

MEMÒRIA DEL TREBALL DE FI DE GRAU DEL GRAU (ESCI-UPF)

**Towards sustainable maritime transport:
How are the main shipping companies addressing
the IMO 2020 challenges?**

AUTOR/A: Raquel Muñoz García

NIA: 102687

GRAU: Negocis i Màrqueting Internacionals

CURS ACADÈMIC: 2019-2020

DATA: 19/05/2020

TUTOR/S: Jose Miguel Aliaga

INDEX

1. INTRODUCTION.....	1
2. ANTECEDENTS.....	2
3. OBJECTIVES	7
4. DEVELOPEMENT	7
4.1 Scope of IMO 2020	7
4.1.1 Management innovations	8
4.1.2 Technological Innovations.....	10
4.2 Beyond IMO 2020	14
4.2.1 Management innovations.....	15
4.2.2 Technological Innovations.....	18
5. CONCLUSIONS.....	19
6. BIBLIOGRAPHY AND WEBGRAPHY.....	20
7. ACKNOWLEDGEMENTS	21
8. EXHIBITS	22

1. INTRODUCTION

The vast majority of the goods traded around the world are transported by sea, a 10% of them being distributed in containers. Despite containerships occupying a relatively low share of the global fleet, they were responsible for more than 20% of carbon dioxide (from now on, CO₂) emissions between 2013 and 2015. The source of such degree of pollution is the type of fuel that most of the world's fleet has been using for years, which could contain up to a 3,5% mass by mass (from now on, m/m) of sulphur. The latter is not only negatively impacting the environment, but it is also capable of harming human health.

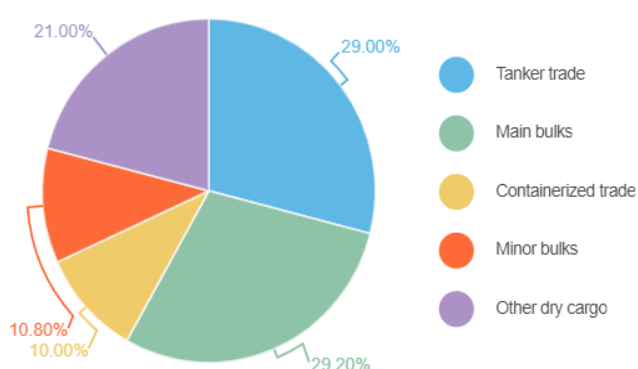
As a response to the increasing levels of pollution, the International Maritime Organization (from now on, IMO) has developed a long-term plan with the aim of helping the maritime transport sector to become emission-free in a century, starting with the IMO 2020 regulation, which entered into force on the 1st of January 2020. The organization has proposed three different propositions by which shipping companies can comply with the regulation – each of them being suitable for different time horizons - but shippers are allowed to decide which ones to implement without restraint. Therefore, the five biggest shipping companies worldwide have been analysed to devise the measures they are applying in the short-term and the ones in which they will invest in the future. The initiatives taken by each company have been divided between the ones in the scope of the IMO 2020 and the ones that go beyond it, distinguishing between management and technological measures.

Globalization is undoubtedly increasing the transactions between regions and, thus, it is urgent that action is taken with the aim of reducing the negative impact caused by the multiple transport modes. Therefore, the project stems from the need of understanding how we can transform the logistic processes that take place worldwide into more sustainable operations.

Notwithstanding, the coronavirus outbreak - a great example of the side-effects of living in a globalized world - has completely altered the situation, dramatically slowing the pace of the economy and directly impacting on the volume of goods traded. The shipping industry, along with many other sectors, is suffering substantial economic consequences from the current crisis that will most probably affect the development of the sustainable actions companies were going to undertake in a near future. Consequently, during the realization of the project, the outcomes for the industry and the impact on the future actions have been assessed as well.

2. ANTECEDENTS

Maritime transport accounts for more than an 80% of the world merchandise trade by volume, albeit there has been a slowdown on its growth during 2018 and 2019, as stated by UNCTAD (2019). The reason behind it is a reduction of the world gross domestic product, a global decrease of industrial production and a decline in the levels of imports and exports among the major trading regions; Europe and Asia (see table 1, exhibit 1). Despite trade activity volumes still increasing, they have only seen an increment of 2.7% in 2018, while growth in 2017 was of 4,1%. Indeed, the historical growth average between 1970 and 2017 has been 3%. It is worth mentioning that, regardless of the decrease in growth rates, total trade volumes reached their maximum level in the UNCTAD record in 2018 (see graph 1, exhibit 1).



Graph 1. Global trade volumes by cargo type in 2018. Source: own elaboration based on UNCTAD (2019). Software: Infogram.

As reflected in graph 1, tanker trade accounted for nearly one third of total volumes traded in 2018, followed by main bulks and other dry cargo. Irrespective of containerized trade volumes being the lowest, it has expanded at an annual average rate of 8% between 1980 and 2018, being the cargo type with a fastest growing pace¹.

When the IMO announced the implementation of the IMO 2020 regulation in 2018, uncertainty began to rise, boosted by the multiple trade frictions, the weaknesses of consumer markets and the slowdown in the world economy (UNCTAD, 2019). All these factors have significantly affected the growth rate of containerized trade from 2017, which has shifted from a 6% to a 2,6% regarding 20-foot TEUs, as it is proven in graph 4, in exhibit 1.

While a large share of containerized trade is conducted across the major East-West trade routes, (see table 3, exhibit 1), still a 60% of the volume is being shipped through non-mainlane trade routes, having the intraregional movements of semi-finished goods across Asia gained a lot of importance, as they are ensembled in different Asian regions (see graph 3, exhibit 1).

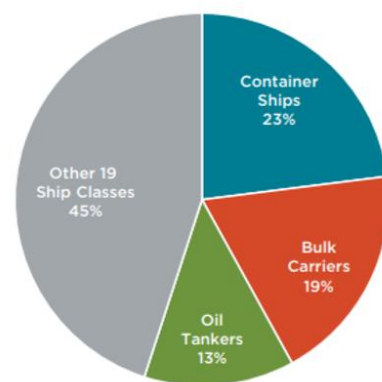
¹ Refer to graph 1 in exhibit 1 to see the evolution of each cargo type between 1980 and 2018.

Vessels are responsible for both air and sea pollution, being the exhaust gas generated by the fuel combustion the main source of the emissions. Before 2020, the vast majority of ships were relying on marine diesel oil, marine fuel oil, and heavy fuel oil to function, generating between a 10% and a 15% of the world's sulphur oxides (from now on, SO_x) and nitrogen oxides (from now on, NO_x) emissions in 2016. In addition, the volume of high sulphur fuel oil (from now on, HSFO) consumed by the sector in 2017 represented a 50% of the global fuel oil demand (Tatar & Özner, 2018).

As Tatar & Özner (2018) declared, transport is the second most polluting sector in terms of greenhouse gas (from now on, GHG) production - after electricity production - representing 24% of the total GHG emissions from fuel consumption in 2015. Marine transport, more specifically, accounts for a 33% of this percentage, resulting in a 3,3% contribution to global carbon dioxide emissions (Walker et al., 2018), which is expected to rise a 5% more by 2050. Nonetheless, shipping emissions are expected to increase between 50% and 250% by 2050, which will depend on how shipping companies overcome the emerging sustainability issues (UNCTAD, 2019).

Research by Walker et al. (2018) shows that gas emissions do not only affect the environment but also human health, given large quantities of SO_x and NO_x can lead to respiratory issues, lung cancer, cardiopulmonary diseases, stroke and asthma. Therefore, the effects are more notorious in people living near ports. Regarding environmental issues, emissions induce acid rain, which not only harms multiple crops, forests and aquatic species but affects ocean acidity as well. Particulate matter (from now on, PM), which is also generated during the vessel's combustion process, can accumulate in glaciers and polar icecaps, increasing the absorption of sunlight and, thus, accelerating its melting rate² (IMO, 2019).

