.) the establishment of Special Economic Zones or Free Zones has attracted significant investment and logistical production facilities and increased port traffic.

The SEZs and the Free Zones are also a link between maritime-logistics and manufacturing players that operate in an environment aimed at promoting export flows in a context of tax and bureaucratic facilitations, supported by the presence of value-added logistics. The existence of logistic nodes and functions in a given territory can be considered as an advantage in territorial competition and as a primary factor for local development processes, because it offers the possibility for those who settle down to benefit from connection infrastructures and access to international networks.

What is needed is an effective, intense and permanent policy of promotion of Special Zones. Since this is considered a tool of Territorial Marketing, the promotional aspect cannot be neglected. The international investor will rarely choose to settle if he does not know all the guarantees that a SEZ offers and does not know enough about the localisation and financial advantages of a territory; moreover, they must also know well the port which, as a protagonist, must be the first to gain the trust of the operator.

Given the presence of a wide range of incentives, SEZs are defined as 'poles of attraction and growth', because in these areas tariffs, quotas, duties and taxes differ from the rest of the national territory and are more appealing to investors while offering better development opportunities due to the services offered.

The port itself, therefore, must be understood as an element of territorial promotion from a dual point of view: a) as the location for industrial or logistic activities; b) as a broad context for the implementation of socio-economic opportunities in a wider sense (through potentially diversified functions, such as the contribution to the implementation of tourist flows or the improvement of urban conditions). Both functions should be included in a more comprehensive and formalised strategic framework that can be described as a 'vision, development and territorial marketing plan' shared by the entire stakeholder system.

4.6 Sustainability

As is well known, transport plays a crucial role in contemporary societies. A well-functioning maritime transport system facilitates the process of globalisation and economic growth. Over the past decades, the transport sector has been characterised by unprecedented growth. This growth can also be observed in maritime transport and is a trend that is occurring on a global scale. In general, growth in freight transport has been faster than economic growth. Port cities not only benefit directly in terms of employment and well-developed infrastructure, but also in terms of related industries and services.

At the same time, however, transport has undesirable side effects. It is increasingly common for the maritime transport sector (including port activities and hinterland connectivity) to have negative connotations: there are concerns about emissions, safety and security, and so on. All these concerns are related to the concept of sustainability.

Improving the performance of navigation, port activities and inland transport to meet environmental standards is a necessary requirement today. Sustainable development is interpreted as 'a process of change in which the exploitation of resources, the direction of investment, the orientation of technical development and institutional change are all in harmony and increase current and future potential to meet human needs and aspirations". However, there is not yet a universally accepted definition of sustainability.

Within the scope of sustainable development, some scholars[20] have identified three correlated systems, namely environmental (the planet), economic (profit) and sociocultural (people). This is commonly known as the 'Triple Bottom Line'.

Ports are nodal points or hubs in the transport network. Its industrial and commercial areas add value to the goods transported and ports are increasingly becoming centres of energy production (and consumption). Increasing environmental awareness creates new challenges for port development. In addition to economic activities, environmental issues and the impact of port activities on public health, climate change adaptation and mitigating measures are also important in port policies today. All these different elements merge into the concept of "green port" as a response to new challenges. But as with the concept of sustainability, there is no clear and comprehensive description of what

[20] Geerlings H., Vellinga T. (2018), "Sustainability", in *Ports and Networks*, New York, p. 297.

the concept of a green port really entails. However, there is general agreement that a sustainable or green port strategy should be a strategy that meets the future development of the port in harmony with the region and the natural environment.

The impact of hinterland connectivity is also a major issue for ports. The modal share indicates the percentage of freight or the number of voyages using a particular type of transport. In freight transport, this can be measured in mass or TEU. The modal share is an important component in the development of sustainable transport within a city or region. In Rotterdam, about 30% of containers entering the port continue their journey through the sea. This transhipment does not put any pressure on hinterland connections. The remaining 70% of the cargo goes inland by inland waterway, road and rail. In addition, there is also pipeline transport for the petrochemical industry. This division according to the type of inland transport is called modal division. In recent years, agreements have been made with all stakeholders to reduce road freight transport in favour of inland waterways and rail transport. The reduction of road transport and its environmental impact has become an important environmental objective.

The current increasing environmental awareness creates new challenges for port development. For example, climate change requires adaptation measures aimed not only at minimising potential impacts such as rising sea and flood water levels, but also at safeguarding the accessibility of ports and waterways and the sustainability of natural and social environmental conditions. The definition of sustainability contains the notion of 'future' as a time scale. Green ports or sustainable ports are widely regarded as the "answer" to the abovementioned challenges. In a green port, that aims to implement a green growth strategy, sustainability is an economic driver to accommodate the future development of the port in harmony with the region and the natural environment.

There are many key issues that sustainable ports have to address. Some of the most relevant can certainly include energy efficiency and energy transition (from fossil to clean fossil and renewable energies), sustainable materials and waste management (circular economy), habitat protection and ecosystem integrity, climate change mitigation and adaptation, sustainable environmental quality (soil, water, air and noise), inclusive stakeholder development and corporate social responsibility, collaboration with the private sector, public authorities, NGOs, academia and other ports.

Finally, ports are in a unique and privileged position in the global logistics chain to acquire and develop their roles, to initiate and carry out the necessary change for their benefit as well as for the prosperity of the region in which they operate. Ports must take up the challenge of development and management that implements the growth paradigm, using innovative and cutting-edge processes and technological developments.

Part Two

Sustainability and Intermodality as crucial assets for the future of ports and shipping

Chapter V

Low-Carbon Shipping:
how decarbonisation is changing maritime transport

1. Foreword

On the 11th of December 2019, the European Commission presented the *European Green Deal*[1], aiming, among other targets, to decarbonise the European Union by 2050 and decouple economic growth from resource use. Maritime transport is featured in the European Green Deal in relation to the need to incentivise short sea shipping further by potentially revising the Combined Transport Directive[2], and the possibility of eliminating tax exemptions for bunker fuels and consider new forms of road pricing. The document also expresses the desire to improve fisheries and the management of maritime spaces, and further regulate pollution from ships potentially mandating the use of onshore-power supply (OPS). In its ambition to tackle climate and environmental challenges, the Commission also expressed the intention to include maritime transport in the EU Emission Trading Scheme (ETS) similarly to the aviation industry.

Given the international nature of maritime transport the European Commission recognises the importance of coordinating its sector decarbonisation efforts with the efforts at the International Maritime Organisation (IMO), which, on the 4th of April 2018, reached agreement during the MEPC 72 session on its *Initial Strategy* to decarbonise international maritime transport. The IMO strategy commits the maritime sector to cut total Greenhouse Gas (GHG) emissions from shipping to at least 50% of the 2008 level by 2050. The IMO signatory States, with the exception of the USA, Russia and Saudi Arabia, agreed in addition that shipping CO_2 emissions should peak as soon as possible, and that the carbon intensity for international shipping should decline by an average of at least 40% by 2030 and efforts should be made to reduce average CO_2 emissions per unit of transport work as much as 70% of 2008 levels by 2050.

Ships remain in operation for decades after they are built and new tonnage launched today, might still be in operation by 2050. The slow rate of replacement of the global maritime fleet and the reliance of the industry today on fossil fuels, implies that reducing the total emissions of the sector by at least 50% by 2050 places considerable pressure on developing new carbon neutral technologies for shipping and will result in the progressive tightening of regulation to force the sector's emissions to converge towards the IMO targets outlined in the Initial Strategy.

[1] European Commission (2019), *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 Deal*, COM(2019) 640 final.

[2] Proposal for a directive amending Directive 92/106/EEC on the establishment of common rules for certain types of combined transport of goods between Member States COM(2017) 648.

The European Green Deal and the IMO Initial Strategy are only two of the many regulatory instruments and ambitions set to progressively decarbonise the maritime sector. Efforts to reduce emissions in shipping started in the mid 1990s as policies at the international level set targets to tackle GHG emissions and the evidence from the science as well as the costs of delaying action became increasingly apparent. However, over 30 years, the response of the international community and of the shipping industry to the evidence provided by climate scientists on the need to reduce GHG emissions has been insubstantial and the regulatory efforts inadequate to trigger change. This implies that if the new ambitions at European and International level require urgent action in generating momentum in technology development and uptake and that all measures available to the sector to decarbonise will need to be used.

The heterogeneity of the maritime industry implies that one-fits-all measures to substantially decarbonise the sector do not exist and each segments of the shipping industry, and potentially each ship-owner or operator, will need to define its own set of measures to reach decarbonisation targets and comply with future regulation. This results in high complexity that is exacerbated by the lack of maturity in many decarbonisation technologies and could impose sizable risks for owners and operators. The development of new technologies and the massive uptake of these technologies that would be required to decarbonise the sector is hampered by an array of financial, regulatory and operational barriers and by the inertia of some industry players.

This chapter will provide clarity on the challenge ahead, the current state of regulation and the potential new regulatory instruments that will affect the sector, the consequences and measures needed by the sector to comply with regulation, with a particular focus on operations, decarbonising technologies and sustainable alternative forms of propulsion. A large portion of this chapter builds on Michele Acciaro's experience as member of the European Sustainable Shipping Forum (ESSF), that is the platform at European level with the aim of favouring the exchange of technical knowledge, dialogue, cooperation, and coordination among maritime industries' stakeholders and the European Commission, his involvement in the seven-year Green Shipping Project, funded by the Social Science and Humanities Research Council of Canada (SSHRC) and his research activities in the last 15 years.

2. The scale of the challenge

GHG emissions from shipping are substantial and they are likely to grow in the future if no action is taken. Shipping accounted for 2.6% of global CO_2 emissions in 2015[3], a figure that could rise to well above 10% by 2050[4] if the sector does not take

[3] Olmer N., Comer B., Roy B., Mao X., Rutherford D. (2017), "Greenhouse Gas Emissions from Global Shipping: 2013-2015", in *International Council for Clean Transportation*, Washington DC.

[4] Cames M., Graichen J., Siemons A., Cook V. (2015), *Emission reduction targets for international aviation and shipping,* Directorate General for Internal Policies, Policy Department A: Economics and Scientific Policy, Publications Office of the European Union, Luxembourg, ISBN 978-92-823-83704, doi: 10.2861/256940, PE 569.964.

steps to decarbonise. The 4th IMO GHG report will be published in 2020, and although expectations are that emissions from the sector will not have grown at the same pace as in the early 2000, it is unlikely that pressure on the IMO will reduce to regulate the sector.

The most recent comprehensive study on GHG emissions from shipping, the *Third IMO GHG Study* projected emissions to grow by between 50% and 250% by 2050 on a business as usual basis. A study published in 2017 by CE Delft[5] suggests that the increase will be more modest between 20% and 120% by 2050. According to the Third GHG Report, in 2008, the reference date chosen by the IMO, shipping emitted 1,135 million tons of CO_2 (or 3.5% of the global total estimated for that year of 32,204 million tons). International shipping was responsible for 921 million tons, about 2.9%, a figure which is slightly lower if we consider CO_2 equivalent (see table below).

3rd IMO Report CO_2 emissions from shipping

Year	CO_2					CO_2e				
	Global	Shipping		Intl. Shipping		Global	Shipping		Intl. Shipping	
	Mt CO_2	*Mt.*	*%*	*Mt*	*%*	*Mt CO_2e*	*Mt.*	*%*	*Mt*	*%*
2007	31,409	1,100	3.50%	885	2.80%	34,881	1,121	3.20%	903	2.60%
2008	32,204	1,135	3.50%	921	2.90%	35,677	1,157	3.20%	940	2.60%
2009	32,047	978	3.10%	855	2.70%	35,519	998	2.80%	873	2.50%
2010	33,612	915	2.70%	771	2.30%	37,085	935	2.50%	790	2.10%
2011	34,723	1,022	2.90%	850	2.40%	38,196	1,045	2.70%	871	2.30%
2012	35,640	938	2.60%	796	2.20%	39,113	961	2.50%	816	2.10%
Average	33,273	1,015	3.10%	846	2.60%	36,745	1,036	2.80%	866	2.40%

TABLE 1 - SOURCE: 3rd IMO Report

The IMO Initial Strategy mentioned before to cut GHG emissions from international shipping to at least 50% of the 2008 emission level by 2050 is the most recent and most ambitious initiative taken in the last 20 years to regulate the maritime sector air emissions, a task that is going to be complex and political, given the international character of the shipping industry and the importance of trade in supporting the global economy. The strategy requires shipping to curb its total CO_2 emissions, independently of the growth in the fleet or operational requirements, as the total emissions will not be allowed to exceed the 461 million tons cap.

It is worth noting that the International Panel on Climate Change (IPPC) advised in 2014 that in order to keep average global temperature for the period 1850 and 2100 below 2˚C of pre-1850 levels, global CO_2e emissions would need to fall 41-72% from a 2010 baseline with even deeper reductions by 2100. Leading to the Paris Agreement negotiation, the IPCC recognised, however, the need to set more ambitious goals to avoid the enormous losses already visible at 2˚C average temperature increases, such as disappearance of island states and more vulnerable habitats, mass extinctions and sea-

[5] LEE D.S. (2017), *Update of Maritime Greenhouse Gas Emission Projections*, publication: 17.7I69.67, CE Delft: Delft, the Netherlands [https://www.cedelft.eu/en/publications/download/2446].

level rise. To limit global warming to a 1.5˚C average increase would essentially require reducing global GHG emissions to 0 by 2050, and substantial negative emissions in the following decades.

ICCT[6] estimated in 2017 that global emissions from shipping declined by 15% between 2007 and 2015. If this rate of decline could be maintained in the longer term the reduction in shipping emissions would be within the IPCC 2˚C target by 2050. The period 2007 to 2015, however, was characterised by relatively slow growth of international trade. The ITF / OECD[7] projected in 2018 much stronger growth of maritime tonne-kilometres over the next thirty years, with compound annual growth rates averaging 3.3%. Achieving deep reductions in total emissions from shipping in line with IMO and IPCC targets for 2050 while accommodating this rate of growth in cargo volumes will require dramatic reductions in the carbon intensity of maritime operations. The level of emissions from shipping that should be generated by 2050 to meet emission targets similar to the global ones are 5 to 20 times lower than the business as usual scenario and equivalent to a sustained 10%-15% yearly reduction in total emissions from shipping.

Given the relative long economic life of vessels and the fact that ships built today might still be in operation in 30 years, it is essential that all measures available to decarbonise shipping are deployed in the coming decade if major disruptions in the sector are to be avoided. The IMO targets in fact imply in essence a progressive reduction in carbon intensity, which could be obtained using current technologies and alternative fuels, but, even more challenging, the development already from 2030 of (nearly) zero-emission ships. At the moment there is no single technology that could provide this type of reduction and it is likely that we will observe different solutions depending on the ship type and shipping segment.

The challenges ahead are not only technical and operational, but also social and legal, and need to be tackled though collaboration, greater awareness and sharing of best practices among shipowners, shippers, producers, ports and local communities. Given the increasing complexity of reducing emissions from what is an already very energy efficient sector it is unlikely that the objective set by the IMO in April 2018 will be achieved without a strong regulatory push and strong economic incentives. Furthermore, decarbonisation comes together with a variety of other issues that are being dealt with in the sector, such as the impact of ballast water on biodiversity, noise, marine mammals protection, ship recycling, waste and operational safety, to mention just a few.

3. Beyond the IMO: the EU position

As already mentioned in the introduction, transportation plays a critical role in the European Green Deal and the European Commission has taken already in the last decade an ambitious position when it comes to decarbonising shipping.

[6] Olmer N., Comer B., Roy B., Mao X., Rutherford D. (2017), *Greenhouse Gas Emissions from Global Shipping: 2013-2015*, International Council for Clean Transportation, Washington DC.

[7] ITF-OECD (2018), *Decarbonising Maritime Transport: Pathways to zero carbon-shipping by 2035* [https://www.itf-oecd.org/decarbonising-maritime-transport].

Transport in Europe is responsible for about one quarter of the EU's GHG emissions. This share is likely to continue to grow as transport demand is projected to increase in the coming 30 years. The Green Deal aimed at reducing these emissions by 90% by 2050. In the *Proposal for a Regulation Establishing the Framework for Achieving Climate Neutrality and Amending Regulation (EU) 2018/1999 (European Climate Law)*, published on the 4th of March 2020 (COM(2020) 80 final), the Commission reiterated its determination to carbon neutrality by 2050. Given that waterborne transport accounts for 13.4% of the transport emissions of the EU, there is a clear intention to reduce emissions from shipping well beyond the IMO initial strategy targets.

International maritime transport contributed in 2017 145.8 million ton of CO_2 emissions in the EU, about 32% above the 1990 levels, with the exception of domestic emissions that have been reduced. On the basis of data collected by the EU Monitoring Reporting and Verification (MRV), emissions from ships to and from the EU in 2018 totalled 138 million tons. According to the PRIMES model emissions from international shipping in the EU are likely to increase 21% in the period 2015-2039 and 51% in the period 2015-2050.

On the basis of these figures it is critical within the EU to facilitate the uptake of zero-emission technologies/solutions and incentivise research and innovation initiatives, and, until these technologies are widely available, to incentivise any mature technology, that does not require additional investment in infrastructure, such a low-carbon drop-in fuels and operational measures, such as slow steaming. Also of particular concern for the Commission is to ensure a clear a and predictable pathway for the sector, as it is well documented that regulatory uncertainty is among the barriers to the uptake of new technologies[8].

In 2013 the commission developed a strategy to the inclusion of the maritime emissions into the EU climate policy, that built on three steps. First the Commission set out to develop a system to track the exact sector emissions, through the EU Regulation 2015/757 of 29 April 2015 on the Monitoring, Reporting and Verification (MRV) of carbon dioxide emissions from maritime transport. Secondly the Commission will set targets for GHG reductions from the maritime sector, and thirdly, additional measures, including market-based measures, would be developed in the medium to long term. The Commission also aimed at aiding the transition to next low-carbon technologies in shipping by providing funding through, for example, the research and innovation policy and the alternative fuel infrastructure (i.e. *Directive 2014/94/EU on the Deployment of Alternative Fuels Infrastructure*).

The new Commission received a clear mandate by the European Parliament to develop far-reaching and ambitious targets to decarbonise the European economy, and for transport this implies a basket of measures. Carbon neutrality for maritime transport in Europe will need to be built on a combination of sustainable alternative sources of energy and energy efficiency (including operations optimisation, design and technical improvements).

[8] See for example: Hoffmann V.H., Trautmann T., Hamprecht J. (2009), "Regulatory uncertainty: A reason to postpone investments? Not necessarily", *Journal of Management Studies*, 46, No. 7 (2009): 1227-1253.

Carbon neutrality in maritime transport can be achieved but a substantial change in the fuel mix is required in addition to the use of energy efficiency measures to the maximum extent possible.

In the in-depth analysis in support of the Commission Communication COM(2018) 773, *A Clean Planet for all: a European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy*, published on the 28 November 2018, the Commission shows how substantial emission reductions can be achieved in various maritime transport growth scenarios. The PRIMES and the POLES-JRC models show 14% energy improvements between 2015 and 2050 in the reference scenario, but highlight how higher energy improvements are possible (up to 39%) which would allow less reliance on liquid biofuels. In these scenarios, liquid biofuels would still represent about 32% of the energy demand at a global level, while hydrogen would provide around 23% of the fuel mix by 2050.

These ambitious plans have been met so far with a limited uptake of alternative fuels in shipping as reported in the 2018 data collected through the MRV system, consisting primarily of LNG, that is unlikely to offer any substantial GHG emission reduction benefit. This would require the European Commission strategy in relation to shipping to be articulated into four areas, to address the most pressing issues faced by the industry with respect to decarbonisation. These four areas would be complementary to the already existing MRV and enforcement policies and the research and innovation pillars already in place.

In terms of energy efficiency, regulatory work at the EU level will aim at addressing incorrect pricing signals, by developing market-based measures for shipping and most likely the inclusion of the shipping in the European Emission Trading Scheme (ETS). Further work will be needed to tighten the regulation of the Energy Efficiency Design Index (EEDI) in the IMO, to eliminate the presence of split incentives. As far as alternative fuels are concerned, the two main issues are the limited availability of alternative fuels both in terms of infrastructure as well as competing use and the lack of predictable demand. The first point is partially addressed by *the Alternative Fuels Infrastructure Directive* mentioned above, while the issue of interdependency and limited demand uptake is addressed by a new initiative aimed at accelerating the uptake of sustainable alternative fuels and technologies.

4. Tightening regulation

From the previous discussion it should be clear that the maritime industry will need to reduce its GHG emissions substantially and that both at the IMO level as well as at the EU level, regulatory action is to be expected in the coming years. This regulation is likely to change the way shipping operates by triggering a major technology change and an energy transition from fossil fuels to low-carbon alternatives. In view of the wide-reaching scope of the regulation that will affect the sector, those companies that are best prepared to meet the upcoming regulatory requirements will be more competitive in the long run.

GHG emission regulation, beyond what is already in place will take multiple forms and will be gradual both at the international level as well as the EU level. To better explain the extent of the regulation we should distinguish between short-term measure (up to 2023), medium-term measures (up to 2030) and long-term measures (2030 to 2050), although such subdivision is by necessity arbitrary. The short-term measures are on the agenda to be discussed during the MEPC 75, planned for early April 2020 (but postponed due to the Coronavirus outbreak). At the moment, the two proposals are worth mentioning which build on a technical index, called EEXI proposed by Japan, and on a goal based mandatory operational index proposed by China, Denmark, France, etc.

In the short-term measures, focus will be on full implementation of existing measures, specifically the IMO Data Collection System (DCS) and the EU MRV for ships above 5000 GT, the EEDI and the other regulatory instruments already in place (such as the Ship Energy Efficiency Management Plan - SEEMP). Most current measures related to energy efficiency go back to MEPC 62 in 2011 which resulted in amendments to MARPOL Annex VI. The newly added chapter 4 of MARPOL Annex VI, cautiously entitled "Regulations on energy efficiency for ships", includes a set of technical and operational measures applicable for all ships of 400 GT and above, aimed at setting an energy efficiency standard for transport work (CO_2 emissions per tonne-mile) performed by new ships, the already mentioned EEDI. The EEDI is a progressive index in the sense that it requires newer ships to improve their efficiency against a gradually rising baseline. Despite its limitations and shortcomings[9], its adoption represented the first binding piece of regulation on emission reduction applied at a global level by any economic sector.

Discussions in the past sessions also focused on modifying the MARPOL convention and tighten the role of the SEEMP, EEDI or developing a new index (e.g. the Carbon Intensity Indicator – CII). Attention has also been on speed limits, that had been seen as a possible short-term measure to cap fuel consumption in case of an improvement in the market conditions. The decisions made in MEPC 75 will be critical to reduce GHG emissions in the short term. But the upcoming session is also critical to shed some light on the medium to long term measures.

The MEPC 70 in October 2016 reiterated that the new GHG emission provision would have to be the subject of a new convention and would not be incorporated as amendments to MARPOL. In addition, Resolution A.963(23) from 2003, tasked MEPC with the identification and evaluation of MBM as instruments additional to the technical and operational measures mentioned above. In July 2009, MEPC 59 recognised that technical and operational measures would not be sufficient to reduce GHG emissions and economic pressures would have to be exerted on the shipping industry. At MEPC 60, ten possible MBMs were submitted by member states and organisations[10].

[9] Smith T., Raucci C., Hosseinloo S.H., Rojon I., Calleya J., De La Fuente S., Wu P., Palmer K. (2016), *CO_2 emissions from international shipping. Possible reduction targets and their associated pathways*, UMAS: London, UK.

[10] Some of the measures were modified substantially, such as the one presented by the USA, while one was entirely withdrawn (Bahamas). Further details on the changes that took place in subsequent years are outlined in Psaraftis H.N. (2016), "Green Maritime Transportation: Market Based Measures", in Psaraftis H. (ed.) *Green Transportation Logistics*, Springer, Cham, pp. 267-297.

They can be grouped into four categories according to their main principles as outlined below:

1. **Cap and trade system**: a ship or operator is given a fixed amount of emission allowances which can be surrendered or traded with others;
2. **GHG fund** for the sector: a fixed cap is calculated for the sector and then allocated to ships and operators, any difference between the allocated amount of emissions and actual emissions requires a payment calculated as a levy on bunker fuel;;
3. **Levy**: a tax is imposed on emissions or on fuel purchases and either collected at the refuelling point or at the port. The amounts collected could be used to provide incentives for good performers;
4. **Efficiency standard**: a specific efficiency standard is defined for all ships which becomes increasingly stringent over time. The standards could be either absolute or relative to the average industry performance. Ships that deviate from the standard would be obliged to pay a certain fee proportional to fuel consumption.

The measures were evaluated by an expert group and their assessment submitted by MEPC 62. Discussion on MBM was postponed to MEPC 63 and then stalled although at MEPC 65 it was decided to adopt a phased approach, building on the DCS mentioned above. However, it is clear that MBM will be necessary if the shipping industry is to achieve the required level of GHG emission reductions and that in addition to technical and operational measures further regulatory instruments will be developed.

5. Compliance options: energy efficiency improvements

As a result of the increasing pressure to reduce emissions from shipping, it is important to consider the solutions that are available for the industry to comply with the upcoming regulation. These solutions can be subdivided into three main areas: energy efficiency measures, alternative fuels and alternative forms of propulsion. In this section we will deal with the energy efficiency measures.

Energy efficiency measures are all operational and technology measurers that allow ships to reduce fuel consumption, and as such to reduce emission of CO_2 and other GHG. It might be valuable to distinguish operational measures from technology measures and from measures at port. Operational measures involved changing operational practices on board of ships, generally with minimal technology modifications. Technology measures include all modifications to the hull or to the engine, including the instalment of new equipment, that results in fuel savings, while measures at port include all measures that can be taken to reduce emissions at port. Also in this case, the subdivision is somewhat arbitrary as any new technology would require some adjustment in processes on board of ships, and, analogously, changes in operational practices can be aided by the use of new technologies, but this should not undermine the general subdivision used here.

Among the most pervasive operational measure are reductions in speed. Speed reduction has been documented to have reduced carbon intensity in the container shipping sector of over 15% and the benefits of slow-steaming as a countermeasure to reduce overcapacity are well known.

While the average industry speed has been reduced in the last decade, it is unlikely that further carbon reductions can be obtained this way, as both from a commercial as well as an operational perspective further speed reductions are unfeasible. On the contrary, as the operational capacity is the result of the product of the total fleet capacity multiplied by the average speed at which the fleet is operated, there is concern that improving market conditions could result in an increase in the average speed, and in turn of emissions.

Other operational measures refer to: monitoring, though for example more advanced sensors; weather routing, based on optimising shipping schedule on the basis of real time weather conditions; and crew training; although evidence of the effectiveness of these measures is limited and are bound to depend on the specific characteristics of the vessel. Further measures to reduce fuel consumption relate to commercial practices linked to better utilisation of the ships, for example by means of finding more cargo in more suitable locations, improved stowage and management of loads, reduction in empty voyages, and network optimisation. Unfortunately, although potentially very effective, these operational measures are subordinate to commercial imperatives, and it is unlikely that owners would be able to obtain substantial reductions beyond what has already been achieved.

Technological measures require the installation of new equipment or the modification of existing equipment, ranging from engine, auxiliary power, hull, propeller to coating and even the design of new vessel. Ships have been refined over the years to be extremely efficient, so, although potential energy efficiency reductions are still possible, it is unlikely that they will allow for reductions beyond a few percentage points. Furthermore, new technologies and vessel modifications also inherently carry some risk and the potential of disrupting operations.

A specific comment should be made on the possibility of reducing emissions per unit of cargo transported, that is carbon intensity, by developing new, larger vessels. Larger ships, by means of the use of economies of scale, allow for reduction of fuel consumed per unit of cargo transported that can appear as an attractive way of decarbonising some shipping segments. However, so far, larger vessels have only partially replaced the existing fleet, that tends to be deployed in less dense routes, and in general, economies of scale are only realised with high utilisation rates. In bulk trades, larger vessels require more cargo, and this limits substantially the deployment of the vessels. So for bulk commodities, it is unlikely that it would be possible to replace the existing fleet with a fleet of larger ships, as there would be enormous commercial implications to such move. In the case of container shipping, the deployment of larger vessels in the last decade has resulted in a protracted period of low freight rates, and it is unlikely that further substantial gains in terms of energy efficiency can be obtained by building larger ships, especially in view of current market conditions.

Finally, there are measures that allow ships to reduce emissions at port. Among those the most relevant are virtual arrivals and onshore power supply (OPS). The discussion on virtual arrivals stems from the observation that ships tend to wait in ports at times even for long periods after they needed to speed up to meet their contractual obligations, and it would be possible to reduce emissions by better coordinating arrivals at berth. Ships wait in ports for various reasons. In some cases, they are simply at anchorage in the proximity

of potential cargo, in other cases they wait as a result of delays in pilotage, mooring, cargo deliveries or inspections.

Various efforts have been made in trying to minimise waiting times at port. One of the most advanced efforts has been carried out by BIMCO in developing charter party clauses that would allow owners and cargo interests to split the benefits of the virtual arrival without substantially changing contractual agreements. In this way ships could arrive in port later, but would not forego demurrage payments, that, in some segments could be a substantial source of revenue for owners and operators.

Notwithstanding the fact that it is possible today to overcome one of the main obstacles to virtual arrival, namely split incentives, the uptake of the virtual arrival clauses has been minimal, and the savings in terms of CO_2 emissions, negligible. This is primarily as a result of the fact that risks of disruption in cargo delivery are a much bigger incentive for ship to speed up and wait in port, that it would be expected in theory. Cargo owners and ship operators are more concerned with the value of the cargo than the savings of virtual arrivals. Without considering that reduced waiting times cause more stress on the ship and some delays are unavoidable as they are caused by inspections and by requirements of the authorities. So, while in general technologies can allow for a better use of virtual arrivals, the demands of cargo owners and the practices of port officials can have much more visible impacts on reducing delays at port.

Another important measures that has been often referred to as an option to decarbonise shipping is the use of electricity at berth, through what is generally referred to as *Alternative Maritime Power, Cold Ironing or OPS*. OPS has been widely applied in North America, Northern Europe and in China, and as of January, container and passenger vessels calling Californian ports need to connect to OPS 80% of the time at berth. California has pioneered mandating OPS to some ship segments, and it is likely to demand the increase in the use of the technology to include also other types of ships and for a 100% of the time in port.

The California regulation, that was primarily motivated by the need to reduce pollution has resulted in high costs and important retrofit work had to be carried out on vessels, but it has been effective in incentivising the use of OPS facilities at port. In Europe and Asia, the experience has been less convincing, as most infrastructure remained underutilised, give the high costs of electricity and the initial operational difficulties. The European Commission, however, has indicated in the European Green Deal the intention to mandate the use of OPS to all ships calling the ports of the EU.

While OPS is available in an increasing number of ports, so far only 30% of EU ports have OPS installations in at least one of their berths, and this has brought criticisms of whether electricity is the appropriate way of decarbonising the sector. It should be noted that the main objective of OPS is reducing pollution, and that the use of the onshore electricity is not economically viable, even if electricity is made more competitive by reducing for example taxation. This is simply because producing electricity on board of ships is extremely cost-effective, as bunker fuels are not taxed and there are no transmission costs.

The impact of OPS in reducing CO_2 emissions is more difficult to assess. In the first place, it should be noted that in general power generation in a power plant is more efficient than by means of an auxiliary engine on board of a ship. However, the fuel used in the

power plant is critical in determining what the carbon content of the electricity provided through OPS is, which could be close to zero, if the electricity is from renewable sources. In Europe the percentage share of renewable is very different from country to country, and although, on average this is in the range of 30%, it would be important for OPS to be an effective measure to decarbonise shipping that this share increases overtime.