As graph 2 certifies, between 2013 and 2015, container ships were the major source of CO₂ emissions, accounting for a 23% of the total share. Bulk carriers and oil tankers are the second and third most polluting ships, the sum of the three producing a 55% of global emissions. Provided they account for around 80% of the world shipping supply, their impact on the CO₂ emissions is very significant (Tatar & Özner, 2018).



Graph 2. Average percent share of CO₂ emissions by ship class, 2013-2015. Source: Tatar & Özner (2018).

² To find more information about the effects of the emissions, refer to Bierwirth, P. (2016) and to the chapter 7.1 of the study conducted by the World Health Organization (2005).

Taking into consideration that the share of containerized trade is expected to extend in the following years and having verified that container ships are the ones creating the highest levels of CO₂ emissions, the study will focus only on the impact caused by containerized trade. It will be based on the five largest shipping container companies in the world³, given they are responsible for more than a 60% of the total volume of goods transported and, thus, account for a significant percentage of the total emissions of NO_x and SO_x. Details on the companies are shown in table 1.






Shipping companies	Number of vessels	Capacity (TEUs)	Market share	Number of serviced ports
 MAERSK	583	4.1 million	17.6%	343
	520	3.8 million	16.1%	500
	403	2.9 million	12.4%	356
	502	2.7 million	11.2%	420
	239	1.7 million	7.4%	600

Table 1. Data on the five largest shipping companies worldwide. Source: Own elaboration based on Alphaliner (2020), and the corporative websites of Maersk (2020), MSC (2020), COSCO (2020), CMA CGM (2020) and Hapag-Lloyd (2020).

In response to the increase in GHG emissions and the multiple sustainability issues (see exhibit 2), the IMO has developed the a strategy; a plan aimed at gradually reducing the emissions from ships during this century. The first stage of the strategy is the IMO 2020, which mandates that, from the 1st of January of 2020, every active vessel must use a low sulphur fuel oil (from now on, LSFO), with a maximum quantity of sulphur allowed of 0,50% m/m. The aim of the regulation is to reduce the level of SO_x and NO_x emissions in a 77% and, consequently, improve the health of worldwide population, especially for inhabitants living near ports and coasts, as well as to contribute to the environment wellbeing. Apart from that, in Emission Control Areas (from now on, ECAs), the maximum level of sulphur allowed in the fuel is of 0,10% m/m, which the new regulation hasn't modified (IMO, 2019).

³ Detailed data about carriers is explained in exhibit 3.

Shippers can comply with the IMO 2020 regulation by implementing one of the options contained in the table 2, which are further developed in exhibit 4.

Option	Advantages	Disadvantages
Use a low-sulphur fuel such as LSFO, very-low-sulphur fuel oil (VLSFO) or marine gas oil (MGO)	<ul style="list-style-type: none"> • MGO doesn't require engine nor infrastructure modifications • Easy to switch from one fuel to another 	<ul style="list-style-type: none"> • More expensive than HSFO • Uncertain demand and production capacity • VLSFO can vary in quality and characteristics
Use HSFO but install an Exhaust Gas Cleaning System (from now on, EGCS).	<ul style="list-style-type: none"> • No need to adapt the engine • HSFO is cheap and could eventually become cheaper if demand falls 	<ul style="list-style-type: none"> • Expensive and require time to be installed (5-9 months) • Require maintenance • Limited number of suppliers • Higher fuel consumption • Higher CO₂ emissions • Can't be used in ECAs
Use cleaner alternative fuels, for example, liquified Natural Gas (from now on, LNG) ⁴ or methanol	<ul style="list-style-type: none"> • Emits a 20% less of GHG • No emissions of SOx • Reduction of NOx emissions between 85-90% • Less maintenance is required • More efficient than HSFO • Can be used in ECAs 	<ul style="list-style-type: none"> • Requires a special engine and staff training • Expensive in the short-term • Reduces capacity in about a 3% • Price varies a lot depending on the region • Emits small quantities of methane

Table 2. Options proposed by the IMO. Source: Own elaboration based on UNCTAD (2019), Walker et al. (2019), IMO (2019), Jaffe, N. (2019) and Slaughter, A. & Ray, S. & Shattuck, T. (2019).

The second target of IMO's strategic plan to be met is to reduce the GHG emissions by a minimum of 50% by 2050, compared to the emissions generated in 2008. Therefore, it is important that shipping companies make decisions contemplating the long-term, since the IMO regulation will become stricter in terms of emission limits every year. The final target of the organization is to become emission-free by 2100 (IMO, 2019).

Consequently, it is crucial to assess one of the main characteristics of the sector, which is the age of the fleet. Since vessels are normally active between 10-15 years, it is impossible for the industry to react quickly to changes, reinforcing the need to make long-term decisions. Depending on the age of the vessel, decisions regarding upgrades, fleet renovations, scrapping and new orders among others, may vary. Younger fleets are less prone to face issues, repairs and to cause less environmental damage than older ones, which in turn, tend to be less efficient. While the average age of the world fleet was of 21 years in 2019, a 56% of the container ships were younger than 10 years old (see graph 8, exhibit 6), meaning container ships tend to be younger (UNCTAD, 2019).

⁴ Deloitte conducted an LNG feasibility study in 2019 which findings are further explained in exhibit 5.

According to UNCTAD (2019) projections, international maritime trade would follow a positive annual growth rate of 3,4% between 2019 and 2024 whereas containerized trade would be expected to grow at 4,5% during the same timeframe. On the other hand, DNV GL (2017) forecasted an increase of maritime trade of 35% by 2030, being gas and container cargo the types of transport that would grow more, with a prediction of 135-150% growth (see table 4, exhibit 7). Concerning container shipping, it was expected to grow at a pace of 3,2% annually until 2030 and at a rate of 2,1% annually afterwards (see graph 9, exhibit 7).

Nevertheless, the recent COVID-19 outbreak has dramatically changed the global maritime trade situation. The UNCTAD published a study at the beginning of March in which the consequences of the pandemics were analysed. According to the data, only during February, the number of exports from China decreased a 2% in an annualized basis, primarily caused by a relevant slowdown of its production (measured by using the Manufacturing Purchasing Manager's Index); if there is no production, there are no goods to be exported (see graphs 10 and 11, exhibit 7).

Berti, A (2020) has been reporting the results of the sector month after month since the virus appeared. While the most affected sector during the first months of the pandemic has been tanker trade, container trade is the most sensible one to economic activity, being the one who could suffer the biggest consequences, especially because most of containerised goods are produced in East Asia. The number of vessels sailing has been significantly reduced, partially due to the close down of some ports, most of them in Asian countries like China. Blank sailings, which are vessels that where expected to arrive to a port but never appeared, are common under the current circumstances, as well as uncollected goods due to full or closed warehouses. Ports have also had to adopt measures to prevent the virus spread, such as reducing the number of workers or prohibiting crew change (Teoh, 2020).

Consequences can't be determined with accuracy, since they will depend on the virus evolution. Nonetheless, data from the World Trade Organization (2020) reveals that the volume of world trade will surely decrease in 2020, differentiating between an optimistic situation in which the decrease will be of 13% and a pessimistic situation, with a 32% fall. We can also expect a decrease in each countries 2020 GDP (see graph 12, exhibit 7).

3. OBJECTIVES

The aim of the project is to devise which methods are the five biggest container shipping companies of the world using to comply with the IMO 2020 regulation. In order to meet the objective, the following research questions will have to be addressed:

RQ₁. Which of the three IMO 2020 options available is each shipping company applying in the short-term?

RQ₂. Which actions will each shipping company conduct in order to comply with the regulation in the long-term?

RQ₃. Is the shipping company contributing to maritime transport sustainability in any other way?

The methodology used to answer them will be to develop a comparative analysis between the five largest carriers in the world in terms of volume traded, which are an appropriate sample of the worldwide fleet considering they hold a 60% of the total market share. The sources of information used are mainly the sustainability reports published by each company, their corporate websites, research papers, studies carried by international organizations such as the United Nations and interviews (see exhibits 24, 25 and 26) to experienced workers in the industry:

- Gerard Pujol, ESCI-UPF alumni currently working in the Import and Crosstrade department of CMA CGM.
- Ignacio Amaro, the Operations Director of Iberia in Hapag-Lloyd.
- Claudia Parera, with more than 25 years of experience in several shipping companies.

4. DEVELOPEMENT

Shippers are aware of the importance of becoming more sustainable due to the recent environmental issues and emissions increase. As a consequence, they are taking multiple actions, some of them being in the scope of the IMO 2020, and others going beyond the regulation.

4.1 Scope of IMO 2020

The measures companies are applying to comply with the IMO 2020 have been divided into two differentiated groups: the technological innovations and the management innovations. The aim of those actions is to reduce the level of emissions generated and thus, to answer research questions 1 and 2. While the IMO has defined several emission goals in the long-term, three of the carriers studied have also set corporate goals that go a step further, contained in table 3.

Goals regarding emissions reduction




 MAERSK	<ol style="list-style-type: none"> 1. To be emission free in terms of CO₂ in their own operations by 2050, which implies having net-zero vessels by 2030. 2. To reduce CO₂ emissions by a 60% before 2030 with respect to 2008 levels.
 CMA CGM	<ol style="list-style-type: none"> 1. To reduce CO₂ emissions per TEU-km by 50% before 2015, which has already been achieved. 2. Emissions of CO₂ will be reduced by 30% per TEU transported by 2025.
 Hapag-Lloyd	<p>To reduce CO₂ emissions from their fleet by a 20% with respect to 2016 data.</p>

Table 3. Environmental goals set by shipping companies. Source: Own elaboration based on corporative websites of Maersk (2020), CMA CGM (2020) and Hapag-Lloyd (2020).

4.1.1 Management innovations

Due to the impossibility of modifying the majority of vessels of their fleets, four out of the five shippers studied have opted for the shift to the use of LSFO or VSFO in most of their ships, which are Maersk, COSCO, CMA CGM and Hapag-Lloyd. The change is almost immediate, since vessels do not require any further modification, which explains why it has been chosen by most of the companies as their main option, partially answering RQ₁. The interviews revealed that shipping companies acquire the fuel for their fleets in large quantities some months prior to its usage, so as to avoid paying different prices for the fuel very frequently, which fluctuate every day. To offset those variations, clients are charged an extra fee calculated through a price adjustment mechanism, which modifies the fuel price according to market fluctuations.

During the last quarter of 2019, shippers purchased large quantities of LSFO to prepare for the IMO implementation, which was significantly expensive compared to HSFO. While the price of HSFO was of 298,5 \$/mt, the one for VLSFO was 531,5 \$/mt (see exhibit 8). Consequently, each firm defined a different price recovery mechanism with the aim of transferring the higher cost to customers⁵. However, due to the COVID-19 outbreak and the stabilization of fuel demand, prices for both fuels have drastically decreased during 2020, leading to a price conflict with carriers, which paid a very high price for a fuel that is currently low-priced. Considering the price decrease, both CMA CGM and Hapag-Lloyd have opted to cancel the application of their price recovery mechanisms from the 1st of April, even though it could be reapplied if prices go up again later.

⁵ Price mechanisms applied by each company as well as further information about the measure application are detailed in exhibit 9.

The rest of the companies have not made any announcements about their price mechanisms yet, which may be due to the fact that the oil that is currently being used was purchased when prices were high, still having costs to recover. However, interviewees have confirmed that depending on the mechanism used, the price difference is automatically applied to the mechanism, meaning that when fuel price decreases, the consumer will perceive a price decrease as well.

Reducing the vessels sailing speed results in a reduced consumption of fuel, impacting in the level of emissions generated (see exhibit 10). Moreover, noise produced by vessels can damage the wellbeing of sea animals, especially the cetaceans, increasing the risk of collision as well. However, Maersk has positioned itself against the French IMO inquiry to set speed restrictions in their coasts because, in spite of the company participating in many speed reduction programs, it believes the best option to reduce emissions is by implementing technological changes, and not setting short-term measures. According to Maersk's Chief Advisor for climate change, the presented measure would favour old and inefficient vessels to keep sailing rather than being updated to be less polluting (Chambers, 2019). In addition, MSC, CMA CGM and Hapag-Lloyd were awarded in 2019 with the Blue Circle Award under the EcoAction program from the Port Metro Vancouver⁶, which rewards carriers who decide to voluntarily reduce emissions and energy consumed with discounts and benefits. All of them also participate in the Voluntary Programmes for Speed Reduction of Santa Barbara and San Francisco Bay, having MSC been rewarded with the highest prize. Taking into consideration that no vessel modifications are required, a reduction of the sailing speed can be considered a short-term measure, providing a partial approximation to RQ₁.

The coronavirus situation has also increased the number of ships sailing at lower speeds, since that way, carriers can get to their destination at a lower cost, which is crucial these last months. As interviewees conveyed, blank sailings have become extremely common in the past months so as to allow a readjustment of routes according to the current demand for each of them, and the availability to unload goods in different ports. Initially, they were caused by the close down of Chinese producers, and as they have been returning to the normal situation, the demand for their products has fallen drastically again due to the progressive lockdown of the rest of the countries. Furthermore, many vessels are currently docked because there is not enough demand to load them completely, and others have changed their routes to adapt to the new situation.

⁶ Go to Port of Vancouver website to learn more about the EcoAction Program and the Blue Circle Awards.

As stated by Merk in 2018, there is an increasing tendency of using larger ships which enable companies to transport a higher number of containers per trip. That way, shippers can benefit from economies of scale and reduce the cost per TEU (see graph 15, exhibit 11). The current largest container vessel in the world is owned by Hyundai Merchant Marine (HMM), its name is Algeciras and it has capacity for 23.964 TEUs. It was launched on April 1st, 2020, overtaking the record held by MSC Gulsun, with space for 23.413 TEUs (V. Alexander & Co, 2020). Companies can also contribute to emissions reduction by improving cargo efficiency, extending the quantity of containers to be fitted in only one vessel and reducing the number of trips to be carried out. MSC has made several system upgrades to increase cargo capacity of their ships and to improve the loading efficiency, allowing for a reduced use of energy during the process. This is the first approximation to RQ₂ provided the purchase of larger ships has to be planned in advance and cargo efficiency plans require previous research and trials.

4.1.2 Technological Innovations

While it is the least used of the three general suggestions made by the IMO, installing scrubber systems⁷ in ships also contributes to decreasing emission levels. MSC has been the only company to opt for the use of hybrid EGCS in all of the newbuilds, being the system present in around 50% of its fleet. However, a lack of prediction and the consequences of the COVID-19 outbreak have caused many delays in its installation, and even a regulation violation (see exhibit 13). It is worth mentioning that while it has focused on scrubber systems for their container ships, cruises are using LNG systems. The rest of the shipping companies studied have also decided to invest on this system in a small share of their vessels - illustrated in figure 1 - depending on their long-term plans and their resources (see exhibit 14). These provides a partial answer to RQ₁, since even though installing EGCS requires further planning than shifting to LSFO, it is a decision that can be taken in the medium-term, considering between 6-9 months are required to equip a vessel.



Figure 1. Scrubber retrofits by shipping company. Source: Own elaboration based on corporate websites of Maersk (2020), CMA CGM (2020) and Hapag-Lloyd (2020) as well as Wackett, M. (2020) and Velmet (2019). Software: Infogram.

⁷ Scrubber system types and differences are explained in exhibit 12.

The third of the options suggested by the IMO is the use alternative fuels, such as LNG, which are less polluting. Nonetheless, there are many other possibilities that have not been further studied and, therefore, require previous research and feasibility studies. A great example of a company extensively investing in the development of new fuels is Maersk, which has resulted in the formulation of a new biofuel made from used cooking oil. The vessel line named Maersk ECO Delivery uses this type of fuel and is currently used by companies such as H&M (see exhibit 15).