Notwithstanding the uncertainty associated with the effectiveness of OPS as a carbon reduction measure, the costs associated with developing OPS infrastructure in all EU ports, and the need to upgrade the European electricity grid to accommodate the electricity demand of ships, it is the need to eliminate pollution in ports that has been driving the implementation of OPS across EU ports. Although there might be reductions in CO_2 emissions, OPS does not represent a solution to decarbonise the shipping sector, partially because emissions in port are but a small percentage of total shipping emissions, and partially because power in most ports is not generated from renewable sources.

6. Alternative fuels

The development of regulation will require the use of alternative fuels in shipping as at the moment there is no solution that is able alone to meet the decarbonisation needs of the sector. The next decade will be critical in determining the most promising alternative fuels, as competing technologies will coexist and the costs of engines and of the fuels will decrease as technologies mature and demand patters become clearer.

Among the alternative fuels the most promising at the moment are:

- **Hydrogen**: that can be burned directly or used in fuel cells. Hydrogen has several benefits among which its availability and the fact that when burned it produces no CO_2 emissions. However, costs are still very high, and concerns remain in relation to storage on board, refuelling points and well-to-tank emissions.
- **Ammonia**: può essere bruciata nei motori delle navi e in combinazione con una riduzione catalitica selettiva è un combustibile pulito. I rischi principali riguardano lo stoccaggio a bordo, le perdite e la maturità della tecnologia dei motori, nonché le emissioni del ciclo di vita.
- **Methanol**: Methanol is a fossil fuel, so in order to qualify as a low emission fuel it needs to be produced either from biomass or by means of other processes that result in capturing carbon from the atmosphere. Bio-methanol is available in limited quantity and is expensive, but the great advantage is that compared to other fuels its storage on board is less problematic, it's a liquid fuel and it has already been tested quite successfully onboard (e.g. Stena and Van Oord).
- **Biomethane**: natural gas as a fossil fuel does not represent a viable solution to reducing GHG emissions, with the added complication that any leakage, given the very high warming potential of methane, is likely to compensate any decarbonisation benefits of the fuel. However, advantages of methane, and specifically biomethane, that is methane produced subtracting carbon from the atmosphere, are that LNG engines for maritime transport have been available already for about a decade and infrastructure has been slowly developed.

- **Biodiesel**: the simplest option to decarbonise the shipping sector is to make use of biodiesel. However, the maritime industry will compete for biodiesel with other sectors and both availability and prices are of concern. Other biofuels, such as cooking oil or bioethanol have been tested also for shipping but with limited success. In the short-run, however, we are likely to see biodiesel being used in blends to gradually reduce the carbon footprint of the industry until other fuels become available.
- **Electricity**: in some shipping applications, such as short-distance ferries, we can expect batteries also to play a role in shipping, either in isolation or in combination with regular engine, fuel cells or power-to-X alternatives. Batteries are, however, still expensive, heavy and bulky and therefore are not suitable for those shipping segments that need more autonomy.

The uptake of most of these fuels is still hampered by economic and technological barriers. Important issues common to all of them relate to the availability of bunkering infrastructure, the availability of the individual fuels especially as a result of demand from other uses and the total emissions generated in the production processes of the fuels (life-cycle analysis), as some of these fuels are available only in limited quantity from renewable sources. Furthermore, the availability of some of these fuels is limited only to developed countries, and there are substantial cost differentials among regions of the world that make a global solution for the shipping sector even more difficult to be found.

Furthermore, on the engine side, while some of these fuels can be burned with limited modification on natural gas of diesel engines, in some cases, as for batteries, substantial capital outlays are necessary for installation that compounded with the risks of the new technology, make some of the solutions financially nonviable. In some cases, in addition to changes in the engine, important retrofit work is also necessary for the fuel storage and distribution system onboard of the vessel, making the availability of finance one of the most urgent issues to be addressed.

An important issue relates to the availability of these alternative fuels, many of which are not produced in sufficient quantitates to serve (a large portion of) the shipping industry. While the scale of production could be ramped up, with substantial economies of scale for hydrogen, methanol and ammonia, the environmental and global warming consequences of producing large quantities of such fuels in non-sustainable ways need to be considered. Most hydrogen, for example, is produced today through steam reforming of natural gas, with high net CO_2 emissions.

Some technologies could allow for the production of some of these alternative fuels onboard, reducing storage and transportation. Some technologies are emerging that could potentially allow for the production of hydrogen directly on board of ships. A Dutch/German start-up for example, sHYp B.V. specialises in the production of hydrogen on board of ships in a renewable way. Investment are being also carried out at ports to increase volumes of renewable hydrogen as in the case of the Finnafjord project in Iceland (see SRM Italian Maritime Economy Report 2018).

7. Alternative forms of propulsion

In addition to energy efficiency and alternative fuels there is the possibility of using other forms of energy to propel ships such as wind and solar energy. While wind has been used in shipping for millennia, the versatility of the diesel engine has made it difficult until recently to give large consideration to wind propulsion as a serious alternative. Wind propulsion is often pushed aside as an energy efficiency measure, as in general it is perceived that only marginal gains can be obtained through wind. One important issue is the lower flexibility of wind-propelled ships. Another issue is that wind assisted propulsion is not commoditized, so that it is difficult to make clear what benefits it can deliver to ship-owners. It is possible, however, to measure what is generated in terms of monetary savings and several projects are underway to test wind propulsion on real-life cases and clarify the business case for wind propulsion.

At least in the beginning, wind technologies might appear expensive, but the great advantage is that many of them have reached a high level of maturity already. Several companies, among which Maersk Tankers and Van Oord Shipping (Offshore) have been testing wind technologies with positive outcomes, as they already have customers that are interested in reducing emissions. Bulkers and tankers for some systems are low hanging fruits and can obtain substantial savings, even with minimal adaptation of routing and operations. Among the most promising applications of wind propulsion it is worth mentioning:

- **Flettner Rotors**, hat make use of the Magnus effect to propel the ship and commercial applications are already available which can offer substantial fuel savings (e.g. Ecoflettner and Norsepower).
- **Suction wings**, which are non-rotating wings with vents and an internal fan (or other device) that use boundary layer suction for propulsion. Various technologies are being tested, including Ventifoil and Turbosail.
- **Sails** which can be divided into hard and soft sails, based on new or traditional concepts that are also being tested on vessels.
- **Kites**, which can be both dynamic or passive installations in the bow of the ship and can contribute to generating thrust or power (e.g. SkySails).
- **Other technologies**, such as turbines, that can be used for propulsion of power generation.

Solar power seems also to offer potential application to shipping, although it is unlikely that a full solar-powered ship will be available soon, but in combination for example, with sails or other alternative forms of propulsion it is possible that solar power will also play a role in shipping. Independently of the technologies, it remains unclear how to facilitate the transition towards a low carbon shipping future, although a variety of issues have been identified that need to be resolved to ensure the new technologies are deployed.

An important issue for alternative forms of propulsion, but also for energy efficiency and alternative fuels, is the training of crew. The commitment of the crew on board of ships is critical to achieve energy efficiency targets, but in addition any low-emission technology installed on the ship need to be operated safely.

The use of new technologies on board of ships will require to retrain crew and allow them to become familiar with the new devices. Test cases show, however, that there are technologies that do not require extensive crew training as a large part of wind operations could be completely automated. Furthermore, the crew on board of ships would have the support of advanced weather routing software that in its own right can offer already fuel consumption reductions. The advantage of new decarbonising technologies is that they could contribute to make the industry more attractive to young people.

Beyond crew training, probably the most important issue in ensuring the uptake of alternative forms of prolusion in shipping is the necessity to develop a level playing field with existing technologies. It is, in fact, very unlikely that alternative propulsion technologies will be able to compete in an industry where there are no taxes on fuels, no carbon tax, and subsidies to the industry are still widespread. In such a context clearly the financial viability of a new technology cannot be seen as a barrier to the uptake of the new low-carbon alternatives. A full transparent look at the technology system that is in place in the shipping industry needs to be carried out. This of course calls for the development of some form of carbon pricing, where the revenues obtained from taxation can be channelled back into the industry to support R&D or make funding available to forward-looking ship-owners.

8. Options to decarbonise

The brief outline presented above shows that there is a wide array of solutions to decarbonise the shipping sector. It should be noted, however, that the reductions that will be necessary in the shipping sector to comply with the IMO Initial Strategy will be difficult to achieve in view of any increase in transport work and in the shipping fleet. Traut *et al.* in 2018[11] showed that carbon intensity reduction rate of 8% p.a. are needed for keeping global warming below 2˚C, and a much higher reduction rate of 23.5% p.a. is necessary for keeping warming below 1.5˚C.

Such reductions are very high even for those industry segments that in the aftermath of the 2008 global economic crisis substantially reduced fuel consumption as a result of slow-steaming and increasing vessel sizes.

[11] Traut M., Larkin A., Anderson K., McGlade C., Sharmina M., Smith T. (2018), "CO_2 abatement goals for international shipping", *Climate Policy*, 1-10.

Potential CO_2 emission reductions from shipping

Type of measure	Main measures reviewed	Short description	Potential CO_2 Reduction [1] [2]	
Hull design	Vessel size	Economy of scale, improved capacity utilization	4–83%	
	Hull shape	Dimensions & form optimization	2–30%	
	Lightweight materials	High strength steel, composite	0.1–22%	
	Air lubrication	Hull air cavity lubrication	1–15%	5–15%
	Resistance reduction devices	Other devices/retrofit to reduce resistance	2–15%	
	Ballast water reduction	Change in design to reduce size of ballast	0–10%	
	Hull coating	Distinct types of coating	1–10%	
	Hull cleaning			1–10%
	Water flow optimisation			1–4%
Power & propulsion system	Hybrid power/propulsion	Hybrid electric auxiliary power and propulsion	2–45%	
	Power system/machinery	Incl. e.g. variable speed electric power generation	1–35%	
	Propulsion efficiency devices		1–25%	
	Waste heat recovery		1–20%	6–8%
	On board power demand	On board or auxiliary power demand (e.g. lighting)	0.1–3%	
	Design speed reduction			10–30%
	Auxiliary power	Auxiliary engine efficiency, efficiency pumps, fans, efficient lighting		0–3%
	Engine efficiency	Engine controls, engine common rail		0–1%
	Thrust efficiency	Propeller polishing, propeller upgrade, rudder		1–8%
Alternative fuels	Biofuels		25–84%	
	LNG		5–30%	
	Hydrogen		0–100%[3]	
	Electricity		0–100%[3]	
	Ammonia		0–100%[3]	
Alternative energy sources	Wind power	Kite, sails/wings	1–50%	2–12%
	Fuel cells		2–20%	
	Cold ironing	Electricity from shore	3–10%	
	Solar power	Solar panels on deck	0.2–12%	
	Nuclear		95–100%[3]	
Operation	Speed optimization	Operational speed, reduced speed	1–60%	10–30%
	Capacity utilization	At vessel and fleet level (fleet management)	5–50%	
		Advanced weather routing, route planning and voyage execution	0.1–48%	1–4%
	Other operational measures	Trim/draft optimization, Energy management, Optimized maintenance	1–10%	
	Autopilot upgrade			1–3%

TABLE 2 - SOURCE: adapted from Acciaro and McKinnon, see footnote 13 and [1] BOUMAN *et al.* (2017) (left column), see footnote 14 [2] WANG H., LUTSEY N. (2013), *Long-term potential for increased shipping efficiency through adoption of industry-leading practices: ICCT White Paper* [http://www.theicct.org/sites/default/files/publications/ICCT_ShipEfficiency_20130723.pdf] (right column) and [3] OECD / ITF (2018) see footnote 7

Independently of the form decarbonisation regulation will take, in the medium to long term multiple solutions will coexist together with alternative fuels. The combination of decarbonisation solutions will be determined by:

- The specific characteristics of the ships, as some technologies cannot be installed on certain type of ships;
- The specific trade requirements in terms of autonomy and time between refuelling;
- The availability of refuelling points and bunkering infrastructure;
- The availability of new technologies both in terms of costs and reliability;
- The specific regulation deo decarbonising the sector;
- Funding opportunities and incentives;
- Fuel availability and costs (including synergies with other modes of transport);
- Public pressure.

In the last decade several studies have been published to compare decarbonisation policies and measures, and it is expected that the upcoming 4th IMO GHG Study will provide a valuable basis for further policy discussions in the sector. A comprehensive comparison of the MBMs has been provided by Psaraftis[12] and an overview of the debate on decarbonisation is offered by Acciaro and McKinnon[13]. Bouman *et al.*[14] provide an analysis of the decarbonisation solutions available for shipping and compiled a detailed list of GHG-reducing measures (reproduced in the table below from Acciaro and McKinnon; see footnote 13).

9. Conclusions

The shipping industry will face enormous challenges in the coming decade, as the firm commitment of the IMO on reducing GHG emission entails the development of almost zero-emission ships in the coming decade. The IMO target of keeping emissions well below 50% of the 2008 levels by 2050 will result in stringent regulation beyond what already adopted and will be at the basis of the industry energy transition and the rapid adoption of new low-carbon technologies. While so far, the pace of regulation has been relatively slow, there is reason to believe that both at the IMO level, but even more so at the European level, more binding regulation is to be expected.

Ship-owners and operators have the option to attempt to delay action until technology costs are reduced and regulatory pathways are clear or proactively engage in a dialogue with regulators, engine manufacturers and technology providers to identify the most cost-effective ways of decarbonising the sector.

[12] Psaraftis H.N. (2016), "Green Maritime Transportation: Market Based Measures", in Psaraftis H. (ed.), *op. cit.*, pp. 267-297.

[13] Acciaro M., McKinnon A. (2020), "International shipping and climate change: policy responses and implications for the maritime industry", in Wilmsmeier G., Monios J. (a cura di), *Geographies of Maritime Transport: Transition from Transport to Mobilities,* New York, Springer-Nature*, in stampa.*

[14] Bouman E.A., Lindstad E., Rialland A.I., Strømman A.H. (2017), "State-of-the-art technologies, measures, and potential for reducing GHG emissions from shipping–A review", *Transportation Research Part D: Transport and Environment*, *52*, 408-421.

For some ship-owners action without external support from R&D funding agencies or strong MBM is unlikely. There are, however, many examples of ship-owners and operators of different sizes and active in different market segments that have been investing in new decarbonisation technologies and have been leading market developments with promising results.

Those companies that will identify the right market solutions, taking advantage of the support instruments that are now available will be in a better position in the future to reduce fuel consumption and meet the more stringent regulatory requirements that will be imposed on shipping in the coming decade. In particular the following set of recommendations can be provided for owners and operators in shipping.

- **The maritime sector is a major contributor to GHG emissions and as such pressure will remain on the sector to decarbonise.** Notwithstanding the importance of the maritime industry in facilitating international trade, as other sectors progressively reduce their carbon footprint, increasing pressure will also come on shipping, that is projected to grow in the coming decade. This will increase the urgency for finding solutions for decarbonisation for individual shipowners and ships (carbon intensity).
- **The pressure on the sector will result in progressively more stringent regulation that will affect the industry in various ways.** The IMO Initial Strategy set the ambition for the sector and the targets laid out, given the long economic life of ships, will imply that various regulatory instruments will be necessary to decarbonise the sector.
- **Especially for European shipowners and for ships calling at European ports, regional regulation will be more stringent.** The European Commission and the European Parliament have provided clear signals that the European shipping industry will need to decarbonise beyond the targets set in the IMO Initial Strategy. The European Green Deal aims at taking advantage of decarbonisation as a business opportunity to strengthen the competitiveness of the European maritime sector and place Europe in the forefront of sustainable new technologies. There will be funding and support for innovation, at least in the initial phases of new technologies uptake, to reduce barriers and risks.
- **Regulation will result in an energy transition for the sector and the rapid uptake of low-carbon technologies.** Regulation will trigger the need to find low-carbon solutions for shipping and will result in the uptake of alternative fuels. Initially multiple solutions will be available at the same time. As some technologies become widely used, their costs will decrease, and it is possible that a handful of decarbonisation technologies will end to dominate the shipping market.
- **No single technology will deliver full decarbonisation.** Only with the inclusion of nuclear propulsion and a substantial uptake of advanced alternative fuels, would it be possible to achieve 95% - 100% decarbonisation, but it is likely that these developments would prove too costly and nuclear propulsion be considered unacceptable on safety and security grounds. It should also be noted that the emission reductions may not be cumulative and some of the technologies may have a counter-acting effect on GHG emissions. The measures listed in the table above are at different levels of development and maturity, and in some cases substantial barriers exist to their implementation.

- **It is important to consider lifecycle emissions of fuels.** The need to reduce emissions across the various stages of fuel production will put pressure on developing mechanisms to account for the lifecycle of the shipping decarbonisation technologies.
- **Customers will increasingly become more demanding in terms of GHG emission reporting and reductions.** In some segments of shipping, such as passengers and containers, there is already increasing pressure for decarbonisation. Various initiatives, e.g. BSR Clean Cargo Working Group, exist already to increase the transparency in the industry, but more needs to be done to ensure cargo owners and final consumers have full transparency on emission reductions along global supply chains.

Chapter VI

Sustainable ports and the relationship between ports and territories

The global connectivity system, on which the very structure of world trade and the world economy is based, represents the foundation of our current way of life.[1]

In view of the fact that in their product cycle approximately 90% of goods complete at least one passage on board a ship, it can be said that industrial production and international trade are based on maritime transport.

This in turn makes the 'Port' infrastructure not only central, but also the essential driver and fundamental piece to all phases of production, both upstream for the supply of raw materials and downstream for the distribution and marketing of semi-finished and finished products.

Ports, however, due to their historical nature, are located in the centre or near the cities that host them. In many cases, they are the very reason why cities have prospered and grown.

The Italian maritime republics, the Hanseatic cities, even some metropolises of the Far East such as Shanghai, Osaka-Kobe, Hong Kong and Singapore, have found their fortune and have grown as a direct result of the wealth and opportunities created by their status as port centres and trade hubs.

However, times and current practice have created, with an urgency that is no longer negligible, a significant rethink of business and organizational models. In short, some of the assumptions that have marked the development of the so-called 'globalization' of logistics and global value chains need to be reviewed, updated and designed with a long-term strategic vision, which combines economic growth and sustainability.

1. Sustainability applied to urban models

Among the themes that will more deeply characterize the twenty-first century there is certainly that of progressive urbanization in every corner of the Earth. The steady shift of large masses of people towards urban centres simultaneously poses the challenge of how to design, develop and live in the cities of the future and to ensure that they do not represent great centres of environmental pollution and extreme consumption of resources. On the contrary, cities need to become great 'containers' of good practices and efficient uses of materials.

[1] The drafting of this paper (between the second half of March 2020 and the end of April 2020) coincides with the emergence of the Covid-19 pandemic and cannot fully take into account the strong and potentially disruptive elements that this crisis will impose on the very structure of global trade governance. It is therefore not possible to confirm, at the time of this publication, whether some of the assumptions hereby presented may appear to have been overtaken by the rapid evolution of decisions and actions linked to the crisis.

Also, they should turn into places where the potential improvement in the quality of life of individuals – achieved through access to well-organised resources, quality services and safe, well-paid work – should not be adversely offset by the significant decrease in the quality of collective life, given by the worsening of living conditions as an urban community.

Top 100 largest cities in 2035 by GDP

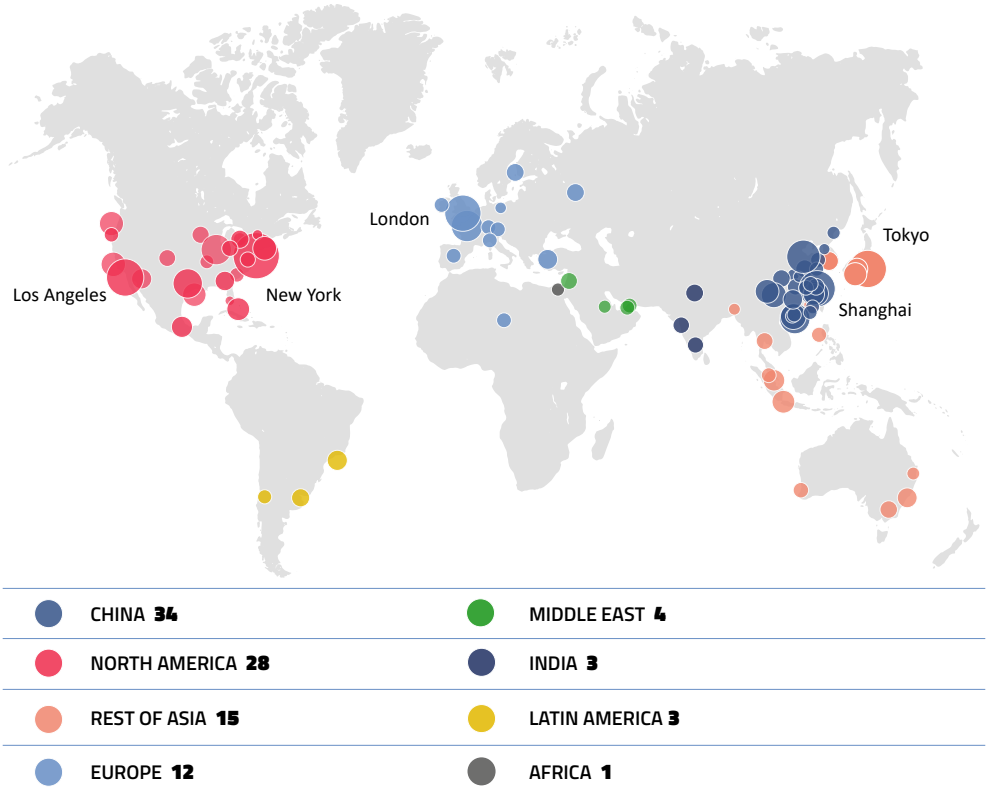


FIGURE 1 - SOURCE: SRM on Oxford Economics

The cities of the future must therefore necessarily be sustainable or smart cities, as the use of technology and thorough planning can lead to the creation of a 'healthy city. *'Into the deep future, the cities in which we live must enable people to thrive in harmony with nature and achieve sustainable development. People oriented, ecocity development requires the comprehensive understanding of complex interactions between environmental, economic, political and socio-cultural factors based on ecological principles. Cities, towns and villages should be designed to enhance the health and quality of life of their inhabitants and maintain the ecosystems on which they depend'.*[2]

[2] *San Francisco Ecocity Declaration* (2008) [https://ecocity.wordpress.com/2008/05/15/san-francisco-ecocity-declaration/], retrieved on 23 March 2020.

In the most extreme visions, cities should be structured following a model similar to the following: 100% carbon-neutral energy production; an interconnected transport system and land use that progressively shifts the mobility model from the car to public transport or alternative means of transport with low or no environmental impact; a circular economic system which results in zero waste; limitations to the use of natural resources, starting with the efficiency of the way water and various energy sources are used; the use of sustainable, low-impact and possibly locally-produced building materials.

The need to combine urbanization, sustainable planning and port connectivity is even more urgent when considering that, in the projection to 2035 of the top 10 metropolis by GDP, the vast majority will be port cities.[3]

Top 10 cities in 2035 by GDP

Rank	City	Country	2035 GDP
1	New York	United States	$2.5T
2	Tokyo	Japan	$1.9T
3	Los Angeles	United States	$1.5T
4	London	United Kingdom	$1.3T
5	Shanghai	China	$1.3T
6	Beijing	China	$1.1T
7	Paris	France	$1.1T
8	Chicago	United States	$1.0T
9	Guangzhou	China	$0.9T
10	Shenzhen	China	$0.9T

TABLE 1 - SOURCE: Visual Capitalist [https://www.visualcapitalist.com/top-10-cities/]

2. SUSTAINABLE PORTS

In order to define the possible relations between a port and its surrounding territory, it is necessary to first try to narrow down what the concept of sustainability applied to ports can represent.

Ports, in a modern description, are at the same time 'nodes' along connection networks and, from a geographical point of view, interdependent clusters of activities, with various forms of coordination, both in terms of the use of resources and strategic choices. Under the latter perspective we should analyse the repercussions in terms of sustainability and the advantages that can be generated with respect to the respective territories.

A port intended as a cluster of activities allows to measure performance not only in terms of the throughput of goods volumes, but also in terms of 'added value' created and levels of investment.[4]

[3] FINANCIAL TIMES (2010), *Green vision: the search for the ideal eco-city* [https://www.ft.com/content/c13677ce-b062-11df-8c04-00144feabdc0], retrieved on 17 March 2020.

[4] DE LANGEN P., HAEZENDONCK E. (2012), "Ports as Clusters of Economic Activity", *The Blackwell Companion to Maritime Economics*, New Jersey, pp. 638 e ss.

Moreover, a port as a cluster includes a significant number of independent, but also interdependent companies, whose results are, to a certain extent, closely interconnected.

Hence, the port model understood as a mere infrastructural 'node' does not pay due attention to the role that the managing and planning body of the port must play. The Port Authority, understood as the managing and planning body of the port cluster, must pay the same attention given to the management of the 'land' also to promotional and marketing actions as well as to the ability to attract investments and activities with high added value, possibly with a strong inclination towards innovation.

In this sense the ports become, or rebecome, great centres of industrial and productive development and not merely places of transit.

In addition, from the perspective of public welfare, the so-called 'common' goods should be provided by the institutions closer to the need, i.e. close to the reference cluster, so again there is a coordination and strategic planning role of the Port Authority, which should represent the reference governance body. However, in order to be able to provide both services and public goods, Port Authorities should be able to base their budgets mainly on their ability to maximize revenues, so as to promote good management, whilst not being oriented towards profit-maximization.

Acting as cluster managers, they should invest in the direction of providing collective assets, such as training, promotion and marketing, and the development of an efficient Port Community System.[5] This improves the overall competitiveness of the cluster, leaving the individual cluster components to focus on profit maximization. In a cluster perspective, therefore, a port must be developed taking into account all the components of its traffic, starting from industry and production, to the point of favouring, wherever possible, the establishment of activities with high added value and a high rate of innovation. All of this should happen while not concentrating exclusively on the growth of commercial traffic, which still remains of utmost importance.

In this perspective, ports thus become great collectors of economic activities that intertwine while collaborating and benefiting from common assets and resources. They become the centres where potential is unleashed and lines of strategic development and industrial policy are put into practice, with positive repercussions that go well beyond the mere physical boundaries of the port areas themselves.

Along this dynamic process, sustainability not only becomes an essential component both for the management of everyday life and for strategic planning, but has the potential of becoming a lever to generate further wealth and improve the overall quality of life in surrounding areas.

This 'Sea Economy' therefore requires ports of call all over the world to adopt sustainability measures in as fair a manner as possible so that, on the one hand, the requirements of environmental protection and social balance can be met and, on the other, to prevent the creation of market distortions linked to the competitive advantage that would result from non-regulation of the sector in certain areas of the planet or a lack of uniform application of common rules.

From a solely environmental point of view, especially in recent years, maritime transport has adopted rules and procedures, often set at global level by the IMO, as well

[5] *Ibid.*

as the adoption of good practices for certain sectors or categories, such as BIMCO for example, but in terms of sustainability and, above all, the relationship between ports and the territory in which they operate, such regulation is not sufficient.

First of all, because IMO regulations tend to rule predominantly on the 'sea side', not taking into account the 'land side' (ports, terminals, hinterland and logistic chains), i.e. the places that bear the heavy burden, in terms of external costs of goods or passenger flows. These represent a non-negligible part of the equation needed to build fully sustainable routes.

Secondly, because a relationship between ports and territories must encompass dimensions that go beyond mere logistical management – of goods and passengers – ensuring, on the contrary, an overall vision capable of tackling all the challenges – social, cultural, economic, environmental – typical of a modern approach to sustainability in the 21st century, as mentioned above.

Therefore, to ensure that sustainability does not stop at 'sea side' or 'land side' alone, but also inspires and crosses the 'place' that serves as a link and framework between the two elements, what we need is globally defined guidelines that serve as a basis for strategic development processes that develop both on a global and a regional scale. A first starting point can be found in the UN Agenda 2030, signed in August 2015 by 193 countries, which set 17 objectives for sustainable development.[6]

Diciassette obiettivi che, stante la loro vocazione "generalista", non possono essere semplicemente trasposti al trasporto marittimo, alla portualità e alle catene logistiche ma possono, quanto meno alcuni di questi, fornire delle indicazioni utili nel perseguire politiche ed azioni strategiche, volte alla sostenibilità e all'implementazione di un positivo rapporto fra la portualità e i territori in cui la stessa produce effetti e genera ricadute.

Se dunque gli obbiettivi SDG 2030 forniscono una utile mappa per guidare i sistemi – economici, sociali, industriali – verso l'implementazione di uno sviluppo sostenibile, è chiaro che, affinché tali principi non vengano intesi quali mere petizioni di principio, utili al più a tacitare qualche rimorso di coscienza, essi devono necessariamente essere tradotti in strategie e azioni concrete, le quali supportano l'adozione di regole che, a loro volta, tengano in debita considerazione le singole specificità di ciascun sistema portuale e di ciascun tessuto produttivo-industriale.

3. Actions and measures for the sustainability of ports

The main tools that can be developed with the aim of creating a Sustainable Port can be summarised as follows.

[6] United Nations, *Sustainable Development Goals Knowledge platform* [https://sustainabledevelopment.un.org/?menu=1300], retrieved on 23 April 2020.

Tools to create a Sustainable Port

Port Management	Energy sources and fuels	Sea-Based activities	Land-Based activities
Environmental policy planning	Wind	Speed reduction/ slow steaming	Technological innovations for road transport /drayage
Monitoring of Port activities	Solar	Efficient organization of vessel handling	Modal Shift
Concessions	Wave and tidal energy	Planning of Just-in-time arrivals	Efficiency/organizational innovations in truck operations
Measures promoting intermodality	Geothermal		Efficiency/organisational innovations in goods loading/unloading
Port costs and tax	Electrification of quays		Automation/robotization
Interinstitutional partnerships	LNG/Low Sulphur Fuels		Green industrial activities
Partnerships with universities and local cultural institutions	Biofuels		
	Methanol and hydrogen		

TABLE 2 - SOURCE: elaborazione dell'autore

3.1 Port Management and sustainability

This is normally one of the least explored and discussed aspects, with reference to the sustainability of the port world, which is a significant paradox.

Where, if not in long-term port planning, should the ability to implement strategies aimed at increasing the sustainability of port clusters be manifested?

However, in order to be able to carry out such a task, the subjects in charge of managing and developing ports must be able to count on the broad involvement of territorial stakeholders, starting with the cities and regions in question. This is necessary in order to move to a participatory sharing with the categories and subjects more closely involved in productive activities and to envisage a sharing of long-term sustainability objectives and projects with each local stakeholder association.

The strategic planning, which passes through the design of new and more efficient masterplans, must necessarily be based on the most stringent sustainability regulations, according to the terms outlined above. Therefore, adequate consideration must be given to the way in which the port of the future is 'designed', i.e. how the areas are arranged and functionally subdivided, with which internal connectivity networks the different port areas are connected and, above all, how they interact with the back ports and cities that develop around port areas. Port traffic heavily affects urban mobility, as do the modes

of transport used there. Prioritizing in the planning stage the forms of transport with the least impact and the highest environmental return, such as railways or, where possible, the river. This means acting on different levels: from the immediate decongestion of urban traffic to the reduction of costs and maintenance of bridges, roads, viaducts, etc.; from the improvement of transit and delivery times to the reduction of morbidity linked to the onset of diseases related to air pollution. It goes without saying that planning must try to interpret long-term future development patterns rather than manage the short and medium term, otherwise it loses meaning and frustrates any attempt to creating sustainable paths.