During 2019, CMA CGM partnered with IKEA Transport and Logistics Services and the GoodShipping Program to test a biofuel equivalent to HFO made of forest residues and waste oil, which is expected to reduce CO₂ emissions by an 80-90% and to eliminate SO_x ones. Successful trials have allowed the company to use a marine biofuel in many of its vessels and have proven to be a great long-term alternative to current fuels. Nonetheless, 20 vessels equipped with LNG engines have been ordered by 2022, nine of them scheduled for 2020. One of the vessels has already been delivered, called CMA CGM Jaques Saadé, and it is the biggest containership using LNG technology in the world, with capacity for 23.000 TEUs (see figure 2, exhibit 16). However, the coronavirus situation may affect the delivery date of some of the newbuilds, causing delays.

Hapag-Lloyd has also elected to invest in a pilot project of LNG. Its fleet counts with 17 vessels that can be converted to Liquefied Natural Gas, also called “LNG-ready”, but by the moment, only one of them is going to be transformed during 2020, the *Sajir*⁸. However, as Ignacio Amaro stated, the COVID-19 outbreak has forced the project to be postponed, as well as any other investment related to alternative fuels. In contrast, COSCO has been the only company that hasn’t invested in alternative fuels, which may force the company to do it when stricter regulations appear.

Interviewees pointed out that LNG technology is not applicable to every active vessel due to the large share of space it occupies. Provided the system reduces the vessel capacity, it would not be efficient to use it in smaller ships, because capacity would be too little so as to compensate the required investment. In addition, Ignacio was able to provide a very interesting insight related to the vessel travel distances, since he explained that, in order for the ship to sail long distances, the space required to fit a large enough LNG tank would take up so much space from the cargo capacity that it wouldn’t be profitable. Further to this, not all ports count with LNG availability, complicating the retrofit of LNG technology even more.

⁸ The Sajir project details are presented in exhibit 17.

Therefore, every decision related to the use or of any alternative fuel has to be planned beforehand, since existing vessels will have to be subject to many modifications of the engine and its structure and newbuilds will require more construction time. Furthermore, it is the option that requires higher initial investments, which partially answers RQ₂, being measures to be taken considering the long-term.

Emissions can also be reduced by reducing the amount of fuel consumed, which not only depends on the engine but also on the shape of the vessel. The more aerodynamic the ship is, the more efficient it will be, since water resistance will be less. Changing the vessel design requires not only the installation or modification process but also the previous R+D, partially answering RQ₂.

Consequently, shippers have been recently undertaking several design improvements to make vessels more aerodynamic (see exhibit 18), which are illustrated in figure 2. Maersk hasn't made any modification of the vessel's shape since 2013, when bulbous bows were modified so as to make them more efficient when sailing at lower speeds (Spilman, 2013).

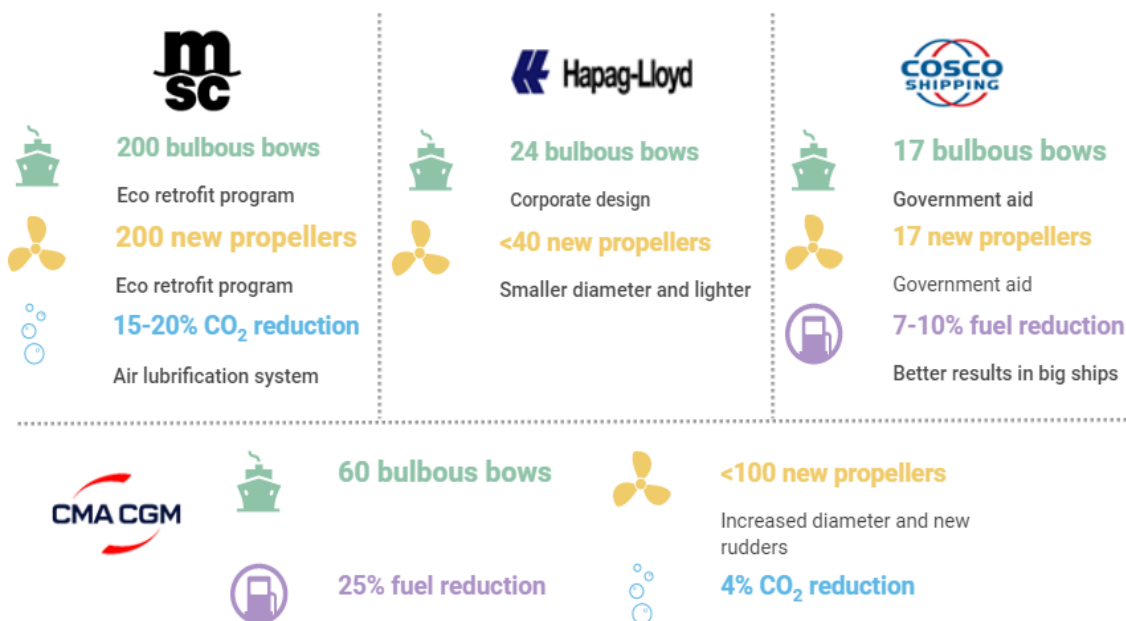


Figure 2. Actions undertaken by carriers to reduce fuel consumption through reducing water friction. Source: Own elaboration based on corporate websites of MSC (2020), CMA CGM (2020) and Hapag-Lloyd (2020) and COSCO (2020). Software: Infogram.

It is common that vessels function by using their own source of energy while they are unloading the goods in ports, which increments the amount of emissions and noise generated in the area. To avoid it, companies are making adjustments to their ships so as to allow them to connect to energy port and, thus, turn off their engines, system known as Onshore Power Supply (OPS).

Despite of being a very effective solution to reduce emissions, not all ports are equipped with the required installation⁹ and, therefore, ships must keep their engines on while docked to ensure reefer containers are kept at the appropriate temperature (TrainMoS II, n.d.).

Both MSC and CMA CGM fleet count with a cold ironing system, thanks to which vessels can connect to shore power when they are in the port, turning off their engines and reducing both noise and pollution levels. MSC has reported a reduction in port emissions by an 80% and by the end of 2018, more than 150 vessels had been equipped with this technology. Hapag-Lloyd's fleet counts with 22 ships that can be connected to the port source of energy. In fact, their ten Hamburg Express ships have also been adapted, and will use the OPS as soon as the ports they frequent invest in the technology. Given it is relatively easy to install system, these initiatives are providing an answer to RQ₁.

Refrigerated containers require a constant source of energy to keep the temperature stable during its transport. Hapag-Lloyd, which holds one of the largest fleets of reefers of the world, has developed containers which use efficient energy to keep the right temperature with an intelligent control system. Additionally, they are equipped with high performance isolation and materials used for its construction are as light as possible, so as to reduce the weight of the container and, therefore, reduce the amount of fuel required to move the ship.

CMA CGM has also redesigned some of its containers, now called eco-containers, to make them more eco-friendly. The floor of the common containers is made of normal wood while the one used by the firm in an 11% of them is bamboo, which regrows easier than trees. Furthermore, a 63% of their reefer containers are low consumption thanks to an efficient engine able to reduce the fuel consumed by two thirds. As mentioned before, reducing the weight of containers leads to an emission reduction, and this is the reason why a 3% of the firm's fleet is made of light steel.

Once more, previous R+D is needed for those measures to be effective, so they can be considered long-term options, partially answering to RQ₂. However, it is worth noting that once the technology has been created, its implementation is rapid and simple, which means that it can be installed with almost no previous planning. Therefore, depending on the case, measures can be considered in the short or in the long-term.

⁹ A detailed list of the ports using OPS system can be found in sustainableworldports.org.

As figure 3 summarizes, while all shippers are complying with the IMO 2020 regulation, the portfolio of measures in which they invest is different to a degree. When it is examined, the long-term mentality of each company can be identified, being COSCO the most short-sighted one. As it can be highlighted, while Hapag-Lloyd and Maersk are the firms which focus more on alternative fuels, CMA CGM is making several efforts as well, followed by MSC. COSCO, however, hasn't invested in any alternative fuel pilot and, by the moment, no future plans about it have been disclosed. The figure is, thus, providing the answer to RQ₁ and RQ₂, graphically concluding the actions each company is conducting regarding the IMO 2020 proposals. Nonetheless, a summary of the measures taken by carriers in order to reduce emissions is provided in table 7, exhibit 19.

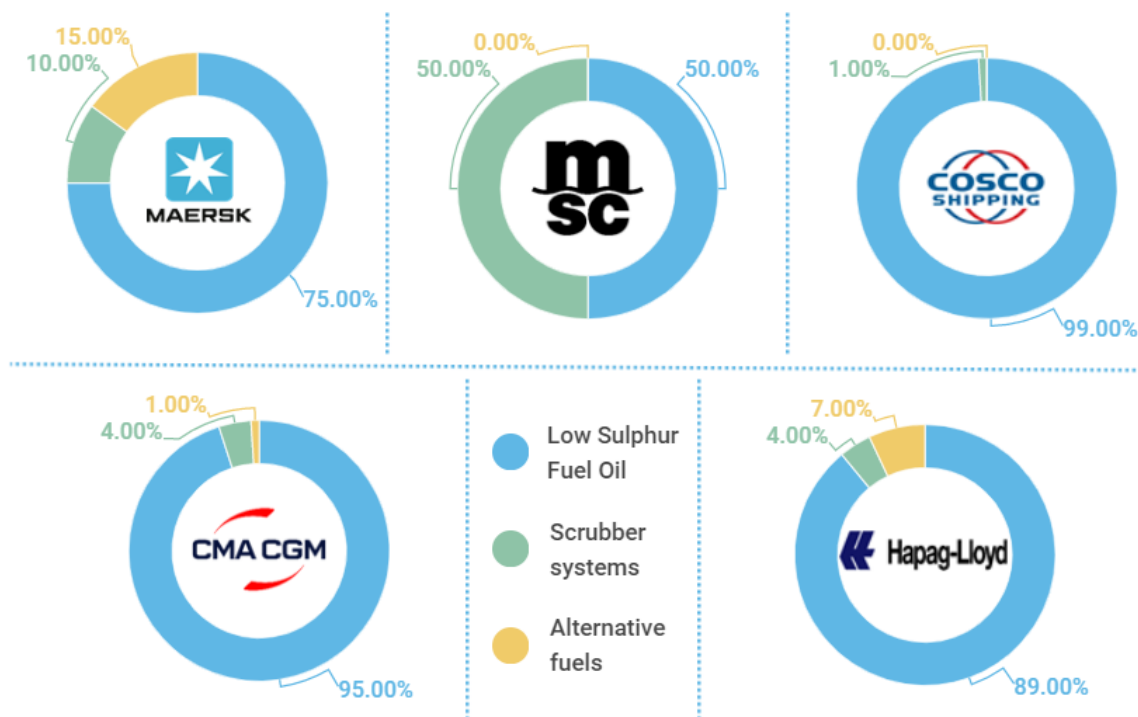


Figure 3. Application of IMO 2020 proposals by shipping company. Source: Own elaboration based on corporate websites and sustainability reports of Maersk (2019), MSC (2018), CMA CGM (2019) and Hapag-Lloyd (2018) and COSCO (2018). Software: Infogram.

4.2 Beyond IMO 2020

While the IMO strategy focuses on the reduction of GHG emissions, shipping companies are also making efforts to become more sustainable in different fields, for instance, energy consumption, sea pollution and animal conservation. Consequently, they are investing in other measures which go beyond the IMO regulation, which have been divided following the same characteristics as the previously explained measures. Every action detailed in the following section will be providing the answer to RQ₃, given its goal is to contribute to human and environmental wellbeing.

4.2.1 *Management innovations*

As stated by Stalls et al. (2019), when ships are docked in ports to be unloaded, there is a risk that, as they are emptied, the propellers or the rudder are not completely immersed, stability is lost or bows emerge from the water. To offset the weight loss, ships are able to pump water from the port into separate ballast water tanks, contributing to ship stability. As the ship is loaded, ballast water is discharged according to the weight of the load, which can take place in other ports or at sea (see figure 3, exhibit 20).

Ballast water is considered to be one of the greatest threats for ocean biodiversity, since water pumped into the tanks also contains organisms, species, eggs and larvae which are not native to the environment where they are released, which can severely damage the ecosystem. Those non-indigenous organisms are called Invasive Alien Species (from now on, IAS) and can create serious human health, infrastructure, economic and ecosystems damage (Stalls et al, 2019).

In order to reduce its generalized impact, which has been enhanced due to globalization, international regulations have been required to control the way in which ballast water is charged and discharged in opposite parts of the world. For this reason, the Convention for Control and Management of Ship's Ballast Water and Sediments (from now on, BMW), created by the IMO, entered into force in September 2017, obliging vessels to manage their ballast water in two different ways: exchanging or releasing a 95% of ballast water far from coasts or eliminating the organisms contained in it, which can be done through ballast water treatment systems.

There is another regulation created by the US Coast Guard which goes beyond the BMW regulation, which means some of the vessels travelling in American waters must comply with even stricter requirements. In 2019, about 19% of containerships had a ballast water treatment installed (see graph 16, exhibit 20), fact that depends on the age of the ships and the routes followed. Larger and newer vessels are bound to have the systems installed, usually linked to the fact that they sail in international water, which increases the risk of IAS transfer. On the other hand, older and smaller vessels travelling in national waters may not require the mentioned system, provided the risk of transferring different species to different ecosystems is lower (UNCTAD, 2019).

Each Maersk ship ordered after 2012 has already been equipped with the water treatment system and all of them comply with the BMW Convention since then. Every new MSC and Hapag Lloyd's vessel is also provided with a proper water management system while the existing ones are installed an external ballast unit in the case of MSC. The type of system that Hapag Lloyd has been installing, along with CMA CGM since 2015, is able to eliminate the present organisms through ultrasounds and UV radiation, avoiding chemicals that may pollute water. The ships which do not count with the system, only discharge ballast water away from the coasts, where organisms aren't able to survive (SKF, 2019).

COSCO has defined several corporate directives to be followed by its fleet, which are aimed at charging and discharging water in the permitted areas rather than to develop systems capable of treating the water. It can be assessed, once more, that COSCO is the only company which is not conducting investments nor trials in options that could be useful in the long-term, taking into consideration that regulations will become stricter in a near future.

When the lifecycle of a ship comes to an end, the majority of them are dismantled so as to reuse some of its materials. However, ship demolition is related to many negative environmental effects (UNCTAD, 2019) and as shipping companies are aware of the situation, they are implementing measures aimed at reducing the environmental and human health impact of the dismantling processes of their vessels (see exhibit 21). Since 2015, the European Union has made it compulsory for shipping companies to equip their newbuilds with an Inventory of Hazardous Materials (IHM) which lists the materials that can damage human health or the environment.

In relation to that, Hapag-Lloyd has been the first company worldwide awarded with the "DNV GL Excellence Green Star" for complying with very strict standards in relation to ship scrapping, specified under their internal Ship Recycling Policy and, in fact, it started equipping their vessels with the IHM before it was compulsory. Together with Maersk and CMA CGM, they have joined the Ship Recycling Transparency Initiative¹⁰ so as to make the information about their recycling processes transparent and available to everyone. All the shipping companies comply with the IMO Hong Kong Convention, which sets some environmental standards to be met during the recycling process, and the European ones comply as well with the EU Ship Recycling Regulation (EU SRR).

¹⁰ Check the Ship Recycling Initiative 2020 report for further details.

The melting of the ice caps of the Arctic has made the Northern Sea Route (from now on, NSR) navigable during certain months of the year, allowing a rapid connection between Northeast Asia and North-western Europe and, therefore, a fuel and emissions reduction as well. In accordance with Bekkers & Rojas-Romagosa (2015) findings, using the route could lead to a 20-30% average cost reduction but, at the same time, trade between regions would be boosted, offsetting the effects of the emissions reduction, which could even slightly increase. Maersk has decided to test whether using the route would benefit the firm but, after conducting a trial, the company will not use the route again. CMA CGM, Hapag-Lloyd and MSC have decided not to even test it for environmental reasons, since they believe that using it would harm the local biodiversity and would be dangerous for local fauna, especially cetaceans. On the contrary, COSCO is a frequent user of the route, which completed 30 trips between 2014-2018 (Humpert, 2018).