Moreover, little is said about the prudent and efficient management of the soil, i.e. the land (and sea) available. In recent years the planning of ports has always involved major infrastructure works or interventions of great quantity, with a considerable usage of new land. This 'cost' has never been sufficiently taken into account when calculating the actual benefits of the completed work, which is often only assessed in terms of increased productivity or terminal capacity. Conversely, the point of view should be reversed and the existing infrastructure should be improved and made more efficient, resulting in significant new construction only when strictly necessary or when their impact produces better results, in terms of sustainability, than the upgrade of existing infrastructure. In short, a radical change of perspective is needed, with a need to reconsider the evaluation of 'profitability' in infrastructure interventions, whilst evaluating all the second and third level effects that such projects have on the territory and its overall balance. In the absence of such a change, constructions and interventions planned will continue to have negative results in the broad sense of the common interest, due to the enormous negative externalities not calculated but actually present in reality[7].

In the management of active policies, on the other hand, the implementation of differentiated charging measures can be particularly useful, depending on whether the various users of the port have certain sustainability features such as, on the ship side, the use of closed-loop scrubbers[8], circular waste cycle planning, and more efficient management of the energy needed for mooring at the quayside. On the land side, managed by the Port Authority, some active policies to support sustainable development can be summarised as follows: the use of specific software for the management of arrivals and departures of trucks that eliminates waiting times and congestion at gates, so as to optimise mobility around the port and minimise unnecessary emissions; the progressive installation of power cables for the supply of electricity to recharge vehicles, including industrial ones, in all operational areas of the port.

Moreover, in order to fully support their role as 'management centre' of the cluster, Port Authorities must increasingly develop and coordinate cooperation policies with research centres in their territory, starting with universities and applied post-graduate training. At the same time, by creating the conditions for an ecosystem of knowledge, research and its application, together with start-up policies of high technological and

[7] Schipper C.A., Vreugdenhil H., de Jong M.P.C. (2017), "A sustainability assessment of ports and port-city plans: comparing ambitions with achievements", *Transportation Research Part D - Transport and Environment*.

[8] Brown I. (17 September 2019), "How can we make ports more sustainable and why it matters?", *Earth Institute, Columbia University* [https://blogs.ei.columbia.edu/2019/09/17/port-sustainability-index/], retrieved on 17 April 2020.

scientific value, it is possible to raise the 'innovation coefficient' of a respective territory and transform this directly into jobs and investments. These additional value-added services, of an intangible nature, make three worlds permeable and interdependent: training, the territory-community and the Port, understood as a cluster of activities.

From this relationship, further activities can develop, whose repercussions in terms of social vitality and sustainability are only positive.[9]

3.2 Energy sources and fuels

A lot of work has been done in this sector in recent years which has led to it reaching the most advanced stage of evolution. Since there is a lot of material to be analysed in this field, for brevity's sake we will refrain from discussing the topic at length and will focus on few specific examples.

Firstly, we will look at the construction of LNG depots for supplying distribution networks and for bunkering directly in port, namely Truck-to-Ship, Ship-to-Ship and Shore-to-Ship. Although LNG does not represent the total elimination of dependence on carbon-fossil sources and still includes high CO_2 emission levels, it has numerous environmental benefits and significantly reduces emissions of SO_x and NO_x. In summary, and based on current technological evolution, it is the perfect 'transitional' fuel, awaiting the availability of hydrogen or other sources with an environmental impact equal or close to zero.

The electrification of docks currently suffers with two major limitations: the lack of a sufficient number of ships in circulation equipped to connect to shore-based energy sources and the production of electricity still too reliant on coal. The 'nimby'-like concept of transferring the polluting moment from the area in front of the quay to the place where the energy is produced certainly does not represent a significant improvement in terms of sustainability. Various hypotheses are being studied for 'mobile' connections involving battery packs (plug-ins) which could act as generators, perhaps powered by LNG, and represent temporary answers while awaiting a diversification of the sources of renewable electricity production in order to be able to seriously supply the ships parked in ports.

3.3 Land-based and Sea-based activities

The shipping world as a whole is increasingly taking measures to manage its impact on ports and surrounding areas in a sustainable manner. While this work might not be highly visible, it is taking on significant contours and will produce noticeable results in the near future. Among many ideas and projects, it is worth highlighting here what is being developed with respect to Just-In-Time (JIT) arrival solutions which, through adequate

[9] De Langen P. (2018), "Ports will become a driving force for the new economy", *Piernext-Innovation by the Port of Barcelona* [https://piernext.portdebarcelona.cat/en/governance/ports-will-become-a-driving-force-for-the-new-economy/], retrieved on 18 April 2020.

planning and computer and technical equipment, make it possible to eliminate or reduce congestion in back port areas, commonplace and on the increase since ships have started to grow in size. At the same time, this procedure allows to increase the overall security of the port, to reduce the concentration of pollutants or harmful substances in the air, to carefully plan way returns and withdrawals, ultimately improving the mobility of urban areas behind the port.[10]

The progressive adoption of modes of transport to and from the last mile by train helps to relieve congestion on roads, bridges and viaducts, improving the overall road system and, due to the consequent decrease in the number of heavy vehicles on roads, reduces the risk factor for other vehicles on the network. The significant drop in emissions resulting from the road-rail modal shift is a priority and this action should be prioritised wherever possible and can no longer be postponed.

4. Case study. Port Network Authority of the North Adriatic Sea

The case of the Northern Adriatic Sea port system is paradigmatic in terms of sustainability and could provide useful indications on the implementation of SDG 2030 objectives in ports. The lagoon ports of Venice and Chioggia are characterized by peculiarities that enable them to be in position to act as a litmus test of the most advanced technological, political and scientific solutions, aimed at promoting sustainability and renewing a profitable relationship between ports and their territory.

Let us start by considering the physical characteristics. The port system of the Northern Adriatic Sea is completely enclosed within a lagoon environment. This is a clear advantage from a purely maritime point of view, as the lagoon offers higher protection from adverse weather and maritime events. On the other hand, from a sustainability angle, there is the need to constantly seek a balance between human activities and the natural environment as is the case with the need to maintain nautical accessibility for naval units calling at Chioggia and Venice by periodically performing maintenance excavations.[11]

In addition, at least 2 of the 3 ports of call that make up the Veneto Port System (Chioggia and the Maritime Station in Venice) are located near towns of enormous cultural value, while the third, Porto Marghera, is located within the lagoon and borders densely urbanized areas.

However, there are two other characteristics that make the Veneto port system a perfect context to implement and test best practices aimed at sustainability, while gauging which of these can produce a better relationship between the port and the territories.

The first concerns the social structure of the city, with particular reference to the historical centre. In recent decades, Venice has lost a large part of its inhabitants, reaching

[10] Warstila (2020), *White Paper – The Future of Shipping* [https://www.wartsila.com/marine/white-paper/the-future-of-shipping].

[11] Although, as is well known, the lagoon of Venice is a reality strongly influenced by man for centuries and modified several times by the Serenissima Republic, before recent times, precisely to promote trade and maritime exchanges.

today a population of just over 51,000, with today's demographic picture including an ageing population with the sole exception of young university students who attend the universities of Ca' Foscari and IUAV.

The second characteristic concerns the economic structure of the city. A highly partitioned territory that has in the historical city and the islands the almost absolute predominance of activities related to tourism (from accommodation to catering). In stark contrast, the mainland areas in Mestre mainly host offices and administrative-commercial operations while Porto Marghera is home to productive and logistic activities.

Against all this, the Port Network Authority has tried to understand not so much in which way the port can be more compatible with the territory that surrounds it but, reversing the problem, in which way the port can be a motor for the positive transformation of the Venetian territory, enhancing its strengths and minimising its weaknesses; thus implementing an approach to sustainable growth detailed in the interdisciplinary forms outlined above.

From an economic point of view, the Veneto port system is an irreplaceable driving force not only for the city but also for the region and nation. Thanks to a joint study[12] conducted by the Port Network Authority of the North Adriatic Sea and CCIAA Venezia Rovigo it has been possible to identify 1,260 companies directly working in Venice and 322 companies in Chioggia. The same study also shows that the companies involved in the port of Venice develop a direct production value of €6.6 billion, accounting for 27% of the municipal economy and 13% of the metropolitan economy. And if it is mainly the local territory that benefits from direct economic impacts, as far as indirect and induced impacts are concerned, most of the benefits are experienced elsewhere, which confirms the external interconnections generated by the port system.

These figures clearly indicate, therefore, that the economic and social sustainability guaranteed by the port, already structured in the form of a complex cluster, in a territory that for too long has linked its fate solely to the development of the tourism sector, guarantees those characteristics of resilience that are particularly necessary in the face of possible exogenous shocks[13]. But it is equally clear that, thanks to an area of 2,200 hectares, their status as multipurpose ports and their commercial and industrial nature, the Veneto ports of call, understood as production clusters, could double both their economic and occupational importance, also becoming districts of innovation for enhanced research, logistic platforms with a high technological content, production and processing, trade and handling of goods aimed at exports.[14]

Actions carried out in favour of greater environmental and cultural sustainability must also be taken into account.

From the environmental point of view, by way of example and wanting to deal with the cruise sector precisely because – albeit in a mystifying manner – it is often used as

[12] Currently being published.

[13] This consideration has acquired particluar importance with regards to the crisis caused by the Covid-19 pandemic.

[14] Gras R. (2019), "Ports as innovation hubs: an opportunity to boost the area's economic growth", *Piernext-Innovation by the Port of Barcelona* [https://piernext.portdebarcelona.cat/en/economy/ports-as-innovation-hubs-an-opportunity-to-boost-the-areas-economic-growth/], retrieved on 12 April 2020.

a 'club' against the Port, Venice adopted in 2007 the Venice Blue Flag Protocol. This requires cruise ships to use low-sulphur fuels in transit and stationary (less than 0.1%, much lower than that required by EU and Italian regulations), which has resulted in a significant reduction in emissions, more than 13 years ahead of IMO regulations. Another important factor in the cruise sector, in 2019 the Port Network Authority elaborated a strategy that should lead to make decisive steps towards the achievement of the SDG2030.

In July 2019, the Cruise2030 initiative was launched and implemented by some of the main European cruise ports – Amsterdam, Palma de Mallorca, Barcelona, Bergen, Cannes, Dubrovnik, Málaga and Marseille-Fos - with the common objective of guaranteeing a future for the cruise industry, a sector of great importance for the economy and employment that needs to be combined with the protection of cities, environmental balance, liveability and the overall management of resources and territories. The proceedings of the working group highlighted that it is necessary to redefine a balance between the model of development of ports and maritime traffic (today unbalanced towards a naval gigantism no longer viable in most European ports) and the territories in which ports of call operate, which requires that at least 5 issues be tackled:

1. Establishing a balance between ship size and port infrastructure.
2. Reshaping cruise ship calendars to avoid excessive concentration of passengers in cultural and artistic sites.
3. Taking decisions on putting ownership of infrastructure back into public hands, at the service of the community and citizens operating in the territory where the port is located. Only in this way will it be possible to establish the necessary infrastructure to contribute to the common good.
4. Define, in agreement with all public and private stakeholders, a new type of units to be deployed in ports.
5. At supranational level, agree on common limits and rules for cruise traffic.

All this in order to promote a balance between the legitimate private interest and the legitimate public interest, leading to the definition of a long-term strategy which, in the future, brings benefits to the community and, at the same time, avoids short-range planning, based on compelling situations, which will also negatively affect the ability of maritime transport to boost the economy.

In recent years, however, equal attention has also been paid to the cultural sustainability of the city. Not only by supporting, where possible, those actors of civil society who, in various ways, celebrate the maritime and port traditions of Venice and its lagoon. The activities aimed at implementing a cultural sustainability of the territory are in fact carried out through the active collaboration between the Port Network Authority and the main training and education institutions of Venice: the ITS Marco Polo Foundation and Ca' Foscari University.

Due to the ITS Marco Polo Foundation, of which the Port of Venice is a founding member, it was possible to inaugurate numerous biennial Secondary school curricula for the training of specialists in logistics, ports and rail traffic management. The ITS Marco Polo Academy training courses guarantee that over 90% of graduates are employed in

the sector within six months.

As for the University, in 2018 a memorandum of understanding between Ca' Foscari and the Port Network Authority was signed in order to train future professionals of logistics and economy of the sea. Another aim was to develop training and research pathways in the maritime-port and logistics sectors with the ambition of creating a Study Centre for research on maritime-port and logistics issues, in support of the training of new professional figures and new entrepreneurship.

5. Conclusions

In this work, an attempt has been made to illustrate a sector that is constantly evolving and which has the potential to have a significant positive or negative impact on future development and the possibility of guaranteeing prosperity to the territories that host and surround a modern port. The key to any development can only be analysed through the lens of sustainability. This concept is evolving rapidly from a simple attention to the environment to an all-encompassing idea that permeates social, cultural and entrepreneurial governance actions and that will be the main challenge of the near future.

Strategic planning of activities and development of territories must therefore be done bearing in mind that sustainability means *'achieving a development that meets the needs of the present without compromising the possibility for future generations to meet their needs'*.[15]

A concept of development that we could define as harmonious, between parameters of a mere economic order and actions that have a direct impact on the quality of life, broadly understood, of the populations of certain territories.

Ports have always been drivers of economic growth, they have often represented and still represent, if not the main one, one of the most important sources of wealth for the place where they are located. During the 20th century the whole concept of economic development has coincided with the maximisation of profit in terms of microeconomic parameters. Even when the evaluation of development has been taken into account from a macroeconomic point of view, it has rarely been judged differently from purely quantitative growth factors. For the near future, major strategic choices must necessarily adopt a broader and more articulated vision, taking into account sustainability, i.e. trying to balance economic growth, social and cultural development, environmental protection and technological innovation in a complex but virtuous combination of actions and knowledge.

As essential components of their territories, Ports therefore have an enormous role to fulfil with the utmost strategic vision, planning aimed at balanced growth and the composition of varied interests. The challenge is not the simplest and will not be without obstacles, but this is the only possible way to ensure prosperity and balanced development for port cities of the 21st century.

[15] World Commission on Environment and Development (1987), *Our common future*, Oxford, Oxford University Press. Conosciuto anche come Rapporto Bruntland, da molti considerato come il primo documento dove si fa riferimento compiutamente al concetto di sviluppo sostenibile.

Chapter VII

The Parabola of intermodality in Italy

1. The innovation of freight villages

Between the 1970s and the 1990s, Italy was the protagonist of a significant transformation occurred in the international logistic system. It is in our country, in fact, that a new infrastructural model was developed and enhanced under the name of *Interporto* ('freight village' in English, *platform multimodal* or *Port intérieur* in French and P*uerto seco/interior* in Spanish).

With Law n. 240 of 8 August 1990, Italy also identified a regulatory framework that, following the National Transport Plan approved in the mid-1980s, defined the rules for the operation of these infrastructures, created precisely to develop intermodality.

Since its first article, the national legislator clarified definition and objectives, underlining also the importance of ports: '*Interporto* means an organic complex of structures and services integrated and oriented to the exchange of goods between the different modes of transport, including a railway hub suitable to form or receive complete trains and in connection with ports, airports and main roads'.

The law introduced some important principles: the definition of a single framework plan for freight villages, the identification of first and second level freight villages, to establish a hierarchy between these infrastructures, a management formula with mixed capital, mechanisms of public financial support for investments and the development of intermodal traffic. In the following years, Law No 240/90 was largely distorted compared with its original identity.

Alongside the main Italian freight villages with a European dimension, capable of generating critical mass and competitiveness, infrastructures with no real significance for the development of intermodal logistics were built which appeared to be business opportunities only for real estate developers.

The phenomenon has been fuelled by the lack of a national strategic vision, with a decision-making framework that has evolved towards excessive fragmentation. Law no. 166/2002 amended Article 24 of Law no. 57/2001, assigning the Regions legislative power over the location of freight village facilities, taking this prerogative away from the central government in the process of devolution of powers in the field of transport.

This shift of the centre of gravity from the national policy in favour of the territorial decisional offices has not favoured the formation of a broader picture of the national logistic system. In fact, there has been a further acceleration of the trend towards a fragmentation of infrastructures at the service of intermodality and logistics.

Law n. 240/90 identified 9 first-level freight villages, one of which was not even built in its configuration as a freight village (Segrate-Lachiarella), so that today Lombardy, the main industrial region of our country, lacks a primary infrastructure for intermodal exchange, which was later built by the Swiss railways in Busto Arsizio.

Over time, on the other hand, there have been many freight villages on a territorial level, often even at close distances, which have not contributed to the growth of intermodal traffic.

The second part of law n. 240 was entirely dedicated to intermodality, the second pillar of the project, since the creation of infrastructures aimed at this model of offer implied the development of such services. The law itself provided for extraordinary contributions to investments in intermodal loading units by road haulage companies, with priority given to loading units for the transport of fresh, frozen or deep-frozen foods.

In addition to investment grants, there was also an incentive to encourage the use of the rail solution as a necessarily complementary measure aimed at bringing about a conversion of road-only traffic to intermodality. There was therefore a rational, timely reform, accompanied by all the appropriate conditions to ensure an adjustment of national transport and logistics towards renewed competitiveness and respect for environmental sustainability.

What did not work was the implementation phase. In the meantime, as mentioned above, pressure has been exerted to extend the perimeter of first level freight villages, with the aim of obtaining the financial resources made available by the State for the construction phase. In addition, the logic of logistic local interests has begun to pervade the various decision-making bodies. It seemed almost as if not having a freight village on one's own territory was considered detrimental to the logistic prestige of the territory.

We have thus witnessed the proliferation of freight villages: a direction exactly contrary to the adequacy of competitive solutions. In fact, such infrastructures are competitive provided that they have critical mass, and that they do not have to compete between neighbouring territories to attract traffic, concentrating instead on their function as traffic aggregators and organisers of logistic space in an efficient way. This proliferation of freight villages has therefore played against the design that planners and legislators had envisaged, at least in the original structure of the reform.

However, the high number of freight villages was not the only factor responsible for making the geography of logistic structures unfavourable for intermodality. What was also lacking were the conditions to favour the concentration of logistic settlements within these infrastructures. Finally, another negative element was the crisis of municipalities' finances, which led many mayors to accept urbanisation charges in order to grant permits for the building of warehouses, approving construction volumes in areas served only by roads and not far from the freight villages.

No one has intervened to try to curb a drift that has increasingly gained ground. As cement advanced outside the perimeter of freight villages, the area available for intermodal services shrank. With the pulverization of real estate for logistics, intermodality has moved away and the doors have opened even wider to the truck solution.

Moreover, those were the years of the prevalence of small and medium enterprises, with bank credit being subject to the availability of patrimonial collateral, generally assured by the possession of own warehouses. As a result, the Italian territory, in particular in the North East and along the Adriatic axis, became scattered with warehouses, which were then progressively emptied after the 2007 crisis, and are now abandoned and constitute in many cases an element of degradation of the territory.

In the meantime, at international level a trend was affirmed that favoured tertiarisation of logistics, with outsourcing processes that generated economies of scale capable of aggregating quantitative dimensions consistent with the development of intermodality. This, unfortunately, was not the case in Italy.

Therefore, this caused the loss of the first pillar of Law 240, i.e. the dominant position of freight villages for the development of sustainable intermodality. Consequently, the second pillar also disappeared: a policy of financial support for the intermodal solution in the usage of services.

Intermodality necessarily requires a breakdown of loading units, and it seems clear that it can only become competitive on the market over long distances, i.e. well beyond those for which the railways were traditionally competitive (around 300-400 km).

2. The lack of stable policies aimed at boosting intermodality

In order to encourage the development of intermodality on national routes, a transparent policy of financial support from the State to those who used this modality was absolutely necessary, as was the case in other European countries.

The promises of Law 240 were not kept, and the resources continued to go mainly towards a policy of State aid to road haulage, without any connection with the strategies of the National Transport Plan and against the European policy, inclined to prohibit financial support to supply chains such as transport, which should be operating autonomously on the market.

Some attempts to move in the right direction have been made, (i.e. the support to intermodality through the iron bonus), but in their first season of application these backfired essentially for two reasons: the extremely short duration of public financial support and the bureaucratic complexity of the mechanisms for the provision of resources.

Those who had believed in a long-term strategic choice found themselves stuck at a crossroads and had to take a step backwards, choosing options which did not constitute an obstacle to logistical solutions for intermodality any longer. Changing the structure of transport choices is never a road that companies take lightly, knowing that any step backwards would inevitably be painful and complex.

Some Italian regions, such as Emilia-Romagna, Friuli Venezia-Giulia and Campania, have tried to offer additional incentives authorised by the European Union for some time, but it is clear that measures of a regional nature could hardly have generated a systemic effect. In reality, changing a logistic organization model requires two conditions: certainty of stable rules in the medium- long-term and ease of access to the tools made available by transport policies.

To complete a picture of conflicting signals that are not favourable to the development of intermodality, came the process of liberalisation of the European railways, the effects of which have been largely underestimated in the reorganisation of transport systems, from many points of view, at least in the case of our country.

In the absence of public contributions to the development of intermodality, before the liberalisation, European public railways, and in particular the Italian ones, had adapted to be the surrogate of a real intermodal policy, in fact absent, offering the final customers

a rail traction price that was too low. This not only did not correspond to the production costs, typical of the old monopolistic management, but not even to the costs of an efficient operator acting in compliance with appropriate productivity standards. During the long monopoly season, the operator of rail freight services was evaluated almost exclusively on the basis of the quantity of production.

Under these conditions, European rail liberalisation has had a very uneven impact on intermodal services. Since 1 January 2007, the rail freight market has been fully liberalised. In the immediately preceding years, an inevitable reversal of this trend had begun. Incumbent railway companies, having to prepare for competition, began to adjust the prices of intermodal rail services, which were considered too low for anyone familiar with the sector's accounts.

The start of liberalisations did the rest. The prices offered for intermodal services approached the frontier of efficient production costs, and countries where there was no public policy for the development of intermodality, such as Italy, have seen the market for these services enter a deep crisis, except in very rare cases.

In these conditions, the only sector that remained standing was international intermodality, which in Italy stops at the terminals immediately downstream of the Alpine arc, because there has been, for some time, no policy of support for the continuation of intermodal on the national route. South of the main freight villages in Northern Italy (Novara, Verona, Bologna) the intermodal routes to the central-southern regions of our country have been cancelled.

Which trends have been manifested in the reorganization of intermodality, following the phenomena of restructuring of international economies, before and during the system crisis that started in 2007? Let us look at the most salient aspects. Intermodality, besides being a transport technique increasingly used as a result of the growth of globalization processes, which have lengthened the geographical distances of logistic chains, represents a qualitative indicator of the level of integration between the different transport systems, in terms of infrastructure, operations, equipment, services and regulatory conditions.

The efficiency of intermodal offer is a decisive component of its success due to the fact that it also has to deal with the additional costs generated by the breakdown of loading units and exchange between different modes of transport. It is estimated that the additional costs arising from loading, unloading and transhipment of intermodal units account for between 25% and 40% of the total handling cost of an intermodal unit in the overall chain of a door-to-door link. For this reason, it is essential not only that the individual components determining the value chain are put in place with a substantial degree of efficiency, but also that those conditions of adequate connection between the links in the logistic activity are built so that the flow as a whole is adapted to the characteristics of demand, in terms of cost and quality of the service provided.

We come from a transport history of the past century characterized by an approach based on individual sectors and modes: each mode of transport (air, river, sea, pipeline, rail, road) has gone through its own technological evolution and has been functionally separated by a specially designed regulatory structure.

While the evolution of transport techniques has continued to progress essentially according to a strictly sectoral logic, the transformation of industrial systems has generated growing demand for intermodal services for the mobility of goods.

A gap has been created between supply and demand for intermodal connections which now needs to be filled: the unitisation of loads, with containers and swap bodies, has made it possible to reduce friction in the exchange between the different modes of transport, without calling into question the organisation of networks and services according to a logic coordinated with the needs of intermodality.

In the 21st century, intermodal freight transport needs to be reinterpreted on the basis of requirements of global logistic chains, while overcoming an articulation of supply strictly functional to a mono-modal design of mobility systems.

The evolution of transport technologies brought about by the unitisation of loads has made it possible to extend the range of application of intermodality, which has become increasingly necessary also as a result of the growth of industrial globalisation processes in recent decades.

With the relocation of factories to newly industrialised countries, the flow of large-scale exchanges has inevitably increased, and transport has developed, connecting final markets with the factories and the various production sites for the exchange of semi-finished products.

This has caused the growth of the so-called forced intermodality, i.e. the condition according to which, due to the length and complexity of the routes of goods, the solution of using two or more modes of transport is not a choice, but an unavoidable necessity.

Moreover, the longer the distance travelled by the goods, the lower the percentage of transhipment costs between the different modes, which makes intermodality more competitive and necessary. The globalisation of the economy has therefore inevitably generated robust growth in the use of intermodal transport solutions.

Nevertheless, when it comes to medium- and short-haul land distribution – both at destination and origin – transport costs lose the effects of economies of scale and suffer with congestion impacts in the relationship between port and hinterland. As a result, medium- and short-haul transfers account for a significant share of the overall cost of transport, thus affecting both the choice of sea ports that make up the routes and the competitiveness of the logistic chain in the different territories.

As a result of the phenomena described above, a gap has been generated in Italy between an increase in compulsory intermodality, induced by the processes of maritimization of economic exchanges, and a decrease in optional intermodality, especially in medium- and short-haul land transport. This asymmetric phenomenon has weakened the completeness of the range of intermodal services as a whole, impoverishing the network effect and creating an advantage to the solution of a maritime intermodality based on the modal exchange between ship and road.

Optional intermodality, which had developed before the processes of globalization that were decisive in pushing towards compulsory intermodality, has left a valuable industrial heritage, indispensable to produce the effects of the transport revolution known between the end of the last century and the beginning of the 21st. Intermodal loading units have been progressively standardised over time, and the container has become the predominant instrument of maritime intermodality, while the swap body has taken on the same function in land intermodal transport.

In order to be part of the upstream and downstream phase of maritime travel, intermodality must present economically better alternatives than the all-road solution

alongside efficient responses from the point of view of the logistics chain. Therefore, ports that are able to offer integrated solutions with competitive intermodality become more attractive if they can ensure a high level of land-based connectivity with competitive characteristics.

In this process of internationalisation of intermodality, an essential role has been played by the already mentioned "maritimization" of the economy. At the end of the twentieth century, an explosion of international flows of goods was witnessed, with real value growing sevenfold from $0.45 trillion at the end of the 1960s to $3.4 trillion at the beginning of the 1990s.

The containerisation of transport has significantly influenced this process, resulting in a rationalisation of flows, a drastic increase in the loading capacity of maritime transport, a reduction in costs of transhipment operations, and a consolidation of administrative procedures.

The widespread use of containers has overcome the bottleneck in international freight traffic represented by the junction between sea and land transport. Originally, between the end of World War II and up to the container revolution, two thirds of ships' productive time was devoted to port loading and unloading operations. The influence of this revolution in transport technology must be read along the entire logistics flow chain, as it led to a profound transformation in the organization of the intermodal cycle.

Until the 1990s, there is evidence that the most significant impact on world trade occurred in transport flows between the most industrialised countries, i.e. in North-North relations. Subsequently, flows changed as a result of the profound innovations generated by industrial location choices, to such an extent that already in 2009 European trade relations with Asian markets were three times greater than transatlantic ones.

Long transport chains have also led to a greater articulation of intermodal shipments, which often have to undergo several breakdowns of loading units, and experience different modes of transport in the production process. The prevailing long-distance route is carried out predominantly by maritime carriers, who are moving from being pure 'carriers' of shipments to 'merchant' operators, taking over the delivery of the loading unit to the final customer.

With the acceleration of the processes of productive delocalization, alongside the delivery of finished products from the factory to the customer, inter-stationary flows of intermediate and semi-finished goods have also become important. We have witnessed a transformation from the district concept of the primary industry supplied by neighbouring suppliers to a constellation of exchanges of intermediate goods which have entered the network of international connections.

In the meantime, due to globalization, forced intermodality was growing thanks to the larger maritime flows on an international scale while in some contexts land intermodality was reduced, despite the fact that this had instead represented the main growth path of this transport technique in previous decades.

It is in this passage that freight villages, and especially the Italian ones, only partially succeeded in adapting their capacity to attract intermodal services.

What prevailed was a logic of real estate development for logistics rather than an operation to attract intermodal traffic.

Some of the reasons for this can be summarised as follows:

- The profit and loss accounts of freight villages are mainly determined by the ability to enhance the areas, giving rise to logistic settlements;
- Intermodal operators have rarely considered freight villages as an eligible facility, since the economic values at stake are higher than in other areas connected to the railways, given the higher quality of the freight village in terms of services and safety.

An opportunity has therefore been lost, also because intermodality in Italy, especially on land, has developed more as a bubble based on the low price of rail traction, rather than on an efficiency strategy for the intermodal cycle, which would have made it possible to guarantee medium and long term sustainability.

It is precisely the pressure brought about by the enormous growth in goods flows caused by globalisation and the "martimisation" of the economy that has made it even more strategic to reorganise land intermodality, even though this risks becoming the real bottleneck for routing large flows of goods on an international scale. This phenomenon has taken on particularly significant dimensions in some countries, including Italy.

3. The different role of railway companies

The liberalisation of railways inevitably led the *incumbents* of this sector to give up policies of support to intermodality through traction prices well below the efficiency threshold and these did not favour the application of market and competition principles for operators that intended to pursue full recovery of economic rationalisation.

This was particularly evident in the medium- and short-haul routes, which connect Italian ports to the most advanced industrial areas of the Padana plain, where prices offered by the incumbents were hardly sustainable in a market perspective. Therefore, for this kind of supply, there could not even be a replacement effect between incumbents and newcomers.

In the absence of explicit public incentive choices towards intermodality, adopted by several European countries (such as Switzerland, Austria and Germany), the network of national intermodal services in Italy has been drastically reduced over a few years. Only more recently, with the new regulations to encourage land and sea intermodality, have the conditions been set for a recovery of traffic in sustainable conditions.

Since 2016, the railway offer in general, and intermodal services in particular, have grown again. It is now a matter of giving continuity to this direction of support to the development of intermodality, with actions aimed at improving the quality of infrastructure, as this component is essential for the structural revival of the intermodal solution.

The loading and unloading operations of intermodal units have been consolidated in the experience of the past decades, and have undergone constant improvement and efficiency processes. In conclusion, standardization of loading units and improvement of industrial processes in terminals have been the necessary prerequisites for the growth of freight traffic on an international level.

It is unaccompanied intermodal transport, in the case of goods, that has experienced the most intense development, thanks to the network of world maritime connections, the standardization of loading units, the development of a network of intermodal terminals that have invested in the automation of loading and unloading operations.

The speeding up of these operations has occurred in particular in port systems, due to the needs linked to naval gigantism, and the high cost of immobilisation of large transhipment units, which must minimise time spent in ports in order to offset the high investment costs.

On the other hand, accompanied intermodal transport techniques have not evolved in an economically sustainable way. These require, as in the case of the rolling highway, the forwarding of the tare weight consisting of the truck and the journey for the truck driver who travels on a dedicated wagon. The onerous nature of this technique still makes it almost totally dependent on government subsidies, and it is used significantly for the Alpine crossing, on the Italy-Austria, Italy-Switzerland and Italy-France connections.

As for intermodal maritime rail transport, one of the obstacles that has not yet been removed to develop this type of traffic concerns the infrastructure layout in ports and the efficiency of rail shunting operations in the terminal segments of the routes. The port reform implemented in Italy with Law 84/94 has assigned to Port Authorities the railway infrastructures located within the perimeter of ports.

This arrangement has generated a sort of no man's land, since the connection networks between the railway terminals and the docks are within two different jurisdictions: that of the manager of the national railway network, for the first stretch, and that of the Port Authority, for the second stretch. The outcome was almost inevitable: a lack of investment which could have otherwise been used to modernise the rail networks in the terminal sections, on whose inadequacy often depend both the excessive cost of shunting operations and the poor level of service.