With the goal of increasing the environmental awareness, MSC has partnered with an Italian marine conservation association since 2015, called Marevivo, to develop three educational activities aimed at educating youth about the conservation of marine resources in schools, to provide knowledge and skills about the maritime sector to nautical institutes and to boost children knowledge about the environment on board of MSC cruises. It is worth mentioning that the firm is part of several wildlife preservation programmes, such as the Buckingham Palace Declaration Against Wildlife Trafficking and the Task Force, both aimed at avoiding the illegal traffic of species like elephants, rhinos and pangolins. In fact, the shipper banned in 2018 the transport of animal hunting trophies and shark fins as well.

To achieve information transparency, Hapag-Lloyd provides an online calculator of emissions in their website, known as EcoCalc. When clients introduce data about the service, which is the port of origin and destination and the volume transported, they are immediately shown a list of the emissions they will be generating of SO_x, NO_x, PM and CO₂. In conformity with what Ignacio explained, there are several clients that only accept the service if the emissions are below their limits, even though most of them look for low prices only. Gerard Pujol confirmed his affirmation, provided CMA CGM has an emission calculator in its intranet. Nonetheless, he verified that they have several clients which specifically pursue services with low emission levels, such as Decathlon, and if they are too high, they reject the service regardless of its price. While MSC also counts with an emission calculator in its intranet, I haven't been able to determine if Maersk or COSCO provide this kind of service.

4.2.2 *Technological Innovations*

In order to create new regulations and develop technologies that contribute to the wellbeing of the environment and the sea, information is key. Maersk is aware of the cost and effort required to collect useful data, and as a consequence, contributes to research initiatives related to the ocean. In April 2019, one of Maersk ships, Olivia, dropped five high-tech buoys into the South Pacific so as to collect data like the sea temperature and the currents. In fact, it has already been able to launch 19 buoys to the sea in two years, which collect data for the World Ocean Council and the National Oceanic and Atmospheric Administration in the US. Furthermore, the carrier is also committed with the compliance of the Sustainable Ocean Principles defined by the United Nations with the goals of reducing pollution and ensuring long-term sustainability among others.

One of the main issues the ocean is currently facing is plastic pollution. As declared by the United Nations in 2017¹¹, between 4.8 million and 12.7 million tons of plastic are thrown into the sea every year due to an incorrect waste management of the residues. The Ocean Cleanup is a non-profit organization created to eliminate the 90% of the plastics of the ocean thanks to the new technologies they develop (The Ocean Cleanup, 2019). In June 2019, the Maersk Transporter went from Vancouver to the North Pacific sea by using a net system with floaters designed by the organization that collects the floating plastic as the ship sails (see exhibit 22).

While CMA CGM is not conducting any action to collect plastic from the sea, the Green Ship program has been launched to assure waste is properly sorted, to prohibit throwing waste to the sea and to optimize the recycling process on shore. Moreover, incinerators used to burn the generate garbage have been replaced with compactors, so as to avoid the emission of the burning gases to the atmosphere. Hapag-Lloyd also counts with strict internal policies with the aim of correctly sorting waste on board and properly disposed when on land by the corresponding recycling companies. The only garbage thrown to the sea are food leftovers. Regarding wastewater, vessels count with treatment plants and concerning the disposal of used oil, it is only conducted in the authorised facilities on land.

¹¹ Refer to the study conducted by the United Nations in 2017 about plastic pollution to discover more insights about the topic.

5. CONCLUSIONS

The aim the paper was to define how were the five biggest shipping companies worldwide complying with the IMO 2020. As I have evidenced, there are differences in the time horizons of their actions. Short-term measures include the shift to LSFO and reducing the speed, initiatives conducted by all shippers. Scrubber systems have been tested by all companies but chosen as the main option only by MSC. COSCO has only equipped 1% of the fleet with the system, using LSFO in the rest of its vessels. Regarding long-term initiatives, retrofits of LNG have been conducted by Maersk, CMA CGM and Hapag-Lloyd. While only Maersk and CMA CGM have invested in R+D to develop alternative fuels, every carrier has modified the vessel shape to reduce fuel consumption.

As I have confirmed, the most practical measure to adopt in the short-term is the use of LSFO. However, the IMO 2020 will become stricter with time, and thus, companies should be looking for ways to avoid generating emissions rather than reducing them, which could be done through the development of alternative fuels or the use of LNG. While installing scrubber systems is an appropriate short-term measure, I would not recommend ships to focus on it, since HSFO could be banned in a future due to its quantity of sulphur. Furthermore, I strictly believe there is a need for a ballast water regulation, given it is the second major threat for ocean biodiversity.

My first contribution has been to gather the measures taken by the shippers - which occupy a 60% of the market share – to comply with the IMO 2020, with the goal of analysing their quick response to a new regulation, which didn't exist. My second contribution is to evaluate how the short-term measures chosen are an adequate transition towards future regulations, assessing how prepared companies are for the long-term. Finally, I have also contributed to the identification of the shippers which are more committed to the environment.

The main limitation has been the impossibility to conduct a cost-benefit analysis, given there is no financial information about the measures studied. The regulation entered into force on January, being its implementation too recent to make conclusions. Furthermore, the COVID-19 has stopped global economy since March, causing delays and leading to an unpredicted situation.

Future lines of investigation could cover the study of the environmental impact of the regulation, a cost-benefit analysis of the measures implemented per company and even an analysis of the violations of the regulation and the bans applied. Finally, analyzing which companies have acted as innovators, as imitators and which as idiots could also be a matter of interest.

6. BIBLIOGRAPHY AND WEBGRAPHY

BIBLIOGRAPHY

- Bekkers, E. & Francois, J. & Rojas-Romago, H. (2015). *Melting ice caps and the economic impact of opening the northern sea route* (Report No.307). Discussion paper, CBP Netherlands Bureau for Economic Policy Analysis.
- Bierwirth, P. (2016). *Carbon dioxide toxicity and climate change: a serious unapprehended risk for human health*. Australian National University.
- DNV GL (2017). *Maritime forecast to 2050*. DNV GL Maritime.
- GL Reynolds (2019). *The multi-issue mitigation potential of reducing ship speeds*. Seas at Risk and Transport and Environment.
- Hughes, E. (2018). *Initial IMO strategy on reduction of GHG emissions from ships*. International Maritime Organization.
- IMO (2016). *Studies on the feasibility and use of LNG as a fuel for shipping*.
- Merk, O. (2018). *Container ship size and port relocation*. Discussion Paper, International Transport Forum, Paris.
- Science for Environment Policy (2016). *Ship recycling: reducing human and environmental impacts*. Report No. 55. Issue produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol.
- Ship Recycling Transparency Initiative (2020). *2020 Report*. Report No. 2.
- Slaughter, A. & Ray, S. & Shattuck, T. (2019). *IMO 2020: Strategies in a non-compliant world*. Deloitte.
- Stalls, S. & Chikae, A. & Zorlu, S. & Kenmochi, S. (2019). *Ballast Water Management*. UCLA Luskin Center for Innovation.
- Tatar, V. & Özer, M. (2018). *The impacts of CO₂ emissions from maritime transport on the environment and climate change*. Vol. 2, Issue 1, 5-24.
- UNCTAD (2019). *Review of maritime transport, 2019*. Report No. E.19.II.D.20.
- UNCTAD (2020). *Global trade impact of coronavirus (COVID-19) epidemic*. Report No. UNCTAD/DITC/INF/2020/1.
- United Nations (2017). *Towards a pollution-free planet*. UNEP/EA.3/25, United Nations Environment Assembly of the United Nations Environment Programme.
- Walker, T. & Adebambo, O. & Del Aguilera Feijoo, M. & Elhaimer, E. & Hossain, T. & Johnson Edwards, S. & Morrison, E. & Romo, J. & Sharma, N. & Taylor, S. & Zomorodi, S. (2018). *Environmental Effects of Marine Transportation*. Dalhousie University, Canada.
- World Health Organization (2005). Chapter 7.1. Nitrogen Dioxide. *Air Quality Guidelines*.