On the other hand, the management of shunting operations in ports, in many cases, is characterised by excessively high costs, which has a significant impact on the overall structure of the intermodal service on land, especially when the railway sections to be served are medium-range, as inevitably happens, for geographical reasons, in the connections between northern Italian ports and the industrial hinterland of the Po Valley.

In addition to the persistent onerous costs of shunting in the port areas where no investment has been made in upgrading the infrastructure, there are the technical characteristics of the national railway network, which, especially in the southern regions, does not reach the technical standards necessary to generate the production of "long and heavy" trains, therefore capable of reducing the unit cost per tonne transported.

Investing in the quality of railway infrastructure is therefore an indispensable factor for the development of sustainable intermodality which, on the one hand is capable of being compatible with the rules of the market, and on the other provides essential logistic support for the growth of port traffic, which cannot rely solely on the road solution.

Part Three

The new challenge of the Arctic Route

Chapter VIII

The Economic Scenario of the Arctic Route

1. Foreword

The transit through the Arctic sea may seem a chimera for most people. Nonetheless, the likelihood that by mid-century the iced passages will be opened is not remote and some countries are preparing to take advantage of this opportunity. The issue is not only about the economic potential of the Northern Sea Route or the Northwest or the Transpolar Passage, that cuts straight across the North Pole, but also about the juxtaposition of different interests, such as the imperative attention related to the safeguard of a pristine and unique environment that belongs to humanity.

This scenario has become more plausible given the climate change phenomenon which has stronger and quicker implications in the Arctic region than elsewhere. The environmental challenges, together with the energy and trade related opportunities, could eventually put under pressure traditional shipping routes such as the Suez one. The outcome is highly uncertain and will depend on several factors among which the geopolitical balance between national powers and supranational bodies. A topic not to underestimate especially considering that the recent viral outbreak has stretched the international relations to a new verge.

This chapter report aims to provide a picture of the actual situation of this maritime passage and a perspective of future developments under the assumption that, in the aftermath of the Covid-19, activities will go back to normal over time. Thus, the content of this chapter is to show the perspectives coming from the opening and reinforcement of this passage.

In conclusion, it will be shown that the span to wait so that the passages open for longer periods during the year and the size of the investment in logistic infrastructure are factors that make measurable economic spillovers unlikely to be seen in a near future.

In the meantime, the passage might exert effects but only for the littoral countries and with limited impacts on other naval routes. This is a key point to keep in mind while reading this chapter.

Indeed, the Arctic Route is a compelling long-term challenge and it is exposed – now more than ever – to several elements of uncertainty.

This chapter does not provide the reader with easy takeaways but it offers an updated overview on a complex topic which is relatively unknown and out of the radar of the public discussion. We deemed it important to bring the context out of the shadows, to the public, also to foster a constructive debate that takes into account the relevance of negative environmental spillovers associated with the exploitation of new maritime routes.

2. The Northern Sea Route: a new economic scenario

Almost 90% of world trade was carried by sea and world seaborne trade volumes in 2019 already reached 11.9 billion tonnes[1] with an increase of 1.1%, even if the first estimates for 2020 show a sharp slowdown. In additiond, Clarkson Research has forecast an average reduction in sea transport of 5%[2]. In a global market that is so competitive and sensitive to the global events, the aim is to look for new routes and new markets in order to increase economic benefits and economic trade. The Northern Sea Route (NSR) becomes a new target because global warming in recent years has accelerated the melting of ice and snow in the Arctic region.

"As economic globalization and regional integration further develops and deepens, the Arctic is gaining global significance for its rising strategic, economic values and those relating to scientific research, environmental protection, sea passages, and natural resources"[3].

In addition, many experts predicted that the NSR, should be largely free of ice in the summers by 2050 if the Polar Ice Cap continued to melt at current rates[4].

In this scenario, "the development of new international trade routes, however, could significantly change existing spatial patterns of freight transport, which would have important implications for global logistics chains and transport network infrastructure"[5].

While traffic on this route until now was light, it will grow in the next future. Experts estimate that during ice-free months, eastward shipments from Northern Range to China through the NSR are estimated to be around 20% faster than the same journey via the Suez Canal; around one week faster than the traditional one. (and about 40% faster from the Northern range to Japan equal to two weeks faster).

However, the NSR was not considered as a real competitor for land transportation transit corridors, somehow reminiscent of the historical Silk Road. At the moment, the Arctic Ocean has just three ice-free months a year but several estimates suggest that number will increase in coming years, boosting access to vessels and driving up traffic. This route is navigable without icebreakers for around two-four months a year.

The important thing, however, is not only to verify the distance of the routes and the commercial advantages of the latter, but above all the interest of big carriers as well as the development of new possible markets such as the Baltic area and Russian ports. It will also be important to evaluate the possible investments and developments coming from the exploitation of the energy and mineral resources of the area. On the one hand, the possible exploitation of new deposits could change global energy assets and the balance between states. On the other, it could also have very negative effects on the environment.

[1] UNCTAD.

[2] Clarckson 2020.

[3] The State Council Information Office of the People's Republic of China, *China's Arctic Policy, The State Council Information Office of the People's Republic of China*, January 2018.

[4] An overview on climate change in the Arctic is provided in Intesa Sanpaolo-SRM (2020), *The Arctic Route. Climate change impact, Maritime and economic scenario, Geo-strategic analysis and perspectives*, pp. 83-84.

[5] OECD (2019), *ITF Transport Outlook*.

A comparison between the NSR and The Suez Route

FIGURE 1 - SOURCE: SRM

The aim of this chapter is trying to understand the possible advantages and disadvantages of this initiative as well as to evaluate the effects on traffic in Europe and consequently in Italy.

As a matter of fact, the question which the chapter tries to address is whether the Mediterranean area of Europe and Italy in particular could see a reduction in traffic or the development of this route could be an opportunity to increase the logistics-infrastructural function of this area by increasing traffic with Russia and the Baltic countries.

It must be noted that the future development of this route is closely dependent on the will of the major carriers to use it. In particular, Maersk and Cosco have different interests from other liners and use the route (even if Maersk is only testing it at the moment) differently from CMA CGM and MSC who have openly declared that they will not operate through the route.

As a matter of fact, these companies want to adopt a specific policy in favor of protecting the Arctic and the climate. For this reason, CMA CGM and MSC have stated that they will avoid using the NSR connecting Asia to Europe through the Arctic in order to protect the fragile ecosystem from the threat of accidents, oil pollution, and collisions with marine wildlife.

3. Different routes and new perspectives of the routes along the Arctic

There are some main routes along the Arctic, thus the use of the Arctic Ocean could become a short-cut between Europe and Asia/North America that until now has been limited. Three main passages can be identified: the Northern Sea Route (NSR) the Northwest Passage and the Trans-Polar route (Figure 2)[6].

According to recent studies published by the European Commission[7], the possibility of navigating the Arctic Ocean will increase substantially. In 2019, was open to shipping for 30% of the year[8], whilst in 2040-2059 the predicted probability is between 94% and 98%, depending on the Intergovernmental Panel on Climate Change (IPCC) scenario.

By 2040-2059 there will be greater potential for moderately ice-strengthened ships to cross the central Arctic Ocean using the Northwest Passage. Again, there will be a northward shift of feasible routes for moderately strengthened ships, meaning that test route becomes possible. The Northwest Passage will also become a possible route for open water vessels. The route using the Northwest Passage is nearly a third shorter than the alternatives. For moderately ice-strengthened ships, the fastest route will go directly over the North Pole.

The findings have important implications for the environmental impacts to this area. If shipping increases, there will be worsened pollution and disruption of ecosystems. Despite the Polar Code (adopted by the International Maritime Organization) being in force since January 2017, there is a pressing need for its actual implementation to ensure environmental protection and vessel safety standards.

We have to consider not only the impact of reductions in sea ice, but also additional factors that may influence the use of these new shipping routes, such as lack of accident-response and search and rescue infrastructure, high insurance fees and poor facility of the area. After examining the various possible routes through the Arctic, this chapter focuses on the NSR that is the most famous and transitable one.

The NSR is the waters off the north coast of Russia – an area extending from Novaya Zemlya in the west to the Bering Strait in the east and outwards to the limits of Russia's Exclusive Economic Zone (EEZ). Russia regulates all traffic on the NSR, which is an integral part of the Northeast Passage, a shortcut between NW Europe and NE Asia

[6] For an overview on main passages see also Intesa Sanpaolo-SRM (2020), *op. cit.*, p. 41.

[7] "Science for Environment Policy": European Commission DG Environment News Alert Service, 2013, edited by SCU, The University of the West of England, Bristol.

[8] In 2019, the transits were realized from the end of July to the beginning of November over a period of approximately 14 weeks. Of the 37 transits only 6 (16%) required icebreakers. The possibility of transit along the route without an icebreaker depends on climate and on the polar class of the vessels. On transits see also [https://arctic-lio.com/nsr-shipping-traffic-transits-in-2019/].

through the Arctic Ocean[9]. The Arctic Route has been developing. "Massive Russian resources, including nuclear-powered icebreakers, have now enabled regular navigation.

Map of the main routes along the Arctic

FIGURE 2 - SOURCE: SRM on Amsa, Arctic Portal 2018search Service Report, 05-02-2020 [https://fas.org/sgp/ crs/weapons/RL34391.pdf]

[9] Businessindexnorth.com

The Northern Russian portion is kept open all year and there are voyages between the Atlantic and the Pacific for three months. The sea route is part of an overall transportation system. Siberian raw materials and delivering goods from Russia transit through coastal ports and the great Siberian river arteries. Although it is seasonal, it is the product that carries the bulk of cargoes to the northern coast"[10]. The use of the Arctic Ocean as a short-cut between Europe and Asia / North America has until now been limited but recent political and economic changes in Russia have been modifying official attitudes about the international use of the sea route; the authorities are currently encouraging foreign interest in shipping across the top of Eurasia.

4. Investment and perspectives of the NSR

"On June 8 2015, the Russian government released Russia's Integrated Development Plan for the NSR 2015-2030. The plan stresses the importance of providing safer and more reliable navigation on the NSR for maritime export of Russian natural resource materials but also the strategic importance of the NSR for Russian national security. The plan is also to increase international transit cargo transportation on the NSR in partnership with Asian countries and especially with China"[11].

For reasons of strategy and proximity, there could be several countries such as Russia, China[12], Northern European countries and even the US interested in taking the Arctic Route and investing in its ports and among these Russia has been more proactive than others in seeking to exploit the region. The area contains, among other resources, approximately one-fourth of the world's undiscovered oil and gas resources.

The Northeast Passage (an extension of the NSR) above Arctic Russia has long been touted as the most likely viable trade route through the Polar waters as the Arctic shipping season in the region lengthens, but developing the route requires a lot of investment which Russia likely cannot afford alone.

On the Arctic Route Russia is present through ROSATOM – a public Russian company entitled with the responsibility of implementing the Federal Project "The Northern Sea Route" which is part of the Integrated Plan of modernization and broadening of the route infrastructure until 2024[13].

Among the most important projects is that of LNG extraction in the Yamal peninsula.[14] Russia's first large-scale gas extraction project in Arctic waters was realized.This was the

[10] Drent J. (1993), "Commercial Shipping on The Northern Sea Route" in *The Northern Mariner/ Le Marin du Nord III*, No. 2 (April 1993), 1-17.

[11] Gunnarsson B. (2016), "Future Development of the Northern Sea Route" in The Maritime executive [https://www.maritime-executive.com/editorials/future-development-of-the-northern-sea-route].

[12] For an overview on the interest of China in the Arctic see also Intesa Sanpaolo-SRM (2020), *op. cit.*, p. 65.

[13] For an overview on Rosatom and Russian investments see also Intesa Sanpaolo-SRM (2020), *op. cit.*, p. 46.

[14] For an overview on investments and China-Russia cooperation see also Intesa Sanpaolo-SRM (2020), *op. cit.*, pp. 43-46.

first large-scale project for the extraction of liquefied natural gas in Arctic waters that consolidates Russian's pivotal role in the LNG sector. This project was a joint venture of commercial stakeholders, including Russian operator Novatek (owner of 50.1%), French Total (20%), China National Petroleum Corporation (20%) and the Silk Road Fund (9.9%). "The project seemed to be facing a major financial challenge in 2014 when the United States imposed sanctions on Novatek. However, the challenge was surmounted by switching the financing from dollars to euros and, significantly, through the acquisition of $12 billion from Chinese lenders to replace Western investment"[15].

As of January 2020, the project reached a 97.8% completion for a total capital expenditures for a project of nearly $30.5 billion at the end of 2019[16]. The Sabetta port takes part in this ambitious project with a year-round export that should reach about 17 million tons per year (construction materials and LNG).

A twin project on the other side of the Ob Bay on the Gydan peninsula was placed: Arctic LNG-2 operated by Novatek, Total, China National Petroleum Corporation and the Mitsui/ Jogmec consortium. With a total investment of $21 bln and an estimated production of 20 mln LNG tons per year by 2023, Arctic LNG-2 is the largest single project worldwide to have obtained the final commitment from its equity partners[17]. The $21 bln-worth plant includes power supply facilities, production wells and quaysides (currently under construction), supported by Novatek's plan to procure up to 42 specialized Arc7 LNG carriers (at least 10 of which from foreign shipyards)[18].

For Russia, the drivers of the Arctic changes could be the development of resource projects, the programs of building nuclear ice-breaking fleet and modernization of seaport and navigation infrastructure which support their dynamics.

NSR cargo flow is expected to increase considerably with further development of Russian Arctic hydrocarbon projects: crude oil from the Novoport Oil Field amounted to 7.26 million tons in 2018 (on a total capacity of 8.5 milion tons)[19]; crude oil from the Payakha Oil Field 7.3 million tons per year by 2024. That estimate might now be increased. As a matter of fact, in June 2019, the China National Chemical Engineering

[15] [https://www.aboutenergy.com/en_IT/topics/arctic-route-for-russian-lng-opens.shtml].

[16] A pool of international financial institutions originally sponsored the venture with a $20 billion multifacility loan, of which Intesa Sanpaolo Bank committed to €850 mln ($1.08,25 mln), residual €814,3 mln ($882,4 mln).

[17] Soldatkin V., Jaganathan J. (5 September, 2019), "Russia ups LNG race with green light on $21 billion Arctic LNG-2 project" in *Reuters* [https://www.reuters.com/article/us-russia-energy-novatek-lng/russia-ups-lng-race-with-green-light-on-21-billion-arctic-lng-2-project-idUSKCN1VQ0IH] and Arab News (5 September, 2019)*, Russia advances LNG race with multibillion-dollar Arctic project* [https://www.arabnews.com/node/1550306/business-economy].

[18] High North News (27 October, 2020), *Novatek To order up to 42 new Arc7 LNG carriers totaling $12bn* [https://www.highnorthnews.com/en/novatek-order-42-new-arc7-lng-carriers-totaling-12bn]. Likely bidders will be South Korea's Daewoo Shipbuilding & Marine Engineering (DSME), Hyundai Heavy Industry and Samsung Heavy Industry (SHI). China's Hudong Zhonghua shipyard, a subsidiary of state-company China State Shipbuilding Corporation, is also reportedly vying for the contract offering attractive financing options. DSME constructed the original tranche of 15 Arc7 vessels delivered between 2017-2019 used to export natural gas from Novatek's first Arctic project, Yamal LNG.

[19] [https://www.gazprom-neft.com/company/major-projects/new-port/].

Group and Russian firm Neftegazholding signed a deal on developing the Payakha oilfield, promising investment of $5 billion over four years.

The Payakha oilfield project includes the construction of six crude oil processing facilities, a crude oil port capable of handling 50 million tonnes a year, 410 kilometres of pressurized oil pipelines, a 750-megawatt power station and an oil storage facility. This could become Russia and China's second energy project after Yamal[20].

Yamal LNG and Arctic LNG-2 projects

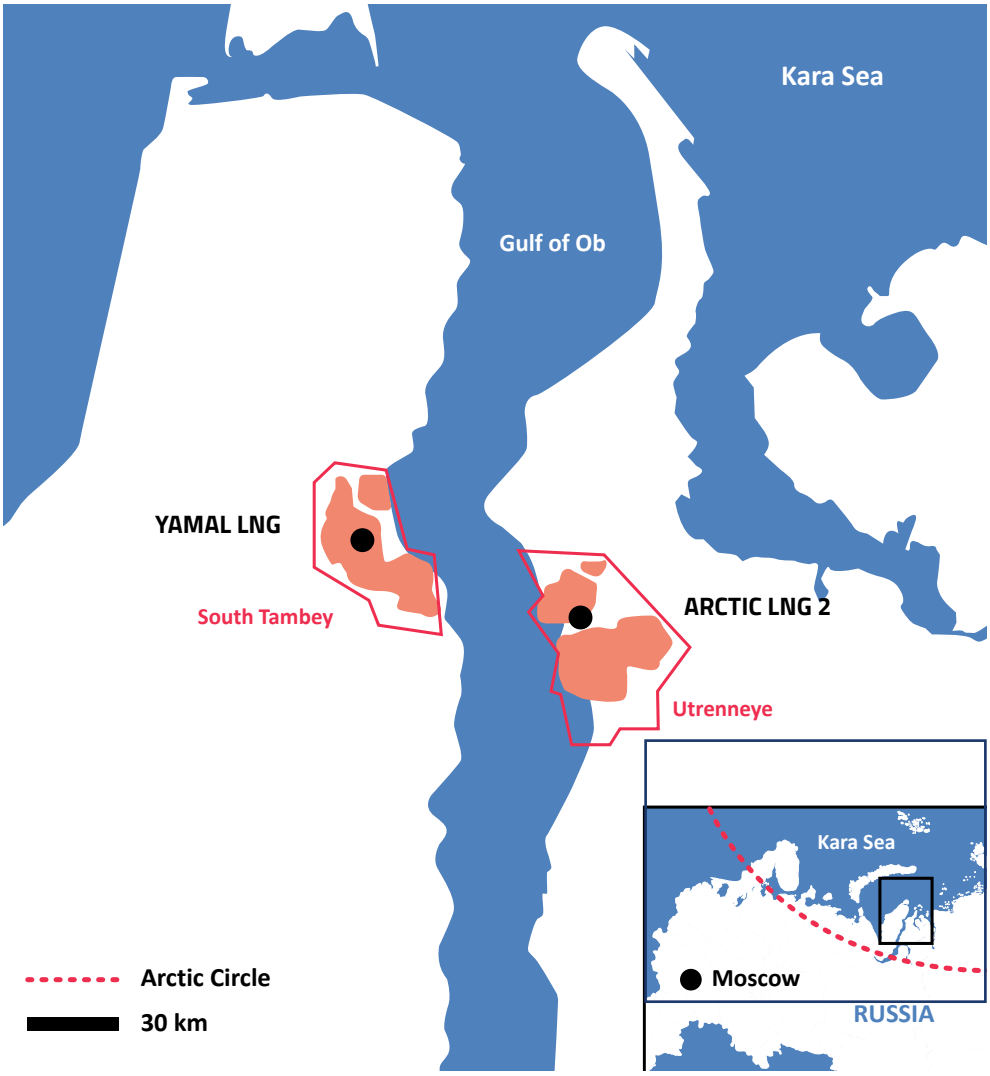


FIGURE 3 - SOURCE: SRM on KOVALENKO A.S., MORGUNOVA M.O., GRIBKOVSKAIA V.V. (2018) *Infrastructural Synergy of The NSR In The International Context*

[20] [https://www.maritime-executive.com/editorials/china-s-arctic-silk-road].

5. Traffic trends of the NSR: Ships and Cargo

Maritime transport via the NSR is the only delivery route for natural resources originating in the remote Arctic regions. In this paragraph we will consider also traffic sailing through the route between ports along the NSR[21].

Transit sailings (along all the route from east to west) on the NSR fluctuated dramatically between 2010 and 2019. In 2010 transits amounted to over 100,000 tons and reached a peak of 1.35 million tons in 2013 after which they fell to 40,000 in 2015, with another rise to 697 thousand tons in 2019. This fluctuation was mainly due to the price of bunker fuel, geopolitical tensions and EU-USA sanctions against Russia (during the Ukrainian-Crimea crisis) and limited icebreaker assistance to escort transiting vessels[22].

Transit cargo through the NSR 2010-2019 (1,000 tons)

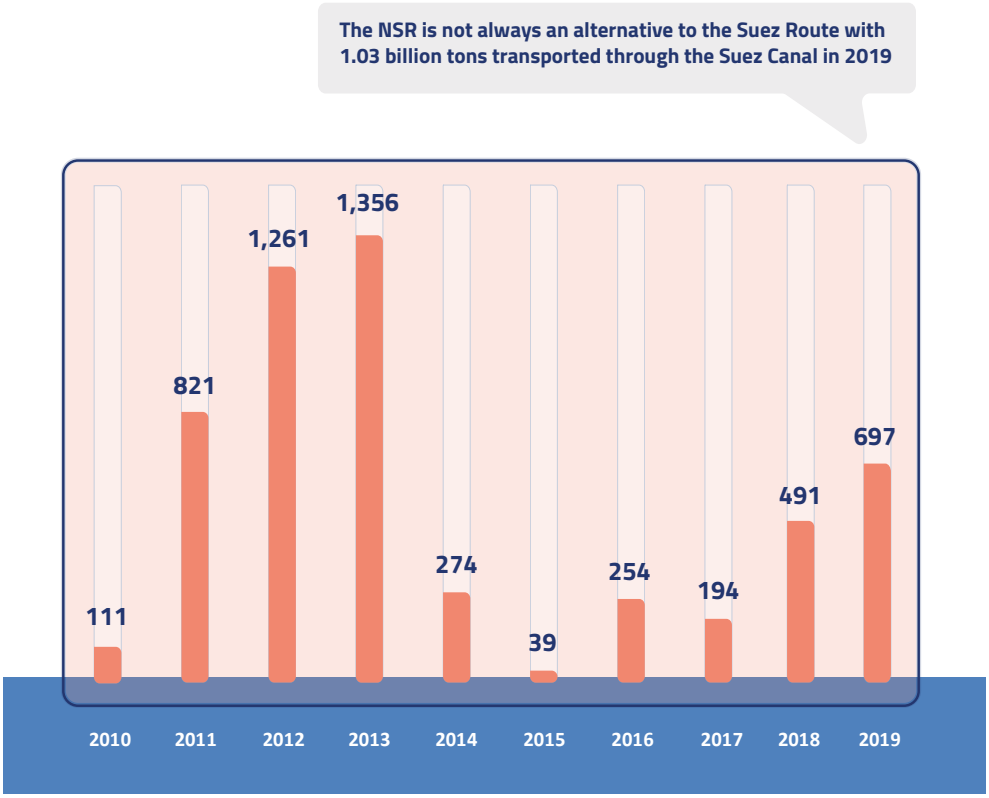


Figure 4 - Source: SRM on CHNL information office, 2020

[21] Most of these information and data come from Business Index North Report, 2019.
[22] For an overview on icebreaker Russian fleet see Intesa Sanpaolo-SRM (2020), *op. cit.*, p. 48.

In 2019, 37 transit voyages were made on the NSR, 16 of which were international transits between two non-Russian ports, which is the highest number ever. The most active shipper was the Chinese shipping company COSCO with 7 international transits. Also, in 2018, the first containership (3,600 TEUs), Venta Maersk, made an international transit on the NSR, between Busan, South Korea, and Bremerhaven in Germany.

Below is the difference in volume and number of voyages between the cargo in transit and the total cargo: the transit cargo is only a part of the entire handling activity on the NSR which is almost concentrated on the Port of Sabetta (55%). In 2019, 31.5 million tonnes were handled in 2,694 voyages, the main products of which were LNG and Oil. Only a part of these were cargoes in transit (697 thousand tons in 37 voyages) in turn characterized by liquid and bulk products.

Transit cargo on the NSR in 2019

Cargo type	Tonnes	Voyages
Liquid	333,499	5
Bulk	175,121	3
General	169,067	13
Fish	12,848	4
Containers	6,742	1
Ballast	0	11
Total	*697,277*	*37*

TABLE 1 - SOURCE: NSR Statistics arctic-lio.com

Total cargo on the NSR in 2019 (thousands of tonnes)

Total volume	**31531.3**
Cargo type	
LNG	18,339.9
Oil and Oil Products	8,162.9
Other cargo	2,768.4
Gas condensate	1,274.8
Transit cargo	**697.3**
Coal,coke, concentraded ore	288
N. Total Voyages	*2,694*

TABLE 2 - SOURCE: NSR Statistics arctic-lio.com

Even in the first quarter of 2020 NRS activity did not stop. In the period January-March of the year, 275 ship voyages were made, an increase of 19% compared to the same period in 2018. However, the NSR can not always be compared to the Suez Route and will not significantly affect the existing schemes of general cargo delivery via traditional routes. It is important to remind that goods in transit through the Suez Canal represent 8-10% of global maritime trade and in 2019 the 18,800 ships that crossed Suez

carried over 1 billion of goods stocks[23].

In addition, while megaships larger than 22,000 TEU can pass through Suez, only ships of much smaller dimensions travel through the NSR.

NSR Traffic in January-March 2020 (N. of Voyages)

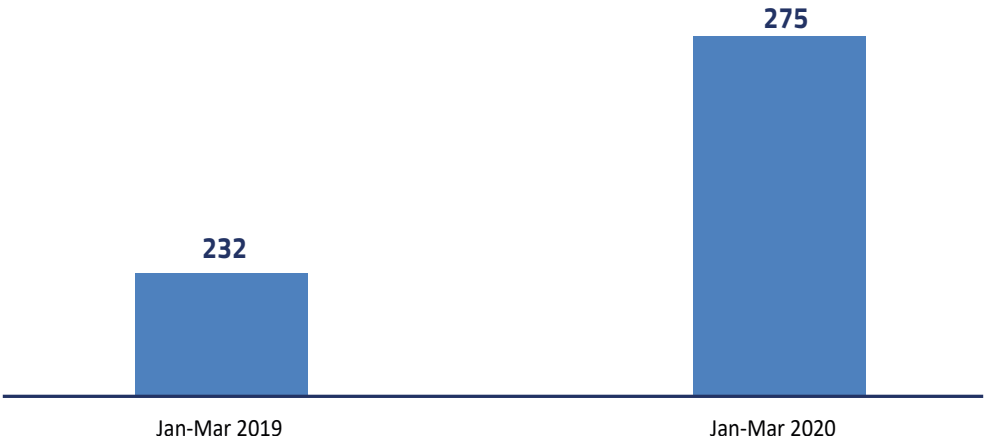


FIGURE 5 - SOURCE: NSR Statistics arctic-lio.com

Cargo on the NSR 1933- 2019

[23] Suez Canal Authority, 2020.

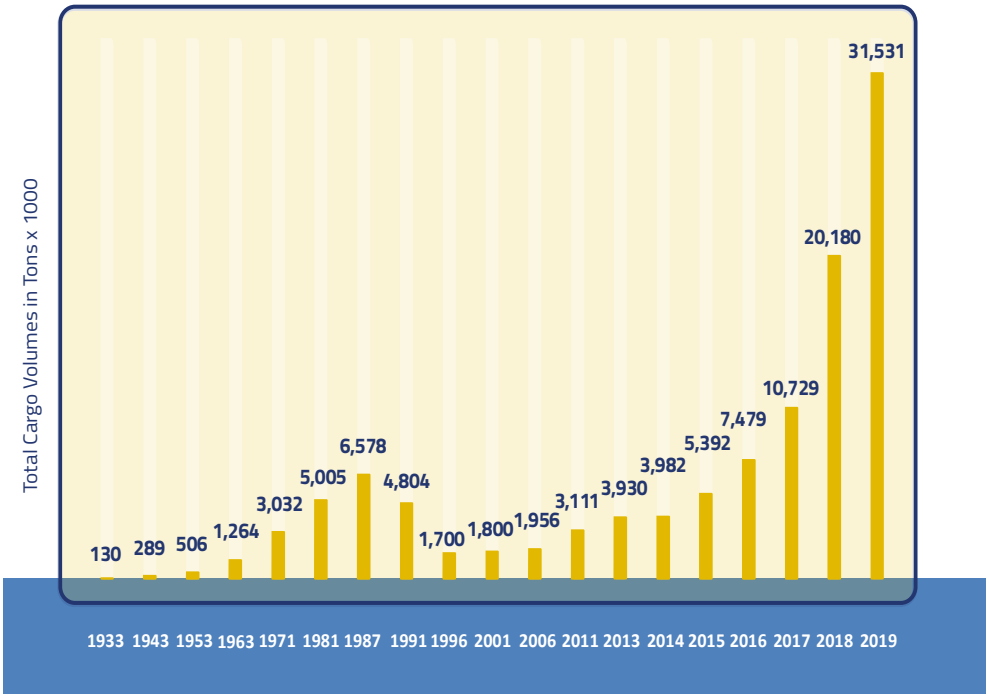


FIGURE 6 - SOURCE: SRM on CHNL information office, 2020

Furthermore, along the traditional Suez route there are many important ports where ships can stop. As a matter of fact, this route is more convenient especially for megaships because it allows more stopovers in strategic and fast growing areas (starting from Shanghai: India, the Arabian Gulf, Suez, Mediterranean also as a base for stopovers in Europe, USA), while along the NSR vessels have long days of solitary navigation before reaching their destination.

Conversely, the NSR could have an additional role especially if the markets around Russian ports and the Baltic area grow quickly. As a matter of fact, the future of the NSR significance lies in its role as a transport corridor along the Eurasian Arctic Coast and between the Eurasian Arctic and port destinations and markets in the Atlantic and Pacific. But the primary use of Arctic Ocean shipping has been to support other industries heading farther north, like mining and oil drilling.

The total volumes exchanged between the ports along the NSR have increased more than fivefold over the last 10 years.

In fact, volumes began to grow in 2010 due to the increasingly favorable conditions for maritime transport linked to the melting of ice and reached 7.5 million tons in 2016, 10.7 million tons in 2017, increased in 2018 and then touched 31.5 million tons in 2019. The shipping volumes constitute an increase of more than 57 percent from last year. The lion's share of NSR ship traffic is related to the liquified natural gas produced by Novatek.

Russian government officials predict cargo volumes on the NSR as high as 92.6 million tons (in order to provide a comparison, this is equal to 60% of the Italian export) per year by 2024, and by 2030 they hope to add a significant part of international transit to that[24]. Russia expects shipping along the NSR to increase more than fourfold by 2024 compared to 2018 levels.

Deepening the analysis by type of ship (latest data available to 2018), a total of 227 ships transited the NSR in 2018, for a total of 2022 journeys. The number of vessels decreased over 2017, but the number of trips increased. The number of oil tankers and of the general cargo is greater.

Of the 2,000 vessel voyages that crossed the NSR, 25% were realised by 53 states that are not part of the Arctic region. Among these there was also Italy, ranking 4th in Europe, 16th among the non-Arctic states and 27th in the world by number of ship voyages.

NSR cargo traffic (million tons) 1987-2030

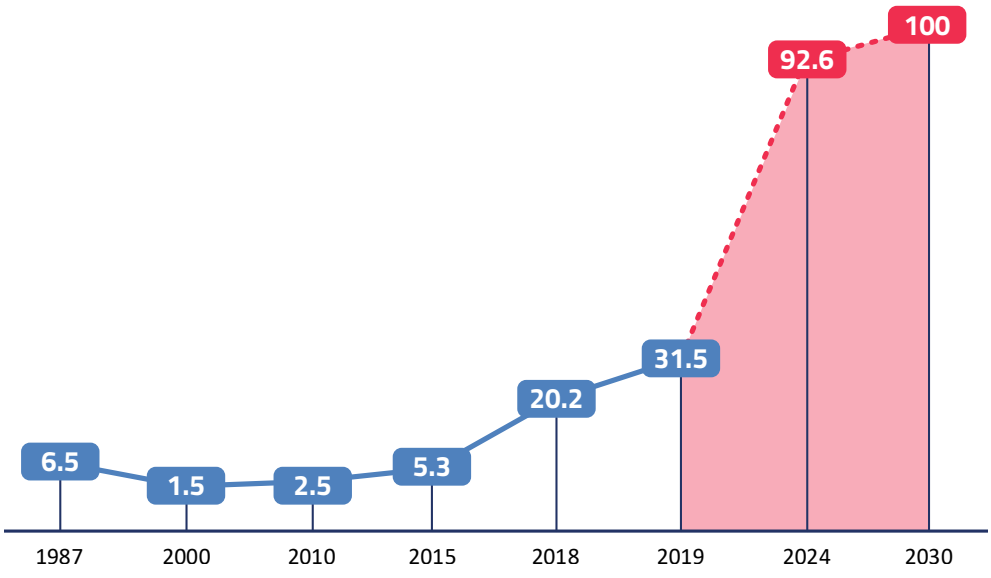


FIGURE 7 - SOURCE: SRM on roscongress.org

[24] Alexey Likhachev, Director General of ROSATOM, at the 5th International Arctic Forum "The Arctic – Territory of Dialogue", April 2019.

Types of vessels and number of voyages for each vessel type on the NSR in 2017 and 2018

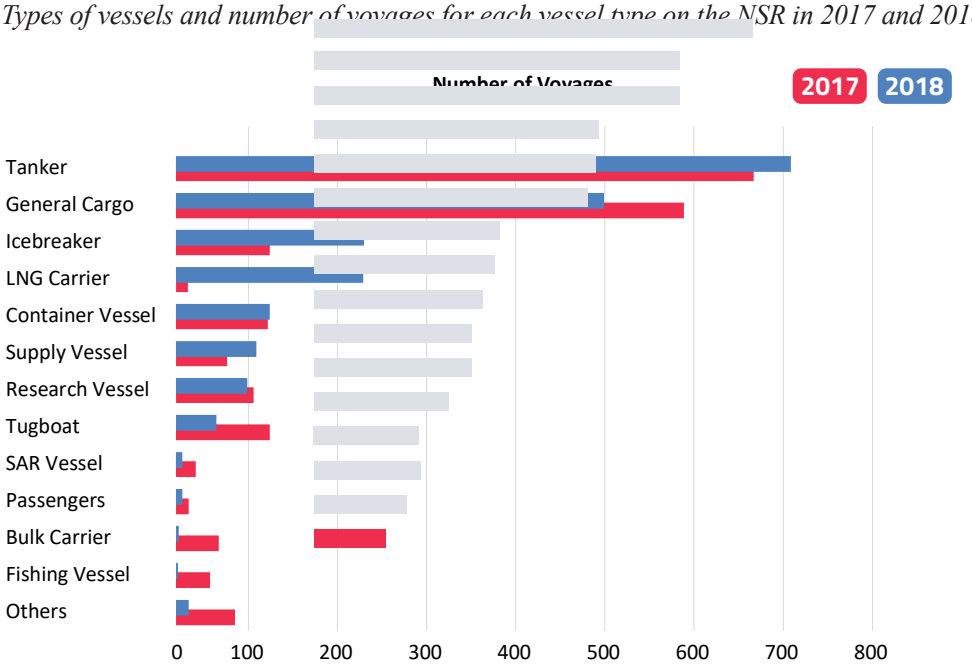


FIGURE 8 - SOURCE: SRM on roscongress.org

Non-Arctic countries passing through the NSR

Ranking	Flag	Vessel voyages
1	Panama	**48**
2	Netherlands	**39**
2	Bahamas	**39**
4	Marshall Islands	**33**
5	UK	**31**
6	Liberia	**30**
7	Malta	**21**
8	Antigua and Barbuda	**20**
9	Cyprus	**18**
10	Hong Kong	**17**
10	Germany	**17**
12	Singapore	**14**
13	St-Kitts & Nevis	**12**
13	China	**12**
15	France	**10**
16	**Italy**	**7**

Note: Netherlands including Curacao; UK including Gibraltar, Bermuda, Caymans I, Falkland I., France in- cluding Wallis et Futuna, TAAF.

Table 3 - Source: Arctic Shipping Summit 2019

6. Comparison between Global Routes

The NSR allows a reduction in transit times of the intercontinental east-west connection between Asia, Middle East, Europe and the east coast of the United States.

This route, usually open between July and November, offers a considerable potential for development due to the large energy resources present in the area. The US Geological Survey estimates indicate that within the Russian Arctic EEZ (exclusive Economic Zone) some 30% of all Arctic recoverable oil and 66% of its total natural gas is to be found. The USGS estimates total Arctic oil recoverable reserves to be about one-third of total Saudi reserves.

However, despite the obvious savings in terms of distance and the recent improvements in infrastructure to support the safety of navigation, the Arctic Route has some considerable operational limits due to the unpredictability of weather. This usually requires a sailing cruise of about 10/15 knots which allows ships and vessels to anticipate problems linked both to the presence of icebergs and to the need for a sudden change of direction in case of uncertainty with respect to the depth of the muddy bottoms – with constant changes depending on the meteorological conditions, often unsuitable to the passage of large ships. This type of restriction makes the route difficult for the regular container services and it is also complex with respect to the flows of oil products and grains. Even in future scenarios involving a possible extension of the period of navigability, due to higher average temperatures in the area, the Arctic Route will have a very marginal role and will be complementary to the transits in the Suez Canal, unable to be a real alternative for all the main flows that use the Suez route.

Nevertheless, the distance between the ports of north-western Europe and the Far East is reduced by about 40% using the NSR as an alternative to the Suez Canal. If only one of the main routes is considered as the Shanghai-Rotterdam route, the NSR allows for a time saving of around 22%. Therefore, the NSR has attracted the interest of shipowners and shipping companies due to its shorter distance and, therefore, the shorter time spent than the other long-haul routes connecting the ports of origin / destination of the ‘Atlantic and Pacific.

Analysis of the distance and time of navigation of some routes between Asia, Northern Europe and Canada

The Shanghai-Rotterdam case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	**8,031**	**22**
Suez	10,525	29
Cape of Good Hope	13,843	38
Panama	13,411	37
The Yokohama-Rotterdam case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*

Northern Sea Route (NSR)	**7,010**	**19**
Suez	11,133	31
Cape of Good Hope	14,448	40
The Vancouver-Hamburg case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	**6,635**	**18**
Suez	15,377	43
Cape of Good Hope	18,846	52
Panama	8,741	25
The Hong Kong-Hamburg case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	**8,370**	**23**
Suez	9,360	27
Cape of Good Hope	13,109	37
The Singapore-Hamburg case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	**9,730**	**26**
Suez	8,377	23
Cape of Good Hope	11,846	33

Note: Average speed 15 knots (at the moment on the NSR the average speed is max. 10 knots).

From the analysis on distances with the port of Hamburg, it also turns out that Ho Chi Minh City could be considered a point of indifference (a point at which two alternatives under consideration are the same) since travel times between the German and Vietnamese ports are the same via Suez or the NSR.

TABLE 4 - SOURCE: SRM on www.sea-distances.com and Didenko 2018

However, from the table below it is clear that the NSR has some competitive advantages on some routes that originate or travel to the northern areas of China and Northern Europe while it is not competitive for Singapore and Central/Southern Europe. Indeed, for a Mediterranean port such as Genoa, there will not be very big changes, as the routes they use will not really be affected by increased travel in the Arctic.

Analysis of the distance and time of navigation of some routes between Italy, Asia and Canada

The Shanghai-Genoa case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	10,239	31
Suez	**8,670**	**24**
Cape of Good Hope	13,619	38
Panama	13,782	38
The Yokohama-Genoa case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	9,218	28
Suez	**9,325**	**26**
Cape of Good Hope	14,271	40
The Vancouver-Genoa case		

Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	9,096	27
Suez	13,511	37
Cape of Good Hope	18,462	51
Panama	**9,232**	**26**
The Hong Kong-Genoa case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	10,831	33
Suez	**7,893**	**22**
Cape of Good Hope	12,837	36
The Singapore-Genoa case		
Route	*Distance (in nautical miles)*	*Hypotetical days of Navigation*
Northern Sea Route (NSR)	12,191	36
Suez	**6,433**	**18**
Cape of Good Hope	11,531	32

Note: Average speed 15 knots (at the moment on the NSR the average speed is max. 10 knots).

From the analysis on distances with the port of Genoa, it also turns out that Yokohama port could be considered a point of indifference; a point at which the two alternatives under consideration have a very close difference: only 107 miles less via NSR than via Suez.

Table 5 - Source: SRM on www.sea-distances.com and Didenko 2018

7. China's interests in the NSR

Over the past decade, Russia and China have cooperated mainly on oil and gas focusing on the Russian Far East and Eastern Siberia. Also, for this reason, the Arctic, where an important share of these resources is concentrated, has gradually become part of the negotiations.

In July 2017, China and Russia signed the "Joint China-Russia Declaration on further strengthening the global, strategic and cooperative partnership". The declaration includes the North Sea route as a strategic area of cooperation, as a formal part of China's Belt and Road Initiative (BRI) infrastructure. For its part, Russia is investing significant resources in the development of new ports and infrastructure for LNG along the route to serve growing maritime traffic passing through its Arctic territorial waters.

China is increasingly interested in the NSR and the Dragon has entered the Arctic Route in the Belt and Road Initiative (BRI) and COSCO has made several trips across the Arctic sea.

The three paths of the Chinese BRI

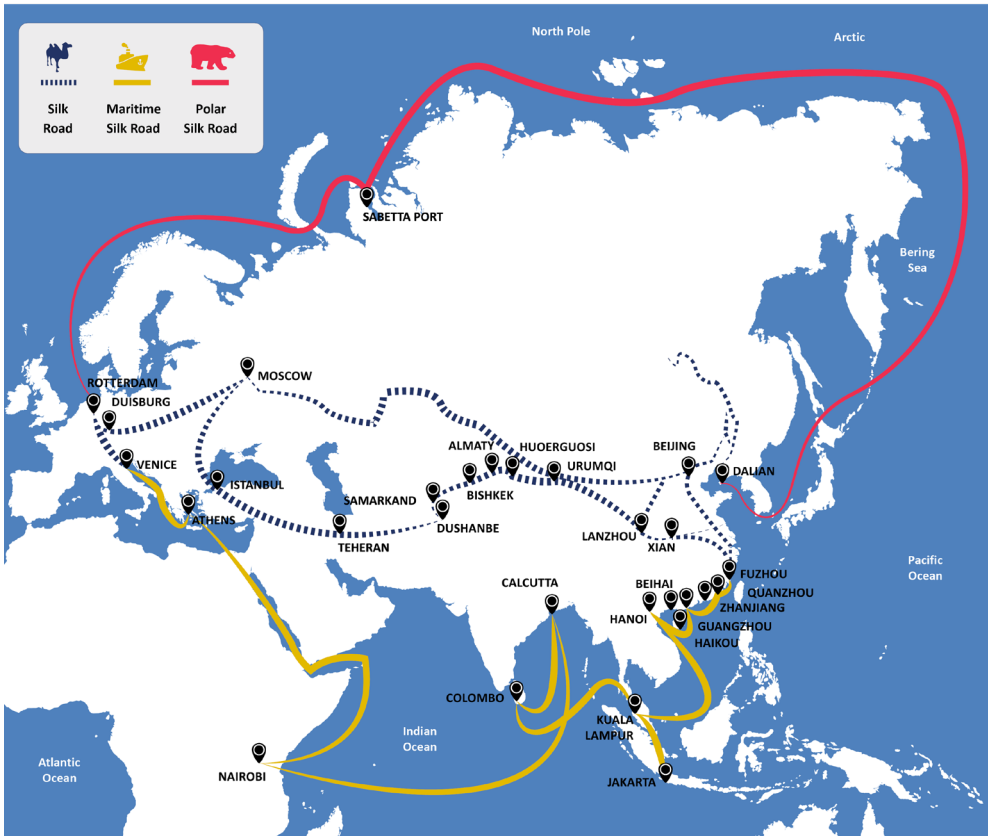


FIGURE 9 - SOURCE: SRM on China's Development and Reform Commission, The Arctic Institute, National Snow and Ice data Centre, Reuters

On January 28, 2018, China published the "Vision for Maritime Cooperation Cooperation under the Belt and Road Initiative"[25] as part of the BRI Initiative indicating the Arctic as one of the priorities. The document states that China is gearing up to build a "polar silk road" together with the Arctic coastal countries, especially Russia. The Polar Silk Road is the "3rd way" of connection with the Eurasian Economic Union.

In this official document[26], we can read that China intends to build the "polar silk road" through the development of Arctic sea routes in collaboration with all states that have an interest in the Arctic. It encourages its companies to participate in the construction of infrastructure along these routes and to conduct test commercial trips in accordance with the law in order then to pave the way for their regular commercial operation. As the Chinese Arctic Policy notes, "The use of sea routes, exploration and development of resources in the Arctic can have a huge impact on China's energy strategy and economic development."

The Arctic shipping routes, particularly the NSR, are called "blue economy corridor"

[25] For an overview on BRI see also INTESA SANPAOLO-SRM (2020), *op. cit.*, p. 43.

[26] The State Council Information Office of the People's Republic of China, China's Arctic Policy, The State Council Information Office of the People's Republic of China, January 2018.

due to saving in costs and time for connecting Western Europe and China. In 2013, Chinese shipping company COSCO sailed the first-ever multipurpose ship through the NSR. In addition, in 2015, five COSCO vessels sailed through the icy route, which is a record for this company. Furthermore, China has built an Arctic cruise ship for the Polar Silk Road which is the first polar expedition cruise ship built by China Merchant Group and delivered in September 2019[27].

In 2015, Chinese banks lent $12 billion to the Yamal liquefied natural gas (LNG) project[28], which lies in the middle of the NSR and is expected to supply China with four million tonnes of LNG a year, according to the state-run China Daily.

China holds a 30% stake in the project of the liquefied natural gas plant at Sabetta on the Yamal Peninsula, Russia. In addition, the first liquid natural gas shipment went to China last summer via the NSR. China is building a second icebreaker able to cruise polar waters. The Chinese government, as well as government-linked firms and individuals, have invested significant funds in the Arctic. Table 6, adapted from a 2017 CNA report, summarizes overall patterns of Chinese investment in select Arctic countries. Chinese investments in Greenland ($2 billion) and Iceland ($1.2 billion) represent a significant percentage of each country's annual GDP.

CNA Report[29] estimates that China has invested over $1.4 trillion in the economies of the Arctic nations (including Finland and Sweden), $89.2 billion of which was in infrastructure, assets, or projects.

As a matter of fact, there are big projects now for the extraction of oil and gas in the Barents Sea and the Kola Peninsula.

Chinese Investment 2012-17

Target Country	Chinese Investment as percentage of GDP	Total Value of Chinese Investment (billion dollars)	Average Size of Chinese Investment per project (million dollars)
Greenland	11.6	2.0	33.4
Iceland	5.7	1.2	30.8
Russia	2.8	194.4	691.7
Canada	2.4	47.3	442.1
United States	1.2	189.7	340.6
Norway	0.9	2.5	147.9

Table 6 - Source: CNA

8. China-Russia oil traffic

"Only 10 years ago Russia, the world's second oil exporter after Saudi Arabia, was hardly exporting any oil to Asia, with the vast majority of its trade being with Western

[27] [docksthefuture.eu/chinas-polar-silk-road-a-threat-or-an-opportunity].

[28] For an overview on investments see also the previous paragraph "Investment and perspectives of the NSR" in the same chapter, p. 152.

[29] Rosen M.E., Thuringer C.B. (2017), *Unconstrained Foreign Direct Investment: An Emerging Challenge to Arctic Security*, CNA Corporation (US).

countries, either seaborne or by pipelines.

As strains between Russia and the European Union mounted, and as the Asian economies expanded, the Russian government decided to diversify oil export routes.

The main element has been the investment in the Eastern Siberia–Pacific Ocean oil pipeline (ESPO) from East Siberian oil fields to the Far East port of Kozmino near Nakhodka. The pipeline was built and operated by Russian pipeline company Transneft"[30].

9. The Russian ports of the Arctic

According to the expert opinion of KPMG, the contribution of the North Sea route to Russia's GDP will be equal to 2% per year (by 2050)[31].

According to recent estimates, 65% of all hydrocarbon reserves in the world are in the Arctic. Most of them (60–65% according to the Ministry of Natural Resources) are located on Russian territory.

In addition, the cost of the development project of the NSR is estimated at 734.9 billion rubles until 2024. Of these, only 274 billion rubles come from the state budget.

Almost all the major ports along Russia's northern coast are experiencing a significant increase in goods volumes. Operators of seaports in the Arctic Basin handled 78.6 million tonnes in September 2019 (+17.5%, year-on-year) equal to 12.3% of total Russian ports. Of the total Arctic basin, 23.5 million tons are dry goods (+4.1%) and 55.1 million tons are liquid bulk goods (+24.2%).

In Sabetta, the new port in the Yamal Peninsula, the year-on-year growth for the first 9 months of the year is as big as 1.9 times. A total of 20.7 million tons of goods were handled in Sabetta in the period. "The growth in Sabetta is driven by the shipments of LNG from Novatek's Yamal LNG plant.

Russian Arctic ports

[30] Hellenic Shipping News (17 December, 2019), *Far East Russia Crude Oil Exports: A Legitimate Tanker Play?* [https://www.hellenicshippingnews.com/far-east-russia-crude-oil-exports-a-legitimate-tanker-play/].

[31] 5th Eastern Economic Forum, 2019

FIGURE 10 - SOURCE: 5th Eastern Economic Forum, 2019

By the end of the year, a fleet of 15 major ice-class Arc7 LNG carriers will shuttle to the terminal to pick up the liquified natural gas. Also, in Murmansk, the growth in shipping continues. In the first 9 months of the year, the increase was 2.8 percent. In the same period, the ports in the Kola Bay handled 46.4 million tons. That includes coal, construction materials and processed materials produced by the region's powerful mining and metallurgic industry. The positive development in Murmansk follows a year with major growth. In 2018, the regional terminals had their best year in several decades. More than 60.7 million tons of goods were then handled by the Murmansk port installations, an increase 18.1% higher than the previous year. Also, the terminal in Varandei experienced growth in the 9 months of 2019. In this period, the infrastructure located on the coast of the Pechora Sea handled 5.4 million tons of goods, an increase of 4.5 percent on 2018. The Varandei terminal is owned by Lukoil and handles exclusively oil from nearby fields in the Timan Pechora area"[32].

10. CONCLUSIONS

Throughout the centuries the Arctic Route has been a merely fascinating challenge, a passage evocating unspoiled glacial and polar nature, hard to dominate. Nevertheless, new technologies from one side and climate change on the other, are currently triggering potential developments that will have implications on the maritime trade, energy supply as well as on geo political aspects.

As has been noted, three main passages along the Arctic Ocean could become a short-cut between Asia, Europe and North America: the Northwest Passage, the Trans Polar Route and the Northern Sea Route (NSR) which is likely to be free of ice sooner and thus repre- sents the highest commercial potential.

The first containership test along the NSR was done in 2018: Venta from Maersk, a vessel of about 3,600 TEUs, made the international transit between Busan in South

[32] [https://thebarentsobserver.com/en/industry-and-energy/2019/09/big-growth-russian-arctic-ports].

Korea to Bremerhaven in Germany through the Arctic. The transit was 40% faster than on the same journey through the Suez Canal. A similar journey from China to Northern Europe was 20% faster (one week).

A shorter way means lower costs and higher economies of scale for shipping industry and this may foster a growing interest to exploit the potentialities of the new route.

In fact, in 2019 the route was open to shipping for 30% of the year from July to the beginning of November over a period of approximately 14 weeks during which only 16% of ships required icebreakers. The deliveries to ports (transit cargo) in the water area of the NSR amounted to almost 700,000 tons of goods.

If we consider the overall volumes traded along the NSR the number is impressive: more than 200 ships in over 2,000 voyages travelled on the NSR – especially tankers and general cargos – transporting 31.5 million tons in 2019, a more than threefold growth over the last 10 years. A trend expected to reach 92.6 million tons by 2024 with an increasingly signifi- cant international traffic.

These figures are not only important to understand the impacts on maritime trade but also to analyze potential evolution in energy trade because of the estimated huge reserves of oil and liquid gas in the Arctic Region. The interest to develop the Arctic Route is now for real, there are many key questions that need to be addressed to fully understand the impact of the NSR on maritime economy and for shipping industry.

Opportunities have been highlighted clearly: shorter transit times between Asia and Europe, huge local oil and gas resources, development of cruise sector and the perspective of the Arctic becoming a touristic destination. At the same time, it has been distinctly stated that there are still huge limits and constraints that prevent to exploit these opportunities for now.

As matter of fact traveling along the NSR requires additional investment and thus produces extra costs that can counterbalance the advantages. Similarly, the limited size of the vessels that can navigate the Arctic Route (because of the ice and icebreakers tracks) compared to Ultra Large Containers Vessels passing through the Suez Canal increase the relative opportunity cost of using the NSR.

These elements together with the fact that containerships need to have stable regular services to be rentable and that the area around the NSR is nowadays deprived of good nautical services and advanced infrastructure, prevent full and immediate exploitation of the new route for commercial purposes. Additional problems are also posed by the lack of accident response, search & rescue infrastructure, high insurance fees and poor charting of the area.

At world level, the public opinion is increasingly more sensitive to and aware of environmental consequences. A point also related to the social responsibilities of companies, shipping carriers, big energy players and banks.

The potential increase of naval traffic in the Arctic and the related expansion of more fuel-consuming icebreakers and ice-resistant ships entail significant repercussions for polluting emissions, which could offset the reduction in CO_2 associated with the shorter northern routes.

Climate change and environmental impact are expected to remain limits (both in terms of reputation and costs) for the ordinary use of Arctic as a transoceanic global

shipping route. However, it is less obvious whether these elements will restrain local cargo traffic and regional energy exploitation especially if one considers the transparency of politics and the weight of the public opinion of some countries.

Although the analysis clearly points out that, in the near future, the Arctic will not become an alternative to the Suez route for Europe-Asia trade – due to reasons involving costs, legal framework and environment – the NSR could still have a strong local and regional role. This is particularly true if the markets around Russian ports and the Baltic area continue to grow as quickly as they have in the last 10 years.

At the beginning, the NSR importance will probably lie in its role as a local transport and energy corridor along the Eurasian Arctic Coast and between port destinations and markets on the Atlantic and Pacific adjacent sides.

In addition, a geo-political context still in balance between competition and cooperation. Will the Covid-19 pandemic change the game?

Due to its natural and geographical characteristics, the Arctic Region (and the NSR) is the field of an active and geo-strategic positioning of three main players: Russia, China and the United States.

The global economic crisis and dramatic drop in World trade due to the Covid-19 are expected to strongly affect the economies of the key players in the Arctic – China, Russia, US and the EU – reducing, at the same time, cargo shipping trade and oil and gas global demand. These circumstances will probably result in a momentary lower interest in the Arctic Rou-te, at least in the short term and especially from non-littoral countries.

As noted by The Economist last April 18th in its cover, one of the key questions is whether China will manage to go through the pandemic supported by its international care aid, the so-called mask diplomacy, or the blame game will prevail. It might also be the case that accusations of scarce transparency and delayed information about the virus will gain so much ground that China's reputation will be hit dramatically and for a significant period of time with negative consequences for its trade flows and for the implementation of the BRI projects.

A further point to consider regards how severe the crisis will be in America and the timeliness of economic recovery alongside the next presidential elections in November.

Whatever the answer to these questions, it seems likely that – in the near future – the US and China will be more focused on their national core issues than on the Arctic. On the other hand, differently from the other players, Russia, being a littoral country, might be tempted to take advantage of the situation.

Finally, the Covid-19 pandemic will probably increase the global public opinion's level of attention towards air pollution and environmental issues. It is precisely in this context that a more active European Union, able to play a balanced and strategic role to blend economic development of the Arctic with high standards for the preservation and defence of this unique environment, could make a difference.

Without the European "voice" the risk is that competitive approaches will prevail over cooperative attitudes but to avoid this, the EU will need to reach a more united and assertive political stance.

Will this be a positive legacy of the Covid-19 pandemic for the Arctic future?

Chapter IX

The challenge of Arctic preservation: environmental and climatic framework

For centuries the Arctic has been a remote region also in the collective imagination, yet it has recently become the object of growing interest for international organizations (namely, the United Nations through its International Maritime Organization agency), regional fora like the Arctic Council and lobbies / NGO concerned about the effects of climate change. The chapter aims at examining the main environmental risks associated with the intensification of maritime traffic and the increased use of natural resources in the area, while also presenting the initiatives taken so far to address such issues.

1. The shape of things to come: an overview of climate change in the Arctic

The North Pole is undergoing a process of profound and rapidly evolving transformation: recent findings from a working group within the Arctic Council[1] show that the region is shifting into a new state, driven by rising temperatures caused by increases in greenhouse gas concentrations in the atmosphere. In particular, the annual average surface air temperature rose by 2.7° from 1971 to 2017, with higher figures during the cold seasons: even more worryingly, in the same period those temperatures rose 2.4 times faster than the Northern Hemisphere average. Such phenomenon has been explained[2] to be driven by a series of "feedback loops" that cause accelerated Arctic ice loss.

The ice-albedo[3] feedback loop, for example, is a major contributor to Arctic ice loss and can be summarized as follows: reduced sea ice coverage increases the proportion of open water exposed to solar radiation, which lowers the surface albedo and amplifies the absorption of solar radiation in the area; in turn, increased solar absorption warms the ocean surface and leads to augmented melt of the remaining ice pack, thereby exposing more areas of open water and feeding the cycle.

[1] Arctic Council (May 2019), "Arctic Climate Change Update 2019", *Arctic Monitoring and Assessment Programme* [https://oaarchive.arctic-council.org/bitstream/handle/11374/2353/ccupdate18.pdf?sequence=1&isAllowed=y]. For more details about the Arctic Council and other international entities related to Arctic governance, see Intesa Sanpaolo-SRM (2020), *The Arctic Route. Climate change impact, Maritime and economic scenario, Geo-strategic analysis and perspectives*, pp. 61-81.

[2] Andrews J., Babb D., Lin Y., Becker A., Ng A.K.Y. (2018), "Implications of climate change for shipping: Opening the Arctic seas", *Wiley Interdisciplinary Reviews: Climate Change*, 9(2), e507 - 2018. DOI: 10.1002/wcc.507.

[3] A surface's albedo is a measure of how reflective it is of sunlight: the lower the albedo, the more absorbing of solar rays (and heat) the surface is.

Sea ice-albedo feedback cycle

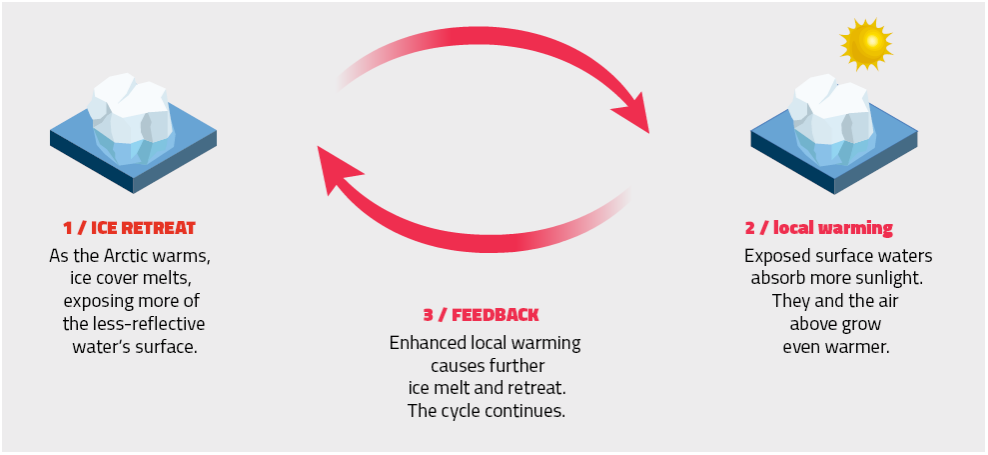


FIGURE 1 - SOURCE: SRM on University of California, Center for climate science, 2019 [https://newsroom.ucla.edu/topics/environment]

The implications of the retiring of ice are several: not only larger portions of northern seas become relatively frost-free and open to navigation – especially during the warm season and along the NSR – but also higher volumes of fresh water flow into the Arctic Ocean, which in turn affect circulation, nutrient levels, acidification and biological productivity. In addition, since sea ice is the greatest physical constraint on Arctic shipping, the ramifications of its fast-paced melting are ample for both the development of the main maritime routes in the region[4] and the global shipbuilding sector. As a matter of fact, only vessels with some measure of ice strengthening (in terms of hull hardness, design and thickness) can operate within sea ice, thus also orienting the production plans of shipyards around the globe (mainly concentrated in China, Japan and South Korea).

The potential increase of naval traffic in the Arctic and the related expansion of more energy-consuming manufacturing of ice-resistant ship structures entail significant repercussions for greenhouse gases emissions, that some academics argue could counterbalance the reduction in CO_2 associated with navigating the shorter northern routes[5].

Furthermore, it must be noted that the shipping industry has traditionally relied upon heavy gasolines that belong to some of the most polluting fossil fuels and generate a broad spectrum of emissions, including CO_2 and short-lived climate forcers such as sulphate aerosols and black carbon: although the total emissions from Arctic shipping with a fully operational NSR may be relatively small on a global scale, the impact of these emissions in a climate-sensitive area like the Arctic could be profound.

[4] An overview of the main sea routes in the Arctic region is provided in INTESA SANPAOLO-SRM (2020), *op. cit.*, p. 7.

[5] GILLE J., VAN HUSSEN K., WHITEMAN G., YUMASHEV D. (2017), "Towards a balanced view of Arctic shipping: estimating economic impacts of emissions from increased traffic on the Northern Sea Route", *Climatic Change*, 2017 doi:10.1007/s10584-017-1980-6.

The 1981-2010 average maximum (March) and minimum (September) sea ice extent. Three northern shipping routes / regions have been added: the Northwest Passage (NWP), the Northern Sea Route (NSR) and the Transpolar Sea Route (TSR)

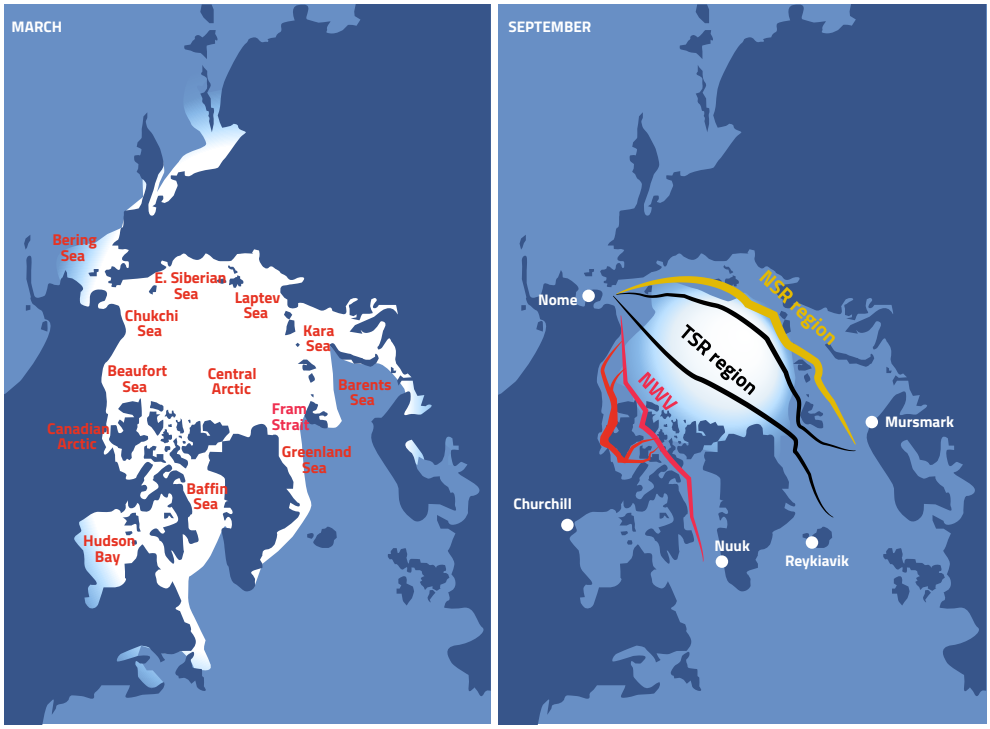


FIGURE 2 - SOURCE: SRM on U.S. National snow and ice data Center, Arctic sea ice news and analysis, 05-10-2016 [https://nsidc.org/arcticseaicenews/2016/10/]

This is particularly relevant for black carbon, which reduces the mentioned surface albedo effect when it is deposited on white ice sheets and snow: the related negative effects are further exacerbated by the stable atmosphere in the Arctic, that increases the lifetime of the sediment and extends the period over which it causes additional warming.

The combined effect of pollutants and non-human related changes in temperature and atmospheric pressure also impacts on two more dimensions of Arctic sea ice:

a. Extent, or the total area with sea ice concentration above a selected threshold (typically 15%), which determines both the width of navigable surface and the length of the ice season;
b. Thickness, defined as the width of ice between the liquid ocean and the atmosphere,

whose measurement defines which ice strengthened ships can navigate through it[6].

The coverage, extent and thickness of sea frost are the most relevant factors establishing the possibility for actual navigation in the Arctic in ice-free conditions during the warmer season (from June to October): many studies[7] estimate these conditions may occur for as many as 78 days in 2025 up to 125-192 days by the end of the century. These forecasts positively contribute to the economic feasibility of Arctic shipping in the mid-long run, but also beg questions on the environmental impacts of an intensification of maritime traffic in the high north. The main concerns can be summarized in two categories:

1. Regional impacts.

   An extensive loss of sea ice and glaciers entails dramatic upheavals in the Arctic flora and wildlife in terms of altered food chain and biodiversity, since higher temperatures and increased flows of fresh water will inevitably change the chemical composition of the northern seas. The gradual development of Arctic sea traffic, coupled with fishing and ancillary activities, is going to affect live resources and possibly favor some species at the expense of others. The increase in sea level will cause more damages to offshore platforms, port facilities and energy corridors.

2. Global ramifications.

   Recent studies[8] show that Arctic glaciers - led by the Greenland Ice Sheet – have been the largest land-ice contributors to global sea level rise (as they accounted for roughly 30% of the total sea level rise that occurred from 1992 to 2017), while other researches indicate that this trend is going to intensify in the future (Figure 3). In addition to storm surges and high tides that will worsen flooding in many regions worldwide, an increase of the water mass of this extent is also going to provoke energy-intensive climatic events like hurricanes.

In this regard it is interesting to notice how, irrespective of the actual accuracy of the various estimates on the matter, several international bodies consider a remarkable change in the shape and composition of the Arctic as inevitable in the next 30 to 80 years, observing that the efforts to reduce greenhouse gas emissions can only limit the extent of climate change even in the most optimistic scenarios. This vison of an unavoidable alteration of the climate in the decades to come is shared also by the United Nations through its "Framework Convention on Climate Change of 2014", a document that adopted a practical approach based more on the concept of adaptation, rather than mere

[6] The different classes of hull-reinforced vessels are defined according to the international guidelines set out in the "Requirements concerning Polar Class" by the International Association of Classification Societies at the behest of the International Maritime Organization (IMO). The classification encompasses a range varying from open water vessels (capable of travelling in ice up to 15 cm thick) to Polar Class ships that can travel in sea ice several meters thick.

[7] Khon V.C., Mokhov I., Semenov V.A. (2017), "Transit navigation through the Northern Sea Route from satellite data and simulations", *Environmental research letters*, 12(2) 2017.

[8] "Mass balance of the Greenland Ice Sheet from 1992 to 2018", Nature, 10-12-2019 https://www.nature.com/articles/s41586-019-1855-2. The study, conducted by NASA and the European Space Agency, also forecasts an approximate 70 to 130 millimeters of global sea level rise by 2100 if the average rate of Greenland's ice loss continues.

opposition to the environmental challenge[9].

Projected mass loss from local glaciers, ice caps and Greenland Ice Sheet for 2030 and 2080, expressed in millimeters of sea level equivalence under a moderate climate change scenario (RCP 4.5)

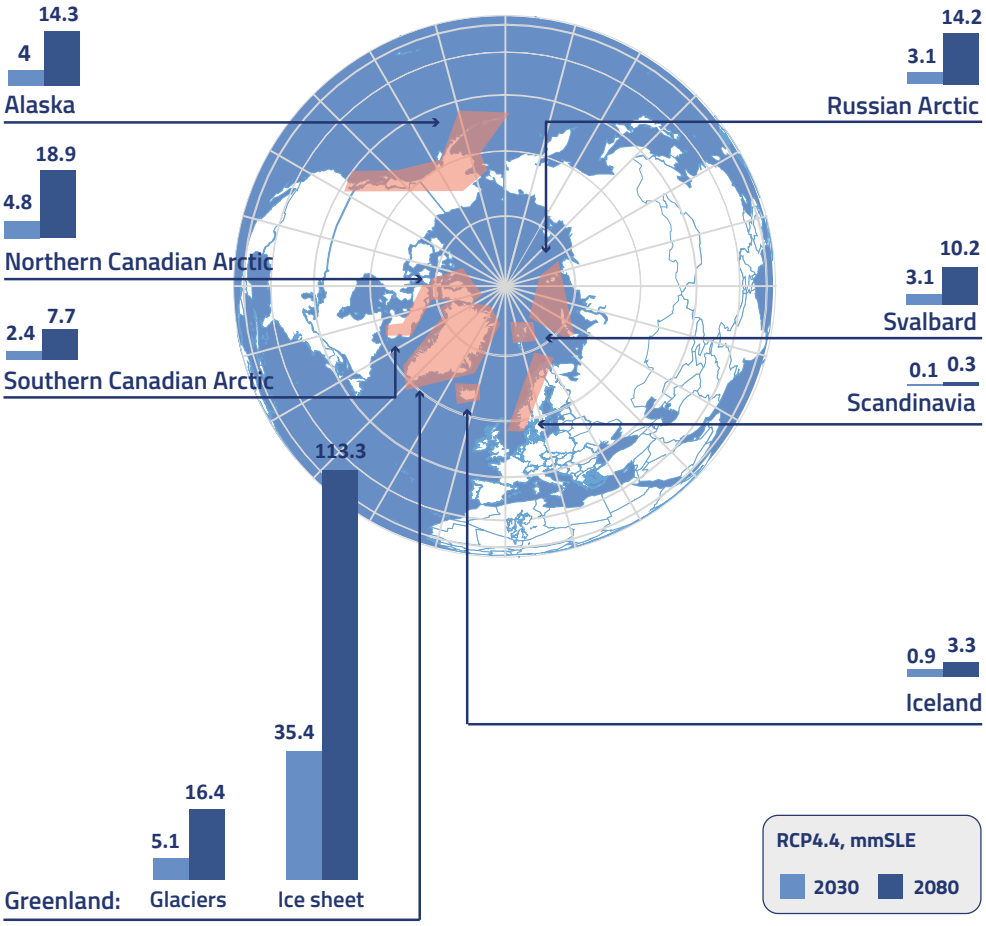


FIGURE 3 - SOURCE: Arctic Climate Change Update 2019, supra note 1

Several researchers seek to model container flows, and, with the results or indications,

[9] For an update on the actions taken since the adoption of the Framework, see UNITED NATIONS CLIMATE CHANGE SECRETARIAT (2019), *25 Years of Adaptation under the UNFCCC. Report by the Adaptation Committee* [https://unfccc.int/].

then suggest possible shifts, trends or conditions among the HLH ports. Tavasszy *et al.* (2011), working with container flows, demonstrate in a scenario in which NSR is used between Port of Rotterdam and Port of Yokohama what the model suggests as the impact on the total container throughput in the Port of Rotterdam. Results suggest that Rotterdam is estimated to gain in 0.65 million TEU traffic. The results for this model show an estimation of 1.5% of the total of container flows would shift to a transarctic route. For this observation, it is verified that the volume handled by considered ports does not change significantly. The estimations presented by Bekkers *et al.* (2015) claim an average 10% increase of trade flows between Asia and Europe, as a result of cost reduction, which needs further research to clearly form a link with demand increase in Rotterdam. It is agreed here that Rotterdam, as the main access point for The Netherlands, a great part of Germany and, substantially, also to other European countries will benefit in the case of an economically feasible NSR, but the dynamic of the operating ports in the vicinity must also be taken into consideration.

2. Canary in the coal mine: estimating the impacts of global warming in the Arctic

Given the certainty of significant climate variations on a global scale in the mid-long term, a sensible way to look at the Arctic region is by considering it a harbinger of future environmental changes. Higher temperatures are occurring more rapidly in Polar regions, and the magnitude of repercussions is greater than currently experienced in other parts of the world: the Arctic thus functions as a "canary in the coal mine" with respect to direct and indirect responses induced by climate change[10]. In order to provide a general overview of the main threats and opportunities presented by global warming in the region, three levels will be examined: the effects on natural fossil resources, the consequences on the main industrial sectors present in Russian Siberia and along the NSR (with 2 specific focuses on upstream / midstream Oil & Gas operations and maritime shipping) and the potential issues for international relations.

2.1 Natural fossil resources

The combustion of petroleum and, to a lesser extent, natural gas releases carbon dioxide (CO_2) and other greenhouse gases in the biosphere[11] and is currently the major contributor to global warming, as the International Energy Agency reported that in 2017 oil & gas use comprised over 55% of climate-forcer emissions worldwide, with coal covering the remaining 45%. The state of Russian hydrocarbon fields (like any other underground reservoir located in cold regions) is influenced by higher temperatures in that they facilitate the access to previously ice-covered land. However, the reduction of the frost layer on the surface is in part absorbed by the soil through water seeping

[10] Borgå K. (2019), "The Arctic ecosystem: A canary in the coal mine for global multiple stressors", *Society for environmental toxicology and chemistry*, 11-02-2019 [https://doi.org/10.1002/etc.4360].

[11] Selley R.C., Sonnenberg S.A. (2015), *Elements of Petroleum Geology* [https://doi.org/10.1016/C2010-0-67090-8].

underground that, in turn, can alter the morphology of the areas where the fossil deposits are sited. This occurrence can result in a gradual modification of the earth's crust in the area (that involves variations in temperature, pressure and moisture) and might also provoke a process of subsidence similar – to a certain extent – to coastal erosion. In the most extreme cases, the increased volumes of water present below the surface can, together with other external factors including seismic waves, heighten the instability of the oil / gas fields and alter the chemical properties of the energy commodities.

2.2 Oil & Gas operation

Although the current debate about global warming generally focuses on how fossil fuels use affects the Earth's environment, some studies[12] have explored how the changing climate is likely to affect oil and gas operations both inshore and offshore.

In the Arctic region, the major driver and source of operational risk for onshore extraction plants is the thawing of the permafrost, the portion of ground with a temperature that remains at or below the freezing point. Since most of the existing infrastructures and buildings in those areas were conceived to rest on ice-hardened soil, the gradual melting of permafrost can cause structural tensions that might damage or compromise those facilities, unless adequate repairing / upgrading efforts are put into place. In particular, 4 severe effects may distress the industry:

a. frost heave and settlement of pipelines set on pilings or buried in permafrost, increasing construction and maintenance costs and the potential for leakage and spills;
b. settlement of buildings set on pile of foundations laid directly on permafrost, or a decrease in load bearing capacity of such structures;
c. damage to onshore support facilities, waste disposal sites and roads as coastal erosion and land loss accelerates;
d. hazards associated with the formation of thermokarst lakes in coastal areas and the stability of shelf and slope sediments.

The increased atmospheric and ocean temperature of the Arctic undoubtedly facilitates the discovery of new deposits under the seabed and the construction of offshore extraction plants, but also constitutes a major threat for three main reasons:

a. it contributes to extensive algal blooms that impact living resources, local economies and potentially also public health. In particular, severe consequences from harmful algae include human illness form ingesting contaminated shellfishes or fish, mass mortalities of wild and farmed fish, loss of seagrasses by reduced light availability and alteration of marine food chains. While these negative phenomena will not directly impact current coastal or offshore oil and gas operations, they could potentially affect the regulatory environment for future exploration and development, as well as the retirement of existing facilities.
b. it can propagate into seafloor sediments, provoking the release of methane, the second

[12] Burkett V. (2011), "Global climate change implications for coastal and offshore oil and gas development", *Energy Policy*, 39(12) 2011 doi:10.1016/j.enpol.2011.09.016 and Skjærseth J.B., Skodvin T. (2003), *Climate change and the oil industry*, Manchester University Press.

most important long-lived greenhouse gas in terms of radiative forcing[13].

c. it can hamper the disposal of drilling wastes in onshore in-ground sumps, a practice that relies on the presence of permafrost to prevent the surfacing of exhausts into the surrounding environment.

Another factor that can potentially influence the managing of sea and coastal facilities (including those non-oil & gas related) is the change in precipitation patterns and freshwater runoff from estuaries. The energy development in Siberia could especially be affected by increased restrictions on oil & gas activities in stressed or deteriorating coastal ecosystems, by damage to onshore support facilities (due to extreme rainfall events that flood low-lying coastal areas) and by impairment to roads, bridges and ports in the littoral floodplain due to higher peak stream flows.

Furthermore, even though most offshore platforms were designed to accommodate a permanent increase in mean sea level, the menace posed by more intense storms cannot be underestimated.

Since an increase in extreme weather events has been observed in areas with higher sea surface temperatures, occurrences like flooding and structural damage to drilling / production rigs and offshore pipelines cannot be excluded[14]. Similarly, also increasing wave heights (created as a secondary effect of the erosion and submergence of coastal lowlands and barrier islands) can cause damage to energy facilities and transportation infrastructure (bridge decks and supports).

Finally, a relevant side effect of climate change is the acidification of Arctic waters due to the absorption of CO_2 by the surface of the sea, a chemical reaction that, even without affecting directly the energy sector, can potentially alter the lifecycle of marine flora and fauna and thus create an unfavorable business environment due to legislative restrictions.

2.3 Arctic Shipping

Due to the mostly pristine state of its ecosystem, the Arctic marine environment is particularly exposed to potential impacts from shipping and naval activities in general. Commercial vessels of every class can potentially harm the regional flora and fauna through a wide range of accidents such as the release of substances through emissions

[13] In particular, methane clathrate is a solid form of water that contains methane in its crystalline structure and that usually occurs on the continental shelf both in deep sedimentary structures and as outcrops on the ocean floor. Those formations are common in relatively shallow shelf sediments of the Arctic Ocean and the Gulf of Mexico, and their stability is controlled by the combination of pressure and temperature. For a thorough dissertation on the effects of methane clathrate release, see Ramaswamy V. *et al.* (2001), "Radiative forcing of climate change", *Climate Change 2001: the scientific basis* [https://www.ipcc.ch/site/assets/uploads/2018/03/TAR-06.pdf].

[14] The oil and gas industry has been investigating new design of offshore platforms to reduce the potential impacts of changing storm patterns: technologies such as computational fluid dynamics are being used to evaluate the performance of platforms under extreme operating conditions. For an ample overview of those risk-mitigating initiatives, see Ferguson S. (2007), "Ride the wave", *Engineering*, 248 (4) 2007.

to air or discharges to water, releases of oil or hazardous cargo due to collisions or groundings, disturbances of wildlife's lifecycle or the introduction of invasive alien species[15].

In addition, an intensification of Arctic maritime activity is going to have ramifications on a global scale that are difficult to foresee but that can nevertheless enter three main classes[16]:

1. Greenhouse gas emissions

   Among many predictive studies conducted on the impacts of naval traffic along the NSR, a relatively recent one by the University of Rotterdam[17] estimated that the total emissions associated with such regional traffic could fortunately be translated into only marginal increases in global mean temperature and sea level. However, the same analysis indicated that the negative externalities were also going to offset around a third of the expected global gross economic gains associated with NSR over the same period. Noticeably, the study underscored that the gains will mostly occur in Northern Europe and East Asia (as these regions will likely face relatively small climate losses from the additional emissions), while the negative economic impacts of the emission are expected to follow the commonly accepted scenario for climate-induced losses, with poorer regions such as Africa and India set to bear as much as two thirds of the global costs[18].

2. Fisheries

   The fish resources of the NSR play an important role for local communities, but on a global scale live reserves from these Arctic areas are irrelevant, the reason being that the marine fauna is so sparse and difficult to access that no commercial fishing takes place in the open parts of the seas, except from the western Kara Sea and occasionally in the western Chukchi Sea[19]. However, effects of increased shipping and navigation along NSR may be both adverse and positive for fisheries: operational and accidental discharges (such as oil spills) and risks of invasive aquatic species being introduced

[15] Jochmann P., Schroder C., Reimer N. (2017), *Environmental impact of exhaust emissions by Arctic shipping*, 24-10-2017, doi:10.1007/s13280-017-0956-0 and Hänninen N., Pavlov V., Pongrácz E. (2020), *Arctic Marine Sustainability*, doi:10.1007/978-3-030-28404-6

[16] For a constant update on environmental issues of the High North, see Arctic Council – Climate [https://arctic-council.org/en/explore/topics/climate/], while a more technical essay on the implications of global warming, see Kokhanovsky A., Tomasi C. (January 2020), "Climate Change in the Arctic", *Physiscs and Chemistry of the Arctic* [https://doi.org/10.1007/978-3-030-33566-3].

[17] A 2017 joint effort of the University of Rotterdam and other private institutions, whose conclusions are included in the document supra note 5.

[18] The most striking picture is for Africa where the losses are comparable to the net gains in Japan and South Korea.

[19] The commercial fisheries of the NSR are mostly restricted to the lower parts of the large rivers and estuaries. Eger K.M. (2020), "Arctic ecosystems and the impact by shipping activities", *ARCTIS Database*, [http://www.arctis-search.com/Arctic+Ecosystems+and+the+Impact+by+Shipping+Activities].

in the region through ships' ballast water belong to the first category, while the route itself may serve as a mean for transportation of fish products to markets outside the area and also ensure supply of fishing gear and equipment.

3. Oil spills

   The NSR is currently meant to be essentially an energy maritime corridor, with perspectives for a broader use toward cargo and bulk shipping set only in the mid-long term. It is therefore safe to assume that major environmental disasters along the northern shore of Russia might occur essentially in the form of oil spills due to ship collision or grounding. While there has been little research into the effects that these disasters may have on the Arctic environment, some studies have shown that the unique climate of the region poses its own challenges, and nature is slower to respond to such events than it is in more temperate conditions[20]. In particular, it was observed that the activity of oil-eating microbes is slowed down at below-zero temperatures, a conclusion further corroborated by researches that found how low temperatures change the chemical properties of the spilled oil (in terms of higher viscosity) and slow down biodegradation. The lack of waves in the Arctic Ocean constitutes another challenge, since where sea ice is present, fewer waves are created and the oil does not disperse into small droplets. There is also a lower level of nutrients which feed algae and bacteria in the water: without these elements, the bacteria cannot develop at an optimum rate. Finally, one more relevant feature is the long periods of sunlight in the Arctic summer, which can both help and hinder clean-up operations. On the one hand, long hours of sunlight help the microbes to break up oil molecules, but conversely this could make the oil compounds more toxic for aquatic organisms[21].

With the aim of mitigating the risks and costs of environmental shortcomings of this magnitude (as well as the most harmful effects of climate change), several initiatives have been taken on an international level, the most important of which are the introduction of the 2009 Polar Code and the IMO 2020 regulation.

The Guidelines for ships operating in polar waters (Polar Code) defined by the International Maritime Organization (IMO)[22] are intended to cover the full range of shipping-related matters relevant to navigation in waters surrounding the two Poles (ship design, construction and equipment, operational and training concerns and search and rescue activities) and, equally important, the protection of the unique environment

[20] Husseini T. (2018), "Oil spills in the ocean: why the Arctic is particularly vulnerable", *Offshore technology*, 14-10-2018 [https://www.offshore-technology.com/features/oil-spills-in-the-ocean-arctic/]. During the clean-up operations of the Exxon Valdez spill in Alaska (1989) and Deepwater Horizon in the Gulf of Mexico (2010), only 15% to 25% of oil was successfully removed through mechanical methods, such as physical recovery and burning of the spilled oil. The bulk of the clean-up was carried out by oil-eating bacteria in the water.

[21] Supra note 16. Another weakness is the relatively limited capacity for search & rescue and response operations, although the Russian Government is heavily investing in the development of such infrastructure.

[22] The role of IMO and other international bodies in the protection and governance of the Arctic is treated in Intesa Sanpaolo-SRM (2020), *op. cit.*, p. 62 [The most relevant aspects of the Polar Code can be found in: http://www.imo.org/en/MediaCentre/HotTopics/polar/Pages/default.aspx].

and ecosystems of the polar regions. The main provisions of the Polar Code concerning Arctic waters encompass 4 main areas:

a. Oil and oil mixtures

   Discharge into the sea of oil or oily mixtures from any ship is prohibited, and a both a double hull and bottom are required for all oil tankers. Also, ships are encouraged not to use or carry heavy fuel oil in the Arctic and to consider using non-toxic biodegradable lubricants or water-based systems.

b. Invasive aquatic species

   Measures must be taken to minimize the risk of importing invasive aquatic species through ships' ballast water.

c. Sewage

   Except under specific circumstances, no discharge of sewage in polar waters is allowed, with further stipulations specifying the use of approved treatment plants onboard and the safety distances from ice formations at which chemically-sanitized sewage can be ejected.

d. Garbage and chemicals

   No plastic, noxious chemical substances or food wastes can be discharged (the latter benefits from exceptions only if they have been comminuted).

IMO 2020 regulation was another significant step toward environmental protection since, as of January 2020, it enforced a limitation of sulphur content in heavy fuel for ships from 3.50% mass by mass (m/m) to 0.50% m/m. This measure – essentially meant to implement a drastic reduction of sulphur oxides[23] emissions that result from the combustion of naval fuel – also forbids shippers from burning and transporting noncompliant fuel unless appropriate air pollution control devices (scrubbers) are installed on the ship. Before the entry into force of IMO 2020, fuel oil with 3.5% sulfur content counted for roughly 33% of total marine fuels demand worldwide, so the positive impacts are expected to be relevant.

In the face of such a radical "game changer", shippers were left with few alternatives[24]:

a. use marine gasoil, easily retrievable worldwide and without compatibility issues, but expensive.
b. use already tested 0.5% fuel oil blends, but taking the risk of operative limitations in their adoption due to compatibility issues and possible constraints in the availability of specific blends in some ports.
c. install scrubbers. Although considered the cheapest choice (as the initial investment is expected to payback in 1 to 4 years depending on the level of the fuel spreads), this strategy has a major limitation in that not all the ships can accommodate scrubbers

[23] Apart from being harmful to human health, once in the atmosphere sulphur oxides can lead to acid rain and contributes to the acidification of the oceans.

[24] Corsini D. (2029), "IMO 2020: IP week's takeaways" in Intesa Sanpaolo-Banca IMI (March 2019), *Macroeconomic and Fixed Income Research*.

due to technical constraints. It also entails downtime, in terms of time needed to order and install a scrubber and of the relative loss of revenues while the ship is under modification[25].

d. switch to alternative fuels like LNG-powered, electric or new hybrid vessels (those endowed with dual fuel engines). Although being the most expensive strategy, it might offer the best payoff in the long term due to its full compliance with IMO 2020 and the efficiency provided by new generation engines.

2.4 International relations: the ethics of Arctic development

The way that problems and solutions regarding the fossil resources of the Arctic and the development of the NSR are defined and promoted also poses an ethical dilemma of global significance. An important share of the world's as-yet unexploited oil and gas resources is located in Siberia and under the seabed of the Arctic Ocean[26]: as the sea ice keeps on melting, coastal States and energy companies obviously aim at reaching these northern resources. Using them would, however, cause emissions and accelerate climate change, so a debate has started on whether the new Arctic oil and gas reserves should be utilized or left untouched.

In light of the major annual Arctic meetings of politicians, business, academics and NGOs (like the Arctic Circle Assembly and the Arctic Frontiers Conference), there are currently two competing main ways to perceive and communicate about Arctic oil and gas and the shipping lanes set to develop them[27]. In this regard, a pivotal dividing line is whether the development of Arctic resources should be framed as a regional environmental problem or a global climate issue.

The regional approach highlights the risk of oil leaks and contamination from extraction and transportation: from this perspective Arctic oil and gas development becomes a limited environmental problem that can be solved with tools that are readily available: ecological protection and monitoring, scientific standards and advanced extraction technologies. The conclusion from this viewpoint is typically that the use of new Arctic fossil fuel resources is ethically justifiable since it can be done sustainably and in an environmentally-friendly way.

Such vision has however been challenged by a more global viewpoint on the Arctic, that has shifted the attention from the vulnerable Arctic nature to the greenhouse gas emissions that would result on a planetary scale from the utilization of the new under-ice reserves. The key argument is that, since fossil commodities have a climate impact irrespective of their geographical place of origin, it is therefore questionable to promote further development of polluting resources in the Arctic, regardless of how

[25] Further uncertainty is related to regulatory risks, since the "open loop" scrubber category is still not compliant in some major ports like Singapore.

[26] For an overview on the economic development of energy commodities of the region is provided in Intesa Sanpaolo-SRM (2020), *op. cit.* (Chapter 2 "The Northern Sea Route: a New economic Scenario", p. 7; and Chapter 4 "The Strategic positioning of the global players in the Arctic region", p. 41).

[27] Heininen L., Exner-Pirot H. (2020), *Climate Change and Arctic Security*, doi:10.1007/978-3-030-20230-9.

environmentally friendly and safe the extraction and transportation operations might be. The implication surrounding this position is also that that climate change is essentially a global challenge that requires an international response and there is therefore no special responsibility from Arctic States to refrain from using the new resources. Another scientifically sound objection is that it is actually the consumption of fossil fuels (not their production) that matters, as emissions are related to the use of natural resources that mostly takes place outside the Arctic[28].

The debate gradually encompassed other fields like sustainable economics, disputing that the Arctic players benefiting from fossil fuels utilization are basically moving the harms of climate change to future generations or to impoverished people who have little say in global politics. Striking a balance between these conflicting (but not necessarily mutually exclusive) interests is possibly going to become one of the most demanding quests of the century.

3. Promoting the proactive governance and the sustainable development of the Northern Sea Route

In recent years the Arctic has become a complex and multifaceted chessboard for a multitude of players, each with a distinct agenda and priority list on how it should be governed and developed in the near and far future. Also, the peaceful cooperation so far experienced in the region, coupled with the relatively higher costs of operations for the extraction of fossil resources and the slow construction of a logistic infrastructure capable of sustaining commercial maritime traffic, might extend this period of low competition for some decades. Yet, even the most optimistic estimations conclude that this scenario is eventually going to change drastically due to the effects of global warming, begging the question of what kind of Arctic governance will emerge and regulate private business, public needs and environmental protection.

Many studies[29] have positively assessed the work done so far by international bodies and regional fora in keeping the region a pacific ground for, inter alia, scientific research and international security efforts despite diplomatic and commercial tension erupting in other areas of the world. In this regard, a potentially very effective initiative has been recently put forward: the creation of an Arctic Development Bank (ADB)[30].

Following the footsteps of existing regional and multilateral development banks in successfully implementing large-scale infrastructural projects, a properly endowed ADB

[28] Quillérou E., Jacquot M., Cudennec A, Bailly D. (2017), "The Arctic: opportunities, concerns and challenges", *Ocean Climate* [http://www.ocean-climate.org/wp-content/uploads/2017/03/the-arctic_07-9.pdf].

[29] Bailly D., Cudennec A., Jacquot M., Quillérou E. (2017), "The Arctic: opportunities, concerns and challenges", *Ocean Climate* [http://www.ocean-climate.org/wp-content/uploads/2017/03/the-arctic_07-9.pdf] and Borgerson S.G. (2008), "Arctic Meltdown: The Economic and Security Implications of Global Warming", *Foreign Affairs*, Vol. 87 No. 2 April, 2008 [http://www.jstor.org/stable/20032581].

[30] Gill A., Sevigny D. (January 2015), "Sustainable Northern Development – The case for an Arctic development bank", *CIGI Papers*, n. 54.

would have the capabilities to:

a. raise significant amounts of supplementary financing on international capital markets at relatively low costs to governments;
b. channel collected funds into synergic plans that could host public / private ventures;
c. ease political tensions between funding States and organizations;
d. cover "unfavorable" projects especially in their pioneering stage, like in the case of the construction of logistics hubs in Eastern Siberia and deep-water ports along the NSR;
e. allow the execution of long-term development plans that would also uphold high environmental protection standards;
f. ensure level playing fields among companies from different countries.

Theoretically, the ADB might choose to adopt a governance structure broadly similar to that of the other multilateral entities. For example, in determining its initial member governments it could replicate the membership structure of another Arctic institution (In that case, the Arctic Council appears to be the most logical choice). Alternatively, if the ADB wished to maximize its share capital and access to international capital markets, in addition to the members of the Arctic Council, its membership might be expanded to include non-Arctic governments (for example, Arctic Council observers), which have a demonstrated commitment to promoting sustainable northern development.

The voting power of each member could be determined through negotiations to reflect their economic strength and importance in the region. Governing structures could also include a board of governors (which would be responsible for major decisions), a board of directors (with responsibility to oversee the institution's day-to-day activities), and a president who would be responsible for the overall management of the institution.

Finally, the ADB might consider a number of innovative features, like requiring a fixed percentage of its lending to be directed to certain specific types of projects (similarly to the European Bank for Reconstruction and Development). As a measure of further protection of Arctic minorities, it could require that a specific percentage of loans directly benefit indigenous peoples in the region.

Chapter X

The impact of Arctic Container shipping on the Hamburg - Le Havre Range Ports; a Case Study of the port of Antwerp

1. Foreword

Today, the circumpolar North area's geography is changing and offering new possibilities. Although this all attracts a lot of interest, it brings a lot of uncertainty. While almost all the results of global warming have affected the shipping industry negatively (Wright, 2013), voyage planning seems to be benefitting from it. Increased temperatures in the Arctic area have made the ice melt and opened up new routes that had previously been deemed impossible. When geographic conditions change, national interests shift as well. For the shipping industry, these new routes are an opportunity by shortening the Far Eastern Asia to North Western Europe trip both in distance and in time (Bekkers *et al.*, 2015), which will result in a reduction of fuel consumption.

This is a big advantage for the shipping industry to drive fuel costs down and to lower shipping related emissions (Wan *et al.*, 2018) in order to follow the International Maritime Organization (IMO) strategy on reducing Green-House Gases (GHG) emissions, which sets a target of 50% absolute reduction by 2050, compared to 2008 levels (Hughes, 2016).

There are many examples of research papers on the Arctic from a maritime perspective, although little research has been done on the Arctic from a port perspective, particularly in the HLH (Hamburg-Le Havre range). The scope of this chapter will be on possible future container shipping lines crossing the Arctic via the NSR, connecting two major global economic regions, North-Eastern Asia and North-Western Europe. Among all possible shipping types, container shipping was chosen to be in focus, since many ports in the HLH range have big interests and investments in container handling.

Ports located in North-Western Europe are responsible for the main flow of importing and exporting goods on the East-West trade route, and the ports on the HLH range are also responsible for handling half of the container traffic in European ports (UNCTAD, 2017). Since the start of commercial shipping operations in the Arctic routes, its possible outcomes (for example: how it will affect the developments of the region) and possible impacts on the ports, have become extremely interesting and debated topics.

The goal of this chapter is to fill the gap in the literature, while focusing on the potential opportunities and threats of Arctic liner shipping in the port of Antwerp. This goal leads us to the following research question for this chapter;

'What is the possible impact of container lines sailing through Arctic Routes on HLH range ports, and port of Antwerp (poA) in particular?'

The process of achieving an understanding of the impact of the opening of the Arctic Route on the HLH range ports requires an in-depth insight into various stated perspectives and components that play a role in NSR. Figure 1 presents the workflow, which takes these different components into account.

Workflow of analysing the impact of NSR on the poA

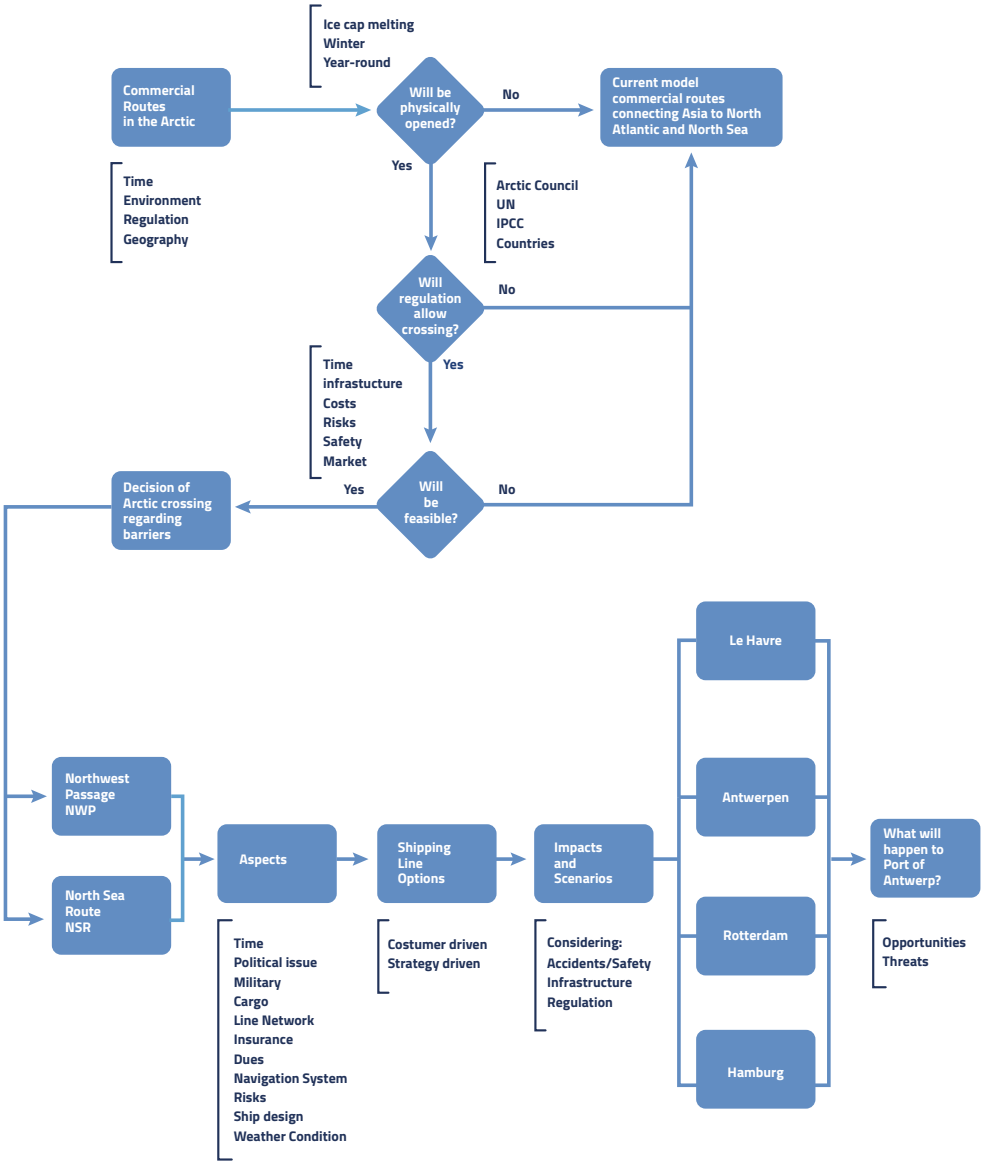


FIGURE 1 - SOURCE: Authors' elaborations

Next to the gathered inputs from the literature review, different stakeholders (representatives of shipping lines) are interviewed and get their perspectives on how their business may be affected from the opening of the NSR and how this would affect port-of-call selection in HLH range ports. Given the uncertainties surrounding the topic, three scenarios to discuss possible effects of NSR on HLH range ports have been proposed.

In the first scenario, NSR will not be viable for the foreseeable future; in the second scenario, NSR has become active in container shipping traffic as a main route. In the final scenario, NSR being used as a supporting route is discussed.

The perspective of this research's goal is investigating and discussing the possible impact of container shipping through the Arctic on HLH range ports (and the poA in particular) due to the drastic change it may bring to the trade route between North-Eastern Asia and North-Western Europe in the future. A SWOT analysis is then applied to illustrate advantages and disadvantages of the NSR for the poA.

A SWOT analysis is a technique to identify the 'Strengths', 'Weaknesses', 'Opportunities' and 'Threats' for a particular business organization. SWOT analysis is used to create a synthesized view of current state of poA, and how it might affect poA if NSR is used for container shipping routes, by demonstrating the opportunities and threats, which point to the possible impacts of container shipping via the Arctic on poA.

This chapter is structured as follows: section 2 presents the literature review. Section 3 gives the results of the interviews with the container shipping lines. Section 4 deals with the scenarios that are developed to facilitate the analysis of possible impacts of NSR. The SWOT analysis is presented in section 5. The chapter concludes with suggestions for future research.

2. Literature Review

2.1 The current situation of the Arctic routes

The downside of the Arctic routes starts with the fact that it is not (yet) possible to use these routes year-round. Nonetheless, increasing temperatures are allowing longer periods of ice-free passage, although it will still take decades until all-year-access is possible. However, with increasing global temperatures, the arctic ice cap is diminishing and enabling longer navigable periods, encouraging shipping companies to utilize northern shipping routes more extensively, particularly using the Russian Northern Sea Route (NSR), which has been developed and promoted by Russia as a new maritime trading route (Chircop, 2016). The Soviet Union has been working on the development of the NSR by investing in ports and icebreakers, which has gained speed, especially during the 1980s, due to oil and gas industry activities today, which are still mostly 'point-to-point' traffic in the Arctic region (Melia *et al.*, 2016). Consequently, a significant increase in arctic shipping activities has been observed. In this respect, 71 ships sailed using the NSR in 2013, and Russian authorities expect this volume to be 20 times greater by 2030 (Yin *et al.*, 2014 as cited in Zhu *et al.*, 2018).

The commercial use of Arctic routes has the potential to bring massive benefits that are, however, accompanied with disadvantages of their own. The most obvious benefit is the shorter sailing distance, which translates into less fuel burn and a shorter trip time, which will enable an increased frequency for each ship, thus increasing total capacity for the route. However, the harsh environment and ever-changing ice conditions in the NSR have created technical challenges to ships and ports, where ports along the NSR are not well developed and have poor infrastructure.

Hence, if a ship needs repairs along the route, they can only get minimal service at the existing ports, and need to reroute to Murmansk or Vladivostok (Zhu *et al.*, 2018), which means a lengthy diversion from the intended trip route. Ports on the NSR, however, can provide bunkering, provisions and even shelter when this might be needed. For bigger ships, depths in anchorage area and wharfs in NSR ports are yet another problem, and, because current facilities do not meet the shipping companies' fundamental necessities for cargo handling, navigation and rescue, Russia has planned to construct the required infrastructure along the NSR itself (Zhu *et al.*, 2018). Ships will also need to be capable of navigating the rough Arctic sea, which has still not been completely charted. Due to this fact, ships will travel slower compared to the current well-known trade routes. Moreover, ships will need ice-strengthening and they may still need the assistance of ice breakers (Pastusiak 2016, as cited in Zhu *et al.*, 2018). In this respect, sailing in the NSR has always been hazardous due to unpredictable weather conditions and ice in the sea, and the navigable season is always subject to change due to these factors. In this regard, commercial shipping will also be negatively affected from this situation since markets demand goods be delivered on time (Chircop, 2016).

Table 1 provides an overview of NSR for container lines with points for and against derived from the literature review.

Advantages and disadvantages of an NSR for container lines

Advantages	Disadvantages
Shorter distance (North-Eastern Asia to Europe: approximately -40% reduction)	Technical challenges on ships and facilities (changes in ice condition)
Lower risk of piracy (the Strait of Malacca and Gulf of Aden)	Depth of ports in the region are limited (big ships cannot access or secure technical support)
Shorter transit time	Navigation
Fuel-consumption saving	Lack of Search & Rescue infrastructure
Planning and working on sufficient infrastructure along NSR	Effect on a unique ecosystem (unexpected impacts on regional/global environments)
	Infrastructure during the routes
	Transparency (fuel provision)
	Ice-class requirement and escorting icebreakers
	Policy issues
	Complex geographical situation
	Uncertain sea-ice and unfavourable weather conditions
	The length of the sailing season
	Uncertainty in commercial viability
	Waste management in the Arctic areas
	Alternative transport options such as railway
	Differing nature of tramp and liner shipping in container shipping
	High insurance costs

TABLE 1 - SOURCE: Adapted from: Pruyn, 2016; Zhu *et al.*, 2018; Bekkers *et al.*, 2015; Melia *et al.*, 2016; Chircop, 2016; Walkowski, 2015

2.2 Hamburg - Le Havre range ports

Having the most economically-developed hinterland regions in continental Europe, HLH range ports facilitate international trade with regions separated by large water bodies. Stopford (2009) states that a port is part of the transport system and is a pivotal interface between land and sea. Like every other major port in the world, HLH range ports possess crucial importance to the countries they are located in, and the economies of these countries reap the socio-economic benefit that these developed ports bring. In this respect, economic activities are boosted: key infrastructure is developed, jobs are created and other sectors such as banking and insurance are supported indirectly.

Table 2 demonstrates the significance of the container traffic between Asia and Europe in global East-West trade routes. Even though this share of almost 41% includes Mediterranean and Middle East traffic, still a considerable amount of this traffic still has the potential to benefit from a possible NSR in the future.

Advantages and disadvantages of an NSR for container lines

	Trans-Pacific		Asia-Europe		Trans-Atlantic		Total
Year	million TEU	%	million TEU	%	million TEU	%	million TEU
2014	23.2	44.70%	22.0	42.39%	6.7	12.91%	51.9
2015	24.0	45.71%	21.7	41.33%	6.8	12.95%	52.5
2016	25.4	46.35%	22.4	40.88%	7.0	12.77%	54.8
2017	26.6	45.70%	24.0	41.24%	7.6	13.06%	58.2
2018*	27.6	45.70%	24.7	40.89%	8.1	13.41%	60.4

Table 2 - Source: UNCTAD, 2018 (*Note by UNCTAD, 2018 data are projected figures, as the report was released in October 2018)

Container throughput in the HLH range ports, destination/origin independent, is led by Port of Rotterdam, followed by Antwerp, Hamburg, Bremerhaven and Le Havre (Table 3).

Total tonnage of containers handled in HLH range ports in 2018

Port	TEU
Rotterdam	14,512,661
Antwerp	11,025,696
Hamburg	8,700,000
Bremen	5,483,222
Le Havre	3,000,000
Zeebrugge	1,599,467

Table 3 - Source: Clarksons, 2018

Several researchers seek to model container flows, and, with the results or indications, then suggest possible shifts, trends or conditions among the HLH ports. Tavasszy *et al.* (2011), working with container flows, demonstrate in a scenario in which NSR is used between Port of Rotterdam and Port of Yokohama what the model suggests as the impact on the total container throughput in the Port of Rotterdam. Results suggest that Rotterdam is estimated to gain in 0.65 million TEU traffic. The results for this model show an estimation of 1.5% of the total of container flows would shift to a transarctic route. For this observation, it is verified that the volume handled by considered ports does not change significantly. The estimations presented by Bekkers *et al.* (2015) claim an average 10% increase of trade flows between Asia and Europe, as a result of cost reduction, which needs further research to clearly form a link with demand increase in Rotterdam. It is agreed here that Rotterdam, as the main access point for The Netherlands, a great part of Germany and, substantially, also to other European countries will benefit in the case of an economically feasible NSR, but the dynamic of the operating ports in the vicinity must also be taken into consideration.

3. Shipping line's expectations on possible Arctic crossing

The survey participants consider that container shipping through the Arctic will become a reality, and also expect this crossing to become sustainable around the year 2030. The most important criteria for them, regarding making the decision to start using the Arctic route, is safety. They have no plans for the Arctic commercial crossing yet, and they do not think the Arctic crossing will affect the current port-of-call selection in which Port of Rotterdam is the first port of call and any port in the HLH range can be the last port of call. Participants consider that the Arctic route, when it is realized, will be a main route with developed supporting ports and activities along it.

Shipping lines consider available port capacity, port costs and accessibility of the port as the key factors in calling at a port in the future. For ships coming from Asia, Rotterdam is the choice for the first call. However, for the ships returning to Asia to select the last port of call, there is no distinction between the ports in the HLH range. In this regard, small ships will be crossing the Arctic by 2030, medium-size ships by the following decade and large vessels by 2050. A similar thought is expressed regarding route development expectations. By 2030, the infrastructure along the route will be inadequate, while the conditions will have improved and become somewhat fair and, by 2050, average standards will have been reached. Navigation and the ice cap are the biggest risk factors for the possible arctic crossing; risk imposed to the crew, vessel and local people are intermediate level risk factors, and finally threats towards nature are considered, by the shipping line as a minimal risk factor.

4. Scenario development

Reliably determining how and when Arctic routes will allow container liner shipping operations is not feasible, due to the uncertainties within most of the factors.

However, the data obtained with the literature review and conducted surveys can be used to build possible scenarios that can facilitate abstraction on the matter. Evaluation and discussion of these scenarios then give insight into whether container liner shipping operations in the Arctic will become a reality, and how this initiative would affect the ports in the HLH range. As a result of this process, three scenarios are proposed (Figure 2). Scenario A is the current status, in which NSR is not used for container shipping except for trials, thus representing the baseline in this study. Scenarios B and C represent the cases where NSR is viable for container shipping in the foreseeable future.

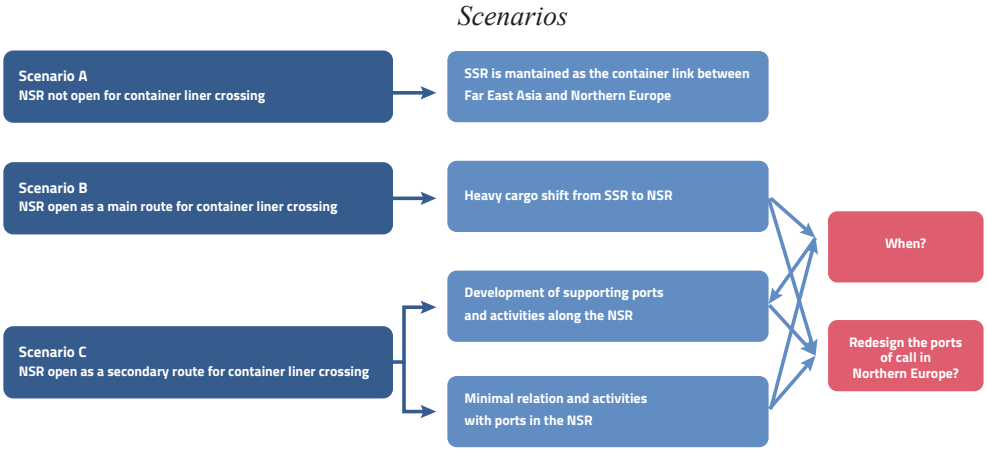


FIGURE 2 - SOURCE: Authors' elaborations

4.1 Scenario A - current SSR as the main link between Far East Asia - Europe

There are various reasons why NSR may not serve as a container shipping route in the foreseeable future. Humpert and Raspotnik (2012) claim in 'The Future of Arctic Shipping' article that not having enough ports of call along the Arctic routes compared to the existing shipping routes such as SSR, is a big concern.

Developing the necessary infrastructure along the NSR is unlikely to be as quick as the global warming that leads to melting of the polar ice cap. For NSR, reaching the same risk and safety standards as existing routes is another challenge. The environmental impact of a possible NSR here is also worrisome.

The ultimate reason why NSR will not attract container shipping is the reliability and punctuality needs of this transport type. "Delays are costly for industry because markets rely on just-in-time delivery of goods (Chircop, 2016)". The navigable season in the Arctic is not predictable. In addition to that, global warming will not only cause the ice cap to melt down, but will also create further adverse weather conditions, free-floating ice and even ice-bergs. A container liner adhering to tight schedules due to business requirements, therefore, would not enjoy the unreliable conditions NSR may offer.

For this scenario, a more environmental approach draws an Arctic where it should keep its current status of navigation for regional purpose and, in this way, maintain the main axis of the Eastern Asia – Northern Europe commerce through the Malacca Straits and Suez Canal.

With this configuration, the Suez Canal will maintain the expected growth rate, since an increase of the trade between China and the ports in the Mediterranean Sea is expected.

4.2 Scenario B - NSR as a main link between Far East Asia – Europe

In Scenario B, NSR emerges as the main route for container shipping lines looping between North-Eastern Asia and Northern-European ports. This drastic change does not happen in an instant, but will happen gradually due to the ice cap reduction happening gradually. Bekkers *et al.*, (2015), Comiso, (2012), Rodrigues, (2008) and Rogers *et al.*, (2015) advocate that a navigable window of ice-free sea will be long enough to enable a tremendous shift of container traffic by half-way through this century. With the progressive retreat of the Arctic ice cap, research shows that a considerable amount of polar ice will melt permanently between 2030 and 2050, and main fixed seaways could be drawn in the NSR. However, even if the Arctic ice cap allows Arctic crossing, there are three main obstacles that should be tackled before container shipping operations shift towards NSR. Since this change will happen gradually, there will still be considerable ice along the NSR in the early phase. Therefore, ships utilizing this route will need to be ice-class vessels, and adequate ice-breaking activity should be present. This aspect is directly influenced by Russian authorities. The NSR today is supported by two operational bases for icebreakers (NSRA, 2018), and a limited number of available vessels. Russia, with the aim of developing NSR, should open the icebreaking pilotage market to more reliable companies, allowing competition and better services that are able to fulfil the growing number of vessels crossing from 2030 to 2050.

A lack of adequate ports of call along the NSR is the second obstacle. Ports along the NSR will therefore need to develop a minimal structure of supporting activities. Today, most of these locations operate with scarce resources, where shipping companies consider security along the route as a top priority. In the case of an emergency or in demand of urgent mooring, a vessel transiting through NSR, with an expected port call only in Europe, will stop at the closest port having enough capacity to receive it. Therefore, an increase in container shipping via the NSR will demand an improvement of the infrastructure in the ports along the NSR.

Finally, the willingness of shipping companies to utilize NSR for container shipping can be considered the final obstacle. Companies with a more stable financial condition and/or driven by regional or local policies tend to take advantage in the quest and, most likely, these companies will be the first ones to inaugurate a fixed loop in the NSR. With Hanjin's bankruptcy and Hyundai Merchant Marine (HMM) having difficulties (Lee and Kim, 2015), the Korean container liner shipping does not present any strong appetite for NSR. The survey participant from Mediterranean Shipping Company (MSC) has stated that the company has no strategic plan regarding the Arctic yet. Conversely, Maersk has been continuously referring to the Arctic in its strategy, where, after demonstrating interest in NSR to the Northern Sea Route Administration (NSRA) last year, a new ice-class vessel was delivered for trials (Humpert, 2018). Along with Maersk, there is also COSCO.

In this regard, the Chinese shipping line is already having trials in the last years (Zhao *et al.*, 2016) and following the Chinese government strategy (Huang *et al.*, 2015), the company has had the chance to take advantage of China's interest and desire to assert dominance in the area.

4.3 Scenario C - NSR as a supporting route

In this final scenario, a middle ground between the first two scenarios is expected to occur. NSR here will become a route used for container shipping between South-East Asia and North-Western Europe. However, rather than becoming a main route, it will be a supplementary one. This scenario seems most plausible due to various factors.

In most cases, container shipping requires 'just in time' delivery. The uncertainties here regarding how many days in a year the NSR will allow shipping operations, how the infrastructure will develop along the route, lack of ports to call along the route for transhipment and, last but not least, environmental concerns regarding a fully developed route all support this scenario. Pruyn (2016) reflects that NSR "might not be suitable for container traffic, as there is too much uncertainty to run a sufficiently reliable liner operation".

Nevertheless, the opportunity offered by Arctic crossing via NSR, is too valuable to be missed. A few shipping lines, as suggested by the readiness conditions brought by Lee and Kim (2015) and their analytical framework, will attempt first trials, following the ice retreat forecast between now and 2030. By the time period forecast by the three scenarios built in this study, from 2030 to 2050, most of the above-mentioned reservations, if not all of them, are likely to be resolved. COSCO and Maersk here have already exhibited their interest in NSR among other competitors, in a period of financial instability (Wright, 2017). With NSR becoming a secondary / supplementary route, the expectation is that, along with the Belt and Road Initiative, more advances involving Chinese companies and capital will follow. Moreover, NSR can complement the efforts with other routes the initiative represents (Figure 3).

Verifying the NSR movement data from Centre for High North Logistics (CHNL) (2017), one particular insight becomes evident; as the operation in the NSR will be done by ice-class vessels, with or without ice-breaking assistance, the vessels reaching the North Sea will also be able to sail to the Baltic Sea and the Gulf of Finland, calling at the port of Saint Petersburg in Russia, for instance. This is not common today, where a vessel coming from Far East Asia via the Suez Canal will possibly do a transhipment in the port of Rotterdam, and the container will continue by regional services to its final destination. This opportunity is not inclined to replace usual operations, as happens in the HLH range ports, but can bring a measurable impact, as the representativeness of consumption and production centres in the Baltic are not as large as compared to the Northern Europe ones, but still has meaningful demand.

The East - West links

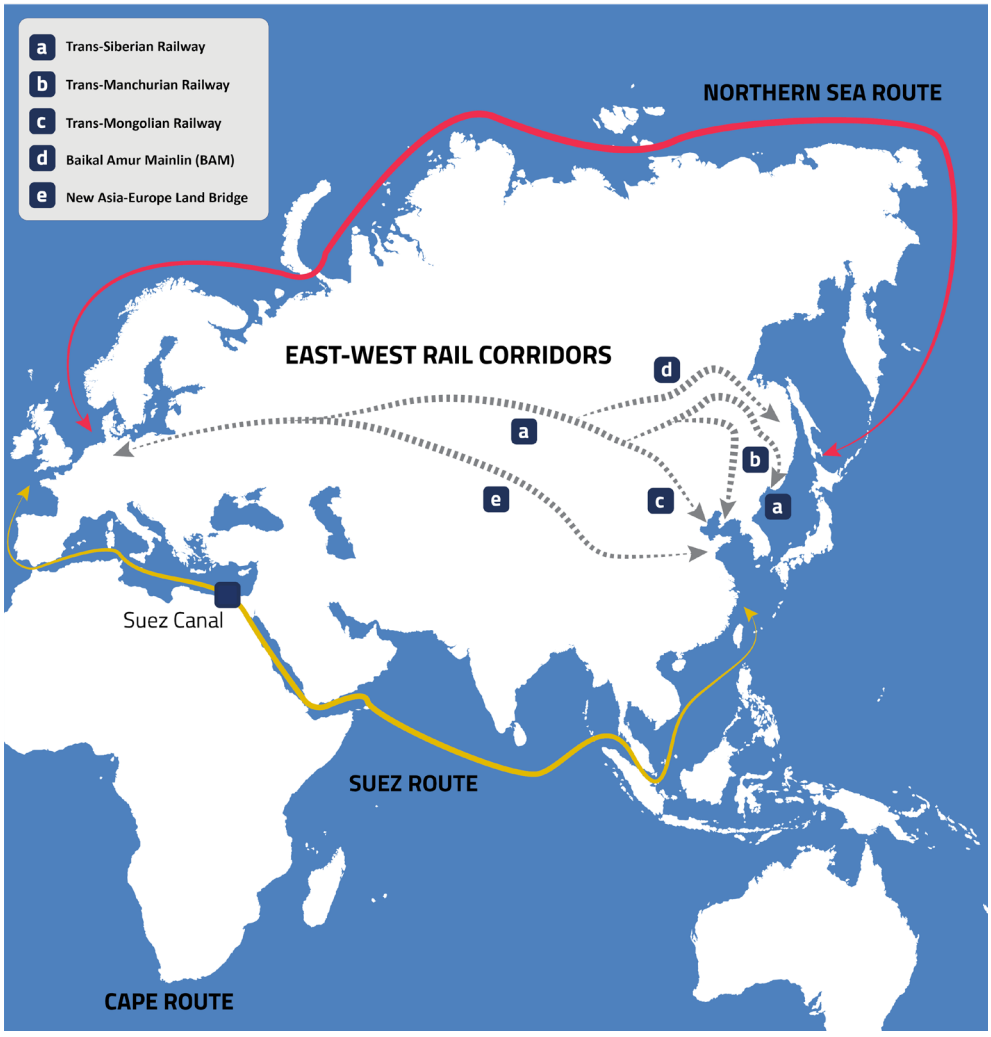


FIGURE 3 - SOURCE: SRM on Tavasszy *et al.*, 2011

5. SWOT ANALYSIS ON PORT OF ANTWERP IF NSR BECOMES VIABLE

Based on the literature review, applied survey and critical examination of scenarios, a SWOT analysis is applied to investigate opportunities and threats for PoA.

The strengths of poA mainly come from its geographical location and it being a long-established port that is part of the global supply chain (Haezendonck and Langenus 2018). The region in which poA is located and serves is densely populated and urbanized. It has been a valuable economic asset for Belgium for centuries, and has thus become a key driver to the local economy and built a flexible labour pool (Haezendonck and

Langenus, 2018). It is a well-developed port, having a high level of terminal operations and container handling productivity. Inland waterway connections and land transport infrastructure (rail and road) complement poA as an intermodal transport hub.

The opportunities of poA are enriched with its attractiveness to related industries, such as petrochemical clusters. Port operations are handled with efficiency, thus customers, shipping companies or terminal operators trust the quality of the service given. In this respect, improving this service quality even further will make poA even more advantageous in HLH range ports. MSC and PSA here has a joint venture terminal investment in poA, which is claimed to be the single largest container terminal in Europe (MPET, 2019). One other opportunity of poA is its good hinterland connections to Northern France. If NSR becomes a viable option, then poA will be the biggest, most southern located port in the HLH, which may create an opportunity and focus on export traffic in order to guarantee port calls for container ships coming from East Asia to the HLH range. The port is also planning to build additional terminal capacity (Saeftinghe dock) to ensure potential further growth of container handlings.

The weaknesses of poA are also mostly related to its geographical location. Container ships need to travel upriver on the Scheldt in order to reach the port, requiring pilotage. Also, there is a limited growth opportunity for intermodal rail freight from the port.

Threats to poA are fuelled by the competition between the HLH range ports: to the North the ports of Rotterdam and Hamburg, to the South the port of Le Havre, and to the west the port of Zeebrugge. If NSR becomes viable, poA may be at a disadvantage, since the ports of Rotterdam and Port of Hamburg are easier and quicker to reach for container ships using NSR. This could impact the potential container handling volume in Antwerp.

Furthermore, even though there is an entirely different transport methodology with railroads, the Chinese Belt and Road Initiative is also threatening poA, since this route will be a direct alternative to the container traffic originating from Eastern-Asian to Northern-European ports, including HLH range ports.

Table 4 summarizes the above in a SWOT table.

SWOT analysis of poA in view of NSR

Strengths	Weaknesses
• Serves a consumption-heavy region • Key driver to local economy • Global supply chain • Container handling productivity • Flexibility of labour pool • Diverse warehouses • Intermodal transport hub	• Accessibility (access via river, pilot is needed) • Limited growth opportunities for rail connection to hinterland
Opportunities	**Threats**
• Attractiveness to other industries • Reposition itself in HLH range as a first port of call for France • Hinterland connection into the main land of Europe	• Competition from other ports (i.e. Port of Hamburg & Port of Rotterdam) which have a shorter sailing distance for the NSR route. • Additional competition might be expected from the Belt and Road Initiative

TABLE 4 - SOURCE: literature research, scenarios and surveys

6. Conclusion, discussion and future research

Given the economic advantage that the NSR offers, also the geo-political interest from Northern countries will rise. However, existing problems such as lack of legal framework, limited sailing period in the region throughout the year, physical challenges and sustainability goals, will take time to be resolved or tackled. The authors predict that NSR is very likely to start being used by container shipping through the Arctic within the next 20 to 30 years. Thus, the NSR has a large potential to attract trade flows, especially between North-Eastern Asia and North-Western Europe. Such Arctic routes will rather offer alternative supporting routes for container shipping liners in order to complement the existing traditional sea routes in a gradual manner. Countries heavily involved with the Southern Sea Route here risk losing the current trade flow to the NSR and, in return, the countries that will benefit from the NSR will face increased economic and political tension. France, the Netherlands and Germany have gained observer status within the Artic Council between 1998 and 2000. So, it can be expected that Belgian government joins this organisation in order to support the development of the region, pursue cooperation and support the interests of PoA.

Regarding the research questions, with respect to effects of such an Arctic route becoming available on the ports on HLH range, no major impact is expected by the authors. However, minor changes in call-of-port selection can be expected since ports in the HLH range will have an opposite order when ranked by route length. For the shipping companies involved, the survey data suggests that available port capacity, accessibility of the port and port costs are the biggest factors driving the port of call selection in the future. These survey results indicate that the port of Rotterdam is likely to keep its favourable position, although the port of Hamburg, for example, may possibly gain a competitive edge due to shorter distance advantage and its good hinterland connections.

Likewise, the port of Le Havre may lose some ground due being the remotest port on the NSR route, having poor hinterland connections and inflexible labour.

On the other hand, poA may find an opportunity when the port of Le Havre loses ground. Realizing that it will be the furthest port in HLH range for ships using NSR, when the port of Le Havre is excluded, it could develop a strategy to become more export-heavy and re-position itself as the southernmost port in the HLH range.

Even though there are scientific predictions about the region, many factors, such as the geo-political interest of Northern countries and the dynamics of container shipping routes are still open for debate, some of which are somewhat speculative. New developments related to the topic are happening frequently, so further research is recommended on top of the results of this study. The effects of (de-) globalization, changes in market structure (the Eastern European market gaining importance), a possible production shift in Asia (production moving from China to South-Asian countries such as Vietnam and Bangladesh) are major factors that may affect any Arctic crossing initiative.

Acknowledgements

The authors we would like to express our appreciation and gratitude to Dr. Patrick Verhoeven for his comments and suggestions.

Chapter XI

AIS-based Cost Estimation of Bulk Carriers per Voyage on Arctic Northeast Route

Based on previous studies, this chapter compares and analyses the costs of dry bulk carriers on Arctic Northeast Route with those on traditional ones, calculates the fuel oil cost based on AIS data, and incorporates the increased risks on the Northeast Route into cost calculation. With single-voyage cost, average annual cost and necessary freight rate as evaluation indicators, this chapter uses the financial indicator NPV (net present value) to make financial analysis on bulk carrier items on Arctic waterways in order to obtain more objective and comprehensive results.

1. Foreword

Arctic waterways are primarily composed of three parts. The Northeast Route, which opened in the 1930s, features relatively straight channels. Presently, the route is navigable for three to five months a year and is covered by ice for the rest of the period when navigation through it requires icebreakers to act as a convoy. The global warming has led to melting of sea ice in the Arctic Ocean, which is expected to become fully thawed in summers in this century. As per current research and studies, Arctic waterways are practical to a certain extent. With the navigable time window widening, the Arctic routes will become safer.

China has seen some success in navigating through the Arctic Northeast Route, such as navigation by Yong Sheng, Tian Xi and Xiang Yun Kou vessels. However, due to the patchy development of Arctic waterways and the various risks involved, current vessels sailing on the Northeast Route are mostly multi-purpose ships and fishing vessels, while container ships and bulk carriers among the three main ship types rarely use the route. Wang Yuqiang and Shou Jianmin designed the China-Europe Route that runs via the Arctic Northeast Route and analyzed its economic significance[1].

Li Yuwei proposed a ship energy consumption model based on ship motion trajectories[2].

[1] Wang Y., Shou J. (2013), "Design and Economic Significance Analysis of China-Europe Route That Runs via Arctic Northeast Route", *Marine Technology*, 2013, 02, 21-24.

[2] Li Y. (2014), "Study on Statistical Algorithms of Ship Energy Consumption and Carbon Emissions Based on Ship Trajectory", *Research Report of Major Discipline Project of Applied Fundamental Research Sponsored by the Ministry of Transport* (2014329810120), Shanghai, Shanghai International Shipping Institute.

Li Zhenfu and Liu Yiying *et al.* studied the economic significance of container shipping through the Arctic Northeast Route[3,4]. Liu Jianlong analyzed the overall economic significance of the Arctic Northeast Route[5]. Yao Mingyue *et al.* discussed the impact of the opening of the Arctic Northeast Route on Sino-European trade based on the Gravity Model of Trade[6]. Zhang Xiao recorded the whole process of Yong Sheng ship navigating through the Arctic Northeast Route[7]. Cui Jianfeng *et al.* analyzed the key must-pass sea areas along the Arctic Northeast Route[8]. Qian Zuoqin *et al.* proposed the navigation strategy of the Arctic Northeast Route and studied its economic significance[9]. Wang Bin analyzed the oil transportation situation of the Arctic Northeast Route[10]. Dong Jiang *et al.* analyzed the navigation environment of key waters along the Arctic Northeast Route and main ports along the route[11]. Ding Kemao *et al.* analyzed the current navigation status and the maritime support capability of the Arctic Northeast Route[12].

Zheng Lei discussed the interests of the countries located along the Arctic Northeast Route and the freedom of navigation[13]. Based on the previous studies, this chapter calculates the fuel oil cost with the help of the AIS data and estimates the cost of bulk carriers that sail through the Arctic Northeast Route to draw more objective and rigorous conclusions.

2. Analyzing fuel oil costs using AIS data

A ship trajectory can be represented as a combination of multiple legs arranged in chronological order. As long as the energy consumption of each leg is known, we can get the total energy consumption of the ship on this trajectory.

[3] Li Z., You X., Wang W. *et al.* (2015), "Economic Significance Analysis on Container Shipping Through Arctic Northeast Route", *Journal of Jimei University* (Philosophy and Social Science Edition), 2015, 18(01), 34-40.

[4] Liu Y., Fan H., Guo Y. (2016), "Economic Significance Analysis of Arctic Northeast Route - Case Study of Container Shipping", *Journal of Shanghai Maritime University*, 2016, 37(1) 13-18+31.

[5] Liu J. (2015), *Economic Significance Analysis on Arctic Northeast Route Based on International Shipping Cost*, Dalian, Dalian Maritime University.

[6] Yao M., Hu M. (2014). Impact of Opening Arctic Northeast Route on Sino-European Trade - Analysis Based on Gravity Model of Trade [J]. Marine Economy, 2014, 4(5), 9-15.

[7] Zhang X. (2016), "Commercial Sailing Practice of Yong Sheng Ship on Arctic Northeast Route", *World Shipping*, 2016, 39(05), 8-14.

[8] Cui J., Liu D. (2017), "Key Must-pass Sea Areas along Arctic Northeast Route", *China Maritime Safety*, 2017, 12, 21-23.

[9] Qian Z., Xu L., Yan X. *et al.* (2015), "Navigation Strategy and Economic Significance of Arctic Northeast Route", *Chinese Journal of Polar Research*, 2015, 27(2), 203-211.

[10] Wang B. (2017), "Oil Transportation Analysis of Arctic Northeast Route", *Shipping Survey*, 2017, 01, 32-35.

[11] Dong J., Liu L., Wei G. (2018), "Navigation Environment of Key Waters and Main Ports Along Arctic Northeast Route", *Marine Technology*, 2018, 03, 43-46.

[12] Ding K., Liu L., Wei G. (2017), "Current Navigation Status and Maritime Support Capability of Arctic Northeast Route", *Marine Technology*, 2017, 05, 40-43.

[13] Zheng L. (2016), !Arctic Northeast Route: Interests of Route-side Countries and Freedom of Navigation", *International Forum*, 2016, 18(2), 39-46+80.

The energy consumption of each leg is from the ship's main engine, auxiliary engine and boiler. This chapter selects the fuel oil consumption model in *Study on Statistical Algorithms of Ship Energy Consumption and Carbon Emissions Based on Ship Trajectory* and implements it in Python code with modifications made to the timestamp calculations.

The model is as follows.

1.1 Model validation

1.1.1 Fuel oil consumption of main engine

$$\mathbf{FCRm = LFm * MCR * SFOCm}$$

Where:

- **FCRm** - fuel consumption rate of main engine, unit: gram/hour (g/h);
- **LFm** - load factor of main engine, dimensionless;
- **MCR** - rated power of main engine, unit: kw;
- **SFOCm** - the ratio of ships' main engine fuel oil consumption to the main engine work, unit: g/kwh.

MCR is available in ship archives databases and the SFOCm value is available in Table A1-1 of IMO2009.

Load factor under general sea conditions and rated draft conditions:

$$\mathbf{LFm} = \left(\frac{\mathbf{V}\text{actual}}{\mathbf{V}\text{design}} \right)^{3}$$

Where:

- **Vactual** - actual velocity, unit: knot;
- **Vdesign** - designed velocity, unit: knot.

1.1.2 Fuel oil consumption of auxiliary engine and boiler

$$\mathbf{FCRa = LFa * MCR * Ra/m * SFOCa}$$

Where:

- **FCRa** - comprehensive fuel oil consumption rate of auxiliary engine, unit: gram/hour (g/h);
- **LFa** - comprehensive load factor of auxiliary engine, dimensionless;
- **MCR** - rated power of main engine, unit: kw;
- **Ra/m** - the ratio of main engine total power to main engine SMCR, dimensionless;
- **SFOCa** - the ratio of auxiliary engine fuel oil consumption to auxiliary engine work, unit: g/kwh.

Detailed Parameters of Ship

Name of ship	QING QUAN SHAN	Call Sign	VRPL7
Owner	CHINA SHIPPING NAUTICGREEN BULK 03 LIMITED. Address: 32/f, tower 2, Kowloon Commerce Centre, 51kwai Cheong Road, Kwai Chung, New Territories, HongKong		
Operator	CHINA SHIPPING BULK CARRIER CO., LTD. Room 402,NO.11 of 56 Jin Gang Da Dao, Nansha District, Guangzhou, P.R.C.		
Builder	CHINA SHIPPING INDUSTRY (JIANG SU) CO., LTD		
Date of delivery	30 N0V 2016	Date of keel laid	24-ott-15
Flag	HONGKONG CHINA	Port of Registry	**HONGKONG**
Official number	HK-	IMO Number	**9741530**
Classification	**CCS**	MMSI	**477854900**
Type of vessel	BULK CARRIER	Light Ship	11753.97MT
LOA	**199.90m**	LBP	194.50m
Breadth	**32.26m**	Depth	18.50m
GRT	**36388**	NRT	**21647**
Engine Power	8050KW	Service Speed	14.4Knots
Allowance for fresh water	301mm	Distance from keel to highest point	50.04m
Distance from bridge to bow	172.94 m	Distance from bridge to stern	26.96 m
H. Cover Type	ELECTRIC HYDRAULIC FORE & AFT OPENING	Grain Capacity	78642.4 m³

DRAFT	DISPLACEMENT	DEADWEIGHT	FREEBOARD	TPC
13,577 m	76958	65240	4951mm	62.5
13,300 m	**75226.7**	**63472.7**	5228mm	62.4
13,023 m	73497	61743	5505mm	62.3
13,601 m	75226.7	63472.7	4927mm	62.5

Hold No.	Hold Capacity	Hatch Capacity	Sub Total	Hatch Sizes	Ship's crane SWL X Grabs capacity
1	**13252.5**	669.16	**13921.7**	**19.68*18.26**	No.1 30 mts X 15 cub
2	**16780.2**	880.48	**17660.7**	**22.96*18.26**	No.2 30mts X 15 cub
3	**14546.7**	754.93	**15301.6**	**22.96*18.26**	No.3 30mts X 15 cub
4	**15060.2**	754.91	**15815.1**	**22.96*18.26**	No.4 30mts X 15 cub
5	**15182**	761.33	**15943.3**	**22.96*18.26**	
	74821.6		**78642.4**	Max allowable Tank top	Hold no.1.3.5: 25T/m2 Hold no.2.4: 20T/m2

Ballast pump rate	900cub/h × 2 sets	**Total ballast capacity**	17786.7+ 15301.6M3
Total fuel oil cap.	2012.1M³	**Total diesel oil cap.**	241.5M³
Total drink water	61.7M³	**Total fresh water**	508.0M³
Port consumption (PER DAY)	FO/2.5, CRANE WORKING FO/5.5, FW/12	**SUEZ GT/NT** **PANAMA NT**	30120
TYPE OF M/E	YMD-MAN B&W 5S60ME-C8.2	**MANUFACTURER**	Yichang Marine Diesel Engine Co., Ltd

TABLE 1 - SOURCE: Authors' elaborations

The SFOCa value is available in Table A1-1 of IMO 2009. The Ra/m values of various cargo ships are between 20% and 40%, but the Ra/m values of bulk carriers, container ships, general cargo ships and oil tankers are between 19% and 22%.

Meanwhile, to verify the accuracy of fuel oil consumption data, this chapter refers to the sailing telexes in three voyages of three sister ships owned by COSCO Shipping Bulk Co Ltd to obtain the actual fuel oil consumption, and uses the AIS data of the three voyages to calculate the fuel oil consumption to analyze and compare the actual values against the theoretical ones.

The actual values come from the captains' sailing telexes.

1.1.3 Measurement and calculation results

(1)

- **Ship:** Qing Ping Shan
- **Period:** July 1-August 1, 2018
- **Route:** Transpacific
- **Main engine fuel oil consumption as per model:** 509.03 mt
- **Auxiliary engine and boiler fuel oil consumption as per model:** 25.48 mt
- **Actual heavy fuel oil consumption:** 507.57 mt
- **Actual light fuel oil consumption:** 1.5 mt

(2)

- **Ship:** Qing Yun Shan
- **Period:** July 1-August 1, 2018
- **Route:** Transatlantic
- **Main engine fuel oil consumption as per model:** 517.24 mt
- **Auxiliary engine and boiler fuel oil consumption as per model:** 24.29 mt
- **Actual heavy fuel oil consumption:** 545.35 mt
- **Actual light fuel oil consumption:** 23.4 mt

(3)

- **Ship:** Qing Hua Shan
- **Period:** July 4-July 31, 2018
- **Route:** Transpacific
- **Main engine fuel oil consumption as per model:** 235.61 mt
- **Auxiliary engine and boiler fuel oil consumption as per model:** 24.21 mt
- **Actual heavy fuel oil consumption:** 258.41 mt
- **Actual light fuel oil consumption:** 1.4 mt

The above real ship validation shows that the AIS-based fuel oil calculation model has high accuracy and is applicable to actual fuel oil calculation. Yet after a comparison between the theoretical data and the actual data, we discover a problem that, though the total heavy oil consumption error in a voyage is not large, the daily errors are relatively significant. Besides, the light oil consumption in actual voyages is extremely small and even zero in some cases.

Consultations with experts show that the low light oil consumption is generally due to the following factors: (1) air conditioning, garbage incineration, and ship cranes; (2) entry into the low-sulfur oil zones. These factors should be taken into account for model revision.

1.2 Model application

Based on the theoretical basis of this model, this chapter selected a ship named Xiang Yun Kou to roughly figure out the fuel oil consumption for sailing through the Arctic waterways while identifying the legs that are more fuel-consuming. However, the detailed fuel oil consumption data of this ship is temporarily unavailable and the data is for reference only.

Voyage Information

Port of Departure	**Port of Qingdao**
Port of Destination	**Port of Sabetta in Russia**
Ice Class	**ICE1**
Main Cargoes	**Yamal Project Modules**
Ice Conditions	**1-2**
Icebreaking Time	**0.8 days**
Range Saved	**7.455**
Shipment Period Saved	**24 days**

TABLE 2 - SOURCE: Authors' elaborations

Main Parameters of Xiang Yun Kou Ship

Hull No.	**413055620**
Length (meters)	**216**
Width (meters)	**43**
Port side distance (meters)	**22**
Back range (meters)	**188**
Draft (meters)	**9.1**
Gross tonnage of ship (DWT)	**35,569**

TABLE 3 - SOURCE: Authors' elaborations

1.2.1 Velocity analysis

The AIS database provides the AIS data for the ship from 12:00 midnight on August 29 to 22:00 p.m. on September 21, 2016. With the data, we can work out the ship's sailing trajectory by extracting the latitude and longitude coordinates, timestamps and velocities of the ship in the AIS and arranging the data in chronological order. Specifically, with the observation points along the trajectory connected by straight lines, the trajectory includes a total of 2,215 observation points and 2,214 legs extending 5,912 nautical miles in total.

Velocity Analysis Based on Ship Trajectory

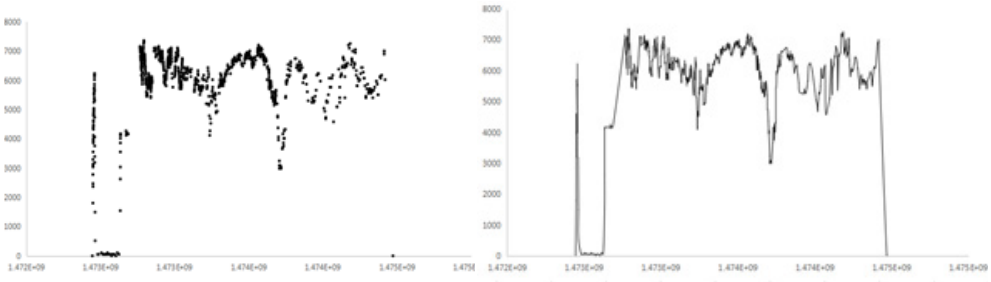


FIGURE 1 - SOURCE: Authors' elaborations

1.2.2 Fuel oil consumption and navigation status analysis

Tracks of Fuel Oil Consumption

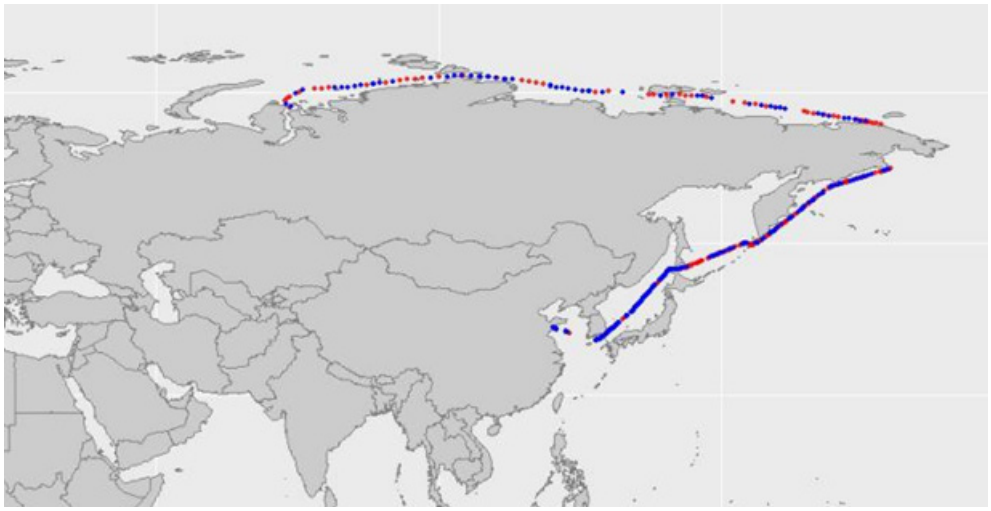


FIGURE 2 - SOURCE: Authors' elaborations

The figure shows the fuel oil consumption tracing points of the ship, where red points stand for the points where the fuel oil consumption is higher than the voyage's average, and blue ones stand for the points where the fuel oil consumption is lower than the voyage's average.

Tracks of Navigation Statuses

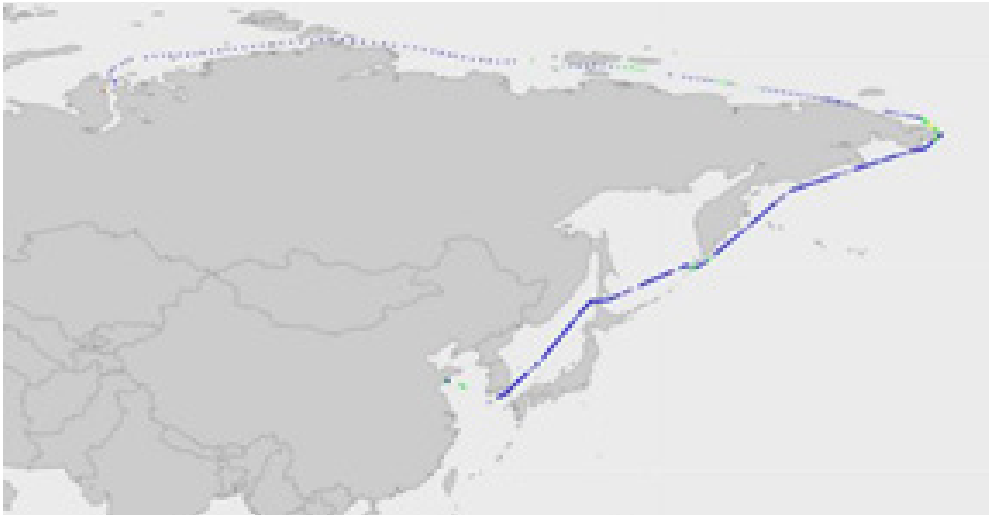


FIGURE 3 - SOURCE: Authors' elaborations

The figure shows the five navigation statuses of the ship. Red, orange, yellow, green and blue points stand for berthing, anchoring, maneuvering, low-velocity sailing and normal sailing.

By adding the data up, we can work out the main engine fuel oil consumption to be 422.3 tons and the auxiliary engine fuel oil consumption to be 19.2 tons.

3. COST ESTIMATION

2.1 Major costs

2.1.1 Cost for icebreaking and piloting

A large part of the Arctic Northeast Route is on the Russian NSR, which is governed by the Russian Northern Sea Route Administration (NSRA) to ensure the safety of the ships on the NSR and protection of the Arctic environment. Currently, Russia adopts a flexible convoying charge system which allows independent sailing of ships without the convoying of icebreakers or ice piloting services during periods of good ice conditions, such as late August and September.

According to relevant fee act provisions of the Government of the Russian Federation in 2014 regarding the rules for charging icebreaking and convoying services in waters along the NSR, the Arctic Northeast Route icebreaking and navaids charge CI is determined by the total tonnage of navigating ships and the ship's ice class. The NSRA has divided the NSR into seven toll areas, as shown in Figure 4. The sailing periods are divided into the summer and autumn sailing period (July 1-November 30) and the winter and spring period (December 1-June 30).

Seven Toll Areas of Northern Sea Route

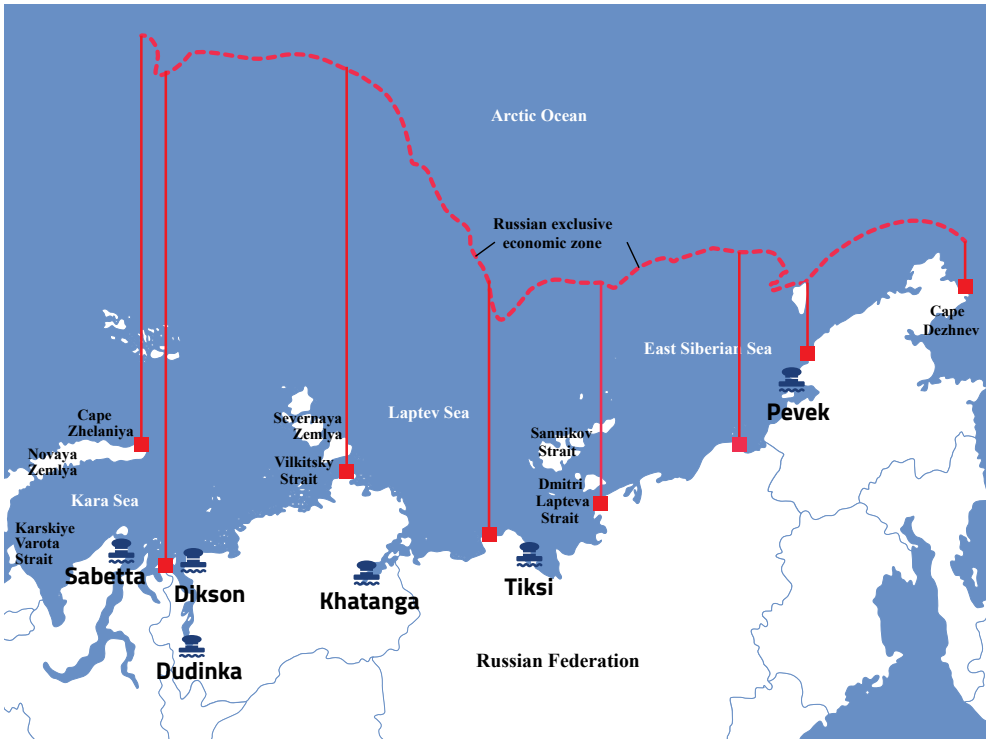


FIGURA 4 - FONTE: SRM on authors' elaborations

2.1.2 Crew wages

Staffing is generally independent from routing, but considering the tough conditions in Arctic sailing, the crew wages are 110% more of those on regular routes. This chapter uses the manning scheme of COSCO Shipping Bulk Co Ltd as the reference for calculations, totaling 22 crew members including the captain. When the amounts are added up, the total wage of the bulk carrier crew members comes to US$62,920/month.

2.1.3 Other expenditures

Other costs include fuel oil cost, port charges, and ship operating costs, and ship operating costs include insurance premiums and ship repair and maintenance expenditures.

2.2 Cost per voyage estimation

Bulk shipping earnings formula:

Freight revenue - Variable cost = Revenue per voyage

- **Freight revenue** = freight rate * actual cargo volume
- **Variable cost** = port charges + fuel oil cost
- **Revenue per voyage** = freight rate * actual cargo volume – port charges – – fuel oil cost + other revenues – other costs
- **Evaluation indicators:** cost per ship voyage and net present value (NPV)

Based on the above formulas, we can use the financial indicator NPV (net present value) for financial analysis of the bulk carrier items for sailing on Arctic waterways.

Ship selection: Handy-size bulk carriers, with Qing Quan Shan vessel in the previous section of this chapter as an example.

Shipbuilding cost: This chapter selects Handy-size bulk carriers as reference. According to the Clarksons Shipping website, the present cost of a general-purpose Handy-size bulk carrier is $24 million. For ice navigation, with various demands posed on ships' materials, structures, functions, etc. taken into account, studies claim that with the same deadweight, ice-class ships are 20% more expensive than ordinary ships. In this calculation, we assume that an Arc5 ice-class ship, which costs about 30% higher than an ordinary vessel of the same type, is used. It is therefore assumed that the shipbuilding cost is US$31.2 million.

Depreciation method: straight line depreciation method.

Depreciation life: 20 years, assuming a salvage value of 10% after the depreciation life elapses.

Revenue per voyage: freight rate * tons.

With regard to freight rate determination, as there are an excessive number of variable factors in bulk shipping contracts which are also non-standardized, differences exist between different shippers, terms and clauses, ship types and ship owners.

Therefore, we can only refer to the freight rates for grain cargo types of the last six months (higher freight rates and larger scales) on traditional routes and make a hypothesis of the freight rate on the Arctic routes with relevant factors taken into consideration. The freight rate is determined to be 15 USD/T.

Tons: Take Qing Quan Shan ship as an example. We assume it is fully loaded. With the ship's deadweight tonnage subtracted by the fuel oil weight, fresh water weight, constants, ballast water weight, etc., and by consulting with ship companies, we reached the conclusion of 54,000 tons (chock-a-block yet not fully loaded).

Port of call selection: Shanghai Port to Port of Rotterdam.

Round-trip time of ship: total mileage/ economical velocity + average stay in port. Specifically, the total mileage from Shanghai Port to Port of Rotterdam is 15,592 nautical miles. The economical velocity of the selected ship is 12 knots at zero load and 11 knots at heavy load, reconciled at 11.5 knots. The average stay in port (Shanghai Port and Port of Rotterdam) is seven days, and the other time is one day. So the total round-trip time is: 15592/11.5/24+14+1=71.5 days.

Fuel oil cost: Based on the AIS data, we can calculate that the fuel oil consumption of the selected ship is 14T/day during anchoring, and 27T/day during sailing at the economical velocity. The round-trip voyage time is 57.5 days and the stay in port is 14 days. If it is an ice-class ship, the consumption will become 30% higher. In January 2019, the IFO380 price in Europe was about 350 USD/T, and that in Asia was 400 USD/T, which was reconciled at 375 USD/T.

Icebreaking and convoying charges: The ARC5 ice-class ship needs icebreaking and convoying services in four sea areas as per the inquiries on the aforementioned official website and the total cost is USDRUB 15.45 million, equivalent to US$233,897. Ordinary ships icebreaking and convoying services in seven sea areas total USDRUB39.02 million, equivalent to US$606,022.

Port charges: Some ports collect port charges in the form of lump sum charges at expressly marked prices, some collect the charges based on the actual implementations by the port authorities, and some charge the fees based on the net tonnages of operating ships. Cargo handling charge refers to the expenses incurred by ships' loading and unloading cargoes at terminals. To facilitate calculation, this chapter refers to the calculation methods of Qiang Meng *et al.* for port charges and cargo handling charges, that is, the port charge rate of Arctic Northeast Route or a traditional shipping route is 0.184 ($/GT/port of call) and the cargo handling charge rate is 0.244 ($/GT/port of call).

The total tonnage of the selected ship is 36,388. We suppose that the port charges of an ice-class ship is 5% higher than those of an ordinary ship, so we can work out the port charges of a ship per round-trip voyage to be US$32,706.

Fixed cost: including crew wages and operating cost per voyage

Crew wages: US$62,920/month

With regard to the operating cost per voyage, this chapter refers to other relevant research results and concludes that the daily operating cost on Arctic waterways is about 25% higher than that on a traditional route. The operating cost of the same type of ship on a traditional shipping route is about 8,000 USD/day, while that on Arctic waterways it is around US$10,000/day.

Based on the above data, we can calculate the NPVs of this item for 20 years, with the following two scenarios assumed:

Scenario 1:

Build an ARC5 ice-class Handy-size bulk carrier that requires convoying service in four ice areas along Arctic waterways. The ship is used on Arctic waterways only and becomes idle during non-navigable periods. We set the inflation rate to 3%, the social discount rate to 8%, the corporate income tax rate to 25%, and the navigable periods to 150/300 days.

Computing model:

$$\mathbf{NPV} = \sum_{\mathbf{n=1}}^{\mathbf{20}} \left(\left(\mathbf{P} * (\mathbf{1} + \mathbf{i})^{\mathbf{n}} * \boldsymbol{T} - \mathbf{K} + \mathbf{D} \right) * \frac{\mathbf{1}}{(\mathbf{1} + \mathbf{n})^{\mathbf{t}}} \right) + \boldsymbol{R}$$

Where ***P*** is the freight rate, **i** is the inflation rate, **n** represents the year, ***T*** represents the tons, **K** stands for the sum of various costs, **D** stands for the depreciation for tax credits and ***R*** is the salvage value of the ship.

Scenario 2:

Rent a regular Handy-size bulk carrier that requires convoying service in seven ice areas along Arctic waterways. This scenario only serves to calculate the revenue per voyage. The rent is set at US$15,000/day.

As per calculations, the NPV of the ship's continuous operation in Scenario 1 when the navigable periods are 150/300 days, respectively, are: US$-22,324,585 and US$-17,559,809.

In Scenario 2, the net revenue per round-trip voyage is US$-1,234,375.

Analyzing the results, we can intuitively find that the sailing costs of bulk carriers on Arctic waterways in scenarios 1 and 2 far exceed the revenues per voyage, and the economic effectiveness is negative, indicating a lack of feasibility. When the freight rates in Scenario 1 reach 23 USD/T and 19 USD/T for the navigable periods of 150 and 300 days, respectively, the NPV value becomes positive, that is, the freight rates should be increased by 53% and 27%, respectively.

4. Conclusions

Navigation through the Arctic Northeast Route indeed enjoys a time advantage over that of traditional routes. However, due to the restrictions on navigation conditions, there exists a threshold size for navigable ships. A traditional shipping theory has it that the larger the ship, the lower the unit shipping cost. But when this theory is applied to Arctic waterways, various limitations will emerge. In the cost estimation, we have drawn the following conclusions through analysis:

(1) The high fuel oil and icebreaking costs as well as the lack of profitability of bulk carriers are the main reasons for the negative revenue per voyage.

(2) When the revenue per voyage is negative, the duration of navigation time does not make any changes to the loss.

(3) Due to water depth restrictions of some straits, it is not feasible to simply increase ship size to improve the profitability.

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This year's Report devotes much of its analyses to the impacts of the Covid-19 pandemic on ports and maritime logistics. The phenomenon, in fact, has had considerable negative effects on all the indicators that measure the state of health of the sea economy and the economy in general.

The scenarios drawn are characterized by a decrease in the volumes of goods moved, caused by the closure of companies as a result of the various lockdowns that have occurred in different countries, which has resulted in a substantial negative impact on the main economic parameters such as import-export, value added, goods traffic and employment.

In this volume, SRM has carried out a detailed analysis of the various aspects with which the phenomenon is manifesting itself and has also tried, with reasoned estimates, to gauge the impact of the Coronavirus on our logistic system at a national level. In the first part of the volume, important events such as blank sailing, the reduction of the Suez Canal passages and the new configuration of world traffic have been monitored whilst providing an overview of the most recent trends of international trade maritime flows.

In addition, a specific analysis is dedicated to providing a strategic vision on what could give our infrastructure more resilience to economic and health shocks in terms of drivers and port models for the future such as intermodality and sustainability, on which the second part of the research is focused. The third part, on the other hand, offers a focus of perspective, dedicated to a topic of great interest that is gradually rising to the forefront given the phenomenon of climate change: the Arctic sea route. This analysis has been carried out by SRM and Intesa Sanpaolo, with the collaboration of prestigious international study centers such as the University of Antwerp and the Shanghai International Shipping Institute.

Ultimately, SRM intended to offer a contribution of analysis and knowledge of all the components that make up a maritime world destined to change in some of its aspects: more digitalisation and more investments in improving the efficiency of our logistics seem to have become strategic imperatives for Italy. The challenge is open.

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Study Centre based in Naples, connected to the Intesa Sanpaolo Group, originally an intellectual and scientific safeguard, has the objective to improve the 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 regional dynamics, and with a particular eye on the Southern Italy, it runs two reasearch observatories monitoring maritime transport, logistics and energy.

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