WEBGRAPHY

- Alphaliner (n.d.). *Alphaliner Top 100*. Retrieved April 01, 2020, from <https://alphaliner.axsmarine.com/PublicTop100/>
- Berti, A. (2020). *The impact of Covid-19 on global shipping sector: part 2, silver linings*. Ship Technology. <https://www.ship-technology.com/impact-of-coronavirus-on-shipping/>
- Berti, A. (2020). *The impact of Covid-19 on global shipping: part 1, system shock*. Ship Technology. <https://www.ship-technology.com/impact-of-covid-19-on-shipping/>
- Chambers, S. (2019). *Speed reduction proposals favour old inefficient ships: Maersk*. Splash. <https://splash247.com/speed-reduction-proposals-favour-old-inefficient-ships-maersk/>
- CMA CGM (2019). *CMA CGM accelerates the deployment of marine biofuel*. <https://www.cmacgm-group.com/en/news-medias/CMA-CGM-accelerates-the-deployment-of-marine-biofuel>
- CMA CGM (2019). *IKEA, CMA CGM and GoodShipping successfully complete 2019 biofuel test programme*. <https://www.cmacgm-group.com/en/news-medias/IKEA-CMA-CGM-and-GoodShipping-successfully-complete-2019-biofuel-test-programme>
- CMA CGM (2019). *Low sulphur IMO 2020 regulation*. <https://www.cmacgm.com/static/UV/attachments/Low%20Sulphur%20IMO%202020%20Regulation%20August%202019%20ENG%20short%202020.pdf>
- CMA CGM (2019, December 04). *CMA CGM chooses Total for the supply of Liquefied Natural Gas in Marseille-Fos for its 15,000-TEU container ships*. <https://www.cmacgm-group.com/en/news-medias/CMA-CGM-and-Total-sign-a-major-agreement-for-the-supply-of-Liquefied-Natural-Gas-for-CMA-CGMs-15000-TEU-container-ships>
- CMA CGM (2020). *CMA CGM and the Port of Dunkirk inaugurate a "cold ironing" system allowing ships to plug into onshore electricity*. <https://www.cmacgm-group.com/en/news-medias/CMA-CGM-and-the-Port-of-Dunkirk-inaugurate-a-cold-ironing-system-allowing-ships-to-plug-into-onshore-electricity>
- CMA CGM (n.d.). *CMA CGM is the first shipping company to choose liquefied natural gas for its biggest ships*. <https://www.cmacgm-group.com/en/news-medias/world-innovation-cma-cgm-is-the-first-shipping-company-to-choose-liquefied-natural-gas-for-its-biggest-ships>
- CMA CGM (n.d.). *IMO 2020*. Retrieved April 16, 2020, from <https://www.cmacgm.com/about/imo-2020>
- CMA CGM (n.d.). *The CMA CGM JACQUES SAADE, the world's first 23,000 TEU powered by LNG*. Retrieved May 7, 2020, from <https://cmacgm-group.com/en/launching-cmacgm-jacques-saad-c3a9-world-s-first-ultra-large-vessel-powered-by-ling>
- COSCO (2018). *2018 Sustainability Report*. <http://lines.coscoshipping.com/home/About/sustainabilityReport>
- COSCO Shipping Lines (2019). *Announcement of new bunker surcharge*. <http://lines.coscoshipping.com/home/News/detail/>
- Hapag-Lloyd (2015). *New noses for lower emissions*. https://www.hapag-lloyd.com/es/news-insights/insights/2015/07/new-noses-for-lower-emissions_42015.html
- Hapag-Lloyd (2018). *Sustainability report 2018*. Retrieved from <https://www.hapag-lloyd.com/en/about-us/sustainability/sustainability-report.html>
- Hapag-Lloyd (2019). *A first in liner shipping: Hapag-Lloyd to convert ship to LNG*. <https://www.hapag-lloyd.com/zh/news-insights/insights/>
- Hapag-Lloyd (2019). *IMO 2020 for greener shipping*. <https://www.hapag-lloyd.com/es/about-us/sustainability/imo-2020.html>
- Hellenic Shipping News (2019). *Maersk: Shippers will only pay for IMO 2020 "cost recovery"*. <https://www.hellenicshippingnews.com/maersk-shippers-will-only-pay-for-imo-2020-cost-recovery/>
- Humpert, M. (2018). *Record Traffic on Northern Sea Route as COSCO Completes Five Transits*. High North News. <https://www.highnorthnews.com/en/record-traffic-northern-sea-route-cosco-completes-five-transits>

- Ihms, M. (2019). *Reinventing the wheel*. DNV GL. <https://www.dnvgl.com/expert-story/maritime-impact/Reinventing-the-wheel.html>
- IMO (n.d.). *Sulphur 2020 – cutting sulphur oxide emissions*. Retrieved April 1, 2020, from <http://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx>
- Innovation technologies (n.d.). CMA CGM. Retrieved April 18, 2020, from <https://www.cmacgm-group.com/en/csr/environment/innovation-technologies>
- Jaffe, N. (2019). *LNG for 2020: IMO Sulphur Limits and the LNG alternative*. Reed Smith. <https://www.assetfinancinbrief.com/2019/05/ling-for-2020-imo-sulfur-limits-and-the-ling-alternative/>
- Maersk (2019). *2019 Sustainability report*. Retrieved from <https://www.maersk.com/about/sustainability/>
- Maersk (2020). *Bunker Adjustment Factor (BAF) & Environmental Fuel Fee (EFF) trigger*. <https://www.maersk.com/news/articles/2020/01/21/baf-eff-trigger>
- MSC (2018). *2020 sulphur cap*. <https://www.msc.com/che/news/2018-september/2020-sulphur-cap>
- MSC (2018). *2018 sustainability report*. <https://www.msc.com/reu/news/2019>
- MSC (2020). *MSC Joanna fuel carriage*. <https://www.msc.com/aze/notices/2020-march/msc-joanna-fuel-carriage>
- Hapag-Lloyd (n.d.). *On board*. Retrieved April 16, 2020, from https://www.hapag-lloyd.com/en/about-us/sustainability/on-board.html#anchor_7c6c29
- OECD (2020). *Coronavirus: the world economy at risk*. <https://www.oecd.org/economic-outlook/>
- Port of Vancouver (n.d.). *Air, energy and climate action: ships*. Retrieved April 23, 2020, from <https://www.portvancouver.com/environment/air-energy-climate-action/marine/>
- Sethi, S. (2020). *A guide to scrubber system on ship*. Marine Insight. Retrieved April 12, 2020, from <https://www.marineinsight.com/tech/scrubber-system-on-ship/>
- Ship Bunker (n.d.). *Rotterdam Bunker Prices*. Retrieved April 8, 2020, from <https://shipandbunker.com/prices/rotterdam#VLSFO>
- SKF (2019). *Hapag Lloyd puts SKF BlueSonic Ballast Water Management System to the test*. <https://www.skf.com/il/news-and-events/news/2019/2019-03-09-hapag-lloyd-puts-skf-bluesonic-ballast-water-management-system-to-the-test>
- Spilman, R. (2013). *Container Ship Nose Jobs - Maersk Retrofits Bulbous Bows for Slow Steaming*. The Old Salt Blog. <http://www.oldsaltblog.com/2013/03/container-ship-nose-jobs-maersk-retrofits-bulbous-bows-for-slow-steaming/>
- Statista (2020). *Leading container ship operators*. <https://www.statista.com/statistics/198206/share-of-leading-container-ship-operators-on-the-world-liner-fleet/>
- Teoh, P. (2020). *The impact of the Covid-19 pandemic on shipping*. The Maritime Executive. <https://www.maritime-executive.com/editorials/the-impact-of-the-covid-19-pandemic-on-shipping>
- The Motorship (2019). *A second wind for air lubrication systems*. Retrieved April 21, 2020, from <https://www.motorship.com/news101/ships-equipment/a-second-wind-for-air-lubrication-systems>
- The Ocean Cleanup (2019). *System 001 overview*. Retrieved May 03, 2020, from <https://theoceancleanup.com/milestones/system001/>
- TrainMoS II (n.d.). *On shore power supply and LNG*. <https://www.onthemosway.eu/wp-content/uploads/2015/06/2-OPS-LNG.pdf>
- UN Global Compact (n.d.). *United Nations Global Compact launches principles for sustainable ocean business*. Retrieved April 30, 2020, from <https://www.unglobalcompact.org/news/4472-09-13-2019>
- v. Alexander & Co (2020). *HMM trumps MSC with new largest container ship introduction*. <https://www.valexander.com/2020/02/12/msc-introduces-largest-container-ship-in-service-so-far/>
- Velmet (2019). *Velmet to supply exhaust gas cleaning systems to COSCO Shipping Lines in China*. <https://www.valmet.com/media/news/press-releases/2019/valmet-to-supply-exhaust-gas-cleaning-systems-to-cosco-shipping-lines-in-china/>
- Wackett, M. (2020). *Carrier bosses angry as scrubber fitting delays start to impact earnings*. The Loadstar. <https://theloadstar.com/carrier-bosses-angry-as-scrubber-fitting-delays-start-to-impact-earnings/>
- World Health Organization (2020). *Covid-19 and world trade*. Retrieved April 17, 2020, from https://www.wto.org/english/tratop_e/covid19_e/covid19_e.htm
- World Maritime News (2020). *MSC investigating how HSFO was left on board MSC Joanna, since its EGCS installation was delayed*. Offshore Energy. <https://www.offshore-energy.biz/msc-investigating-how-hsfo-was-left-on-board-msc-joanna-since-its-egcs-installation-was-delayed/>
- World Maritime News (2020). *UAE bans MSC-operated boxship for violating carriage ban*. Offshore Energy. <https://www.offshore-energy.biz/uae-bans-msc-operated-boxship-for-violating-carriage-ban/>
- World Port Sustainability Program (n.d.). *Ports using OPS*. Retrieved April 25, 2020, from <https://sustainableworldports.org/ops/ops-installed/ports-using-ops/>

7. ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude to my teacher and advisor, Jose Miguel Aliaga, without whom this project wouldn't have been possible. He has not only been giving me support and motivation during the journey but also has been able to reorganise by broad ideas into the right path. My interest for the industry and the logistics has been boosted, and he has been one of the reasons behind it.

I would also like to thank Gerard Pujol, Ignacio Amaro and Claudia Parera for investing some of their time in my project and sharing their knowledge and expertise with me. The information they have provided me has been extremely useful and talking to them has been a great pleasure.

Finally, I also want to express my gratitude to Argimiro Ruiz, a worker from Hapag-Lloyd who has been contacting several of his colleagues to find the right people to help with the project.

8. EXHIBITS

Exhibit 1: Maritime transport. Economic perspective	23
Exhibit 2: Maritime transport. Environmental perspective	28
Exhibit 3: Container Shipping Companies	29
Exhibit 4: IMO 2020	31
Exhibit 5: LNG study results.....	33
Exhibit 6: Age of the fleet	35
Exhibit 7: Maritime trade forecast.....	36
Exhibit 8: Fuel price changes over time	38
Exhibit 9: Shift to LSFO per company	39
Exhibit 10: Effects of speed reduction on CO2 emissions	40
Exhibit 11: Vessel size evolution	41
Exhibit 12: Types of scrubber systems	42
Exhibit 13: MSC scrubber retrofits.....	43
Exhibit 14: Scrubber retrofits by shipping company	44
Exhibit 15: Maersk research initiatives	45
Exhibit 16: CMA CGM alternative fuels strategy	46
Exhibit 17: Hapag-Lloyd's Sajir project	47
Exhibit 18: Fuel reduction initiatives	48
Exhibit 18: Fuel reduction initiatives	48
Exhibit 19: Summary of IMO 2020 measures	49
Exhibit 20: Ballast water	50
Exhibit 21: Effects of scrapping industry.....	51
Exhibit 22: Ocean Cleanup Initiative with Maersk contribution.....	52
Exhibit 23: Summary of measures beyond IMO 2020.....	53
Exhibit 24: Gerard Pujol interview	54
Exhibit 25: Ignacio Amaro interview.....	59
Exhibit 26: Claudia Parera Interview	63

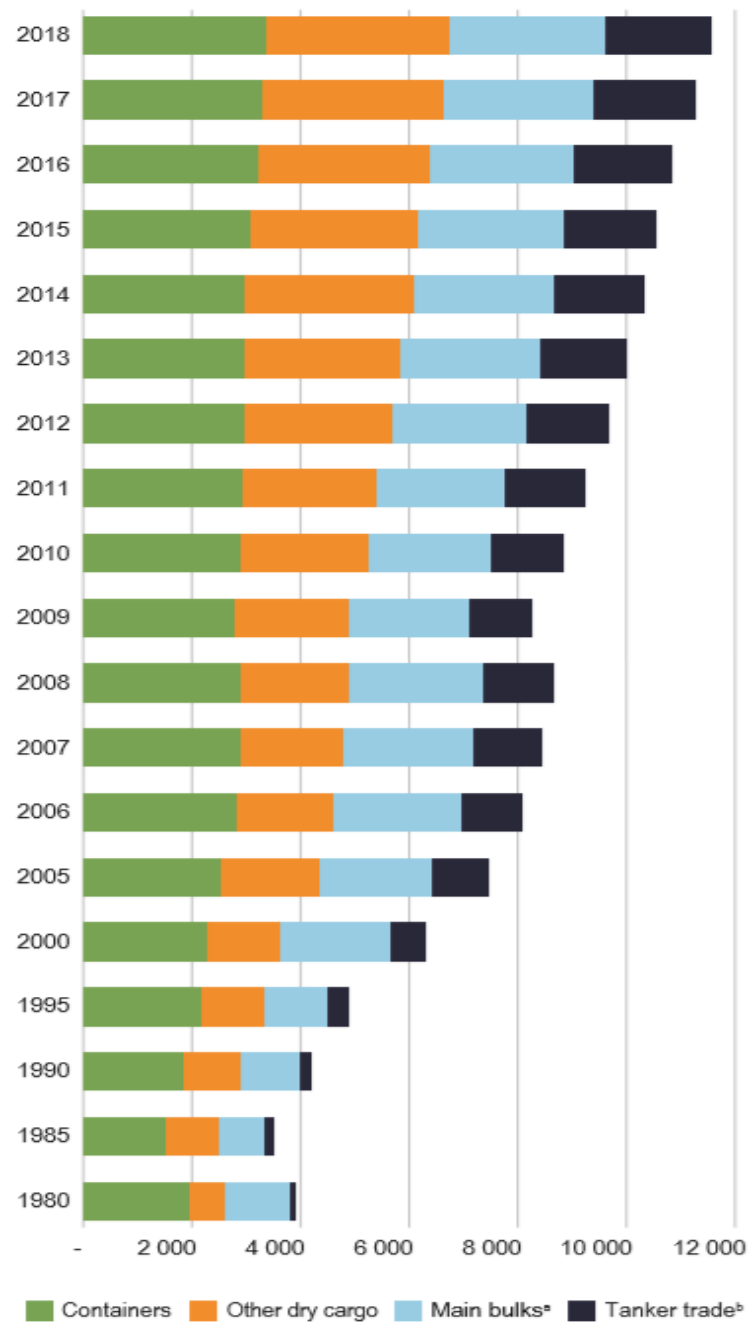
Exhibit 1: Maritime transport. Economic perspective

One of the main indicators of demand for the maritime transport is the global industrial production, which has decreased from a 3,6% growth in 2017 to a 3,1% in 2018. Trade tensions between China and the United States have also led to a reduction in global trade and, as data shows, commercial exchanges between both countries have dropped a 15% since September 2018 (UNCTAD, 2019).

Volume of exports			Countries or regions	Volume of imports		
2016	2017	2018		2016	2017	2018
1.3	4.1	2.5	World	1.2	4.8	3.1
1.0	3.3	2.1	Developed countries <i>of which:</i>	2.2	3.1	2.5
2.3	6.0	2.7	Japan	0.8	2.8	2.0
-0.2	4.0	4.1	United States	0.5	4.0	5.3
1.1	3.6	1.6	European Union	3.1	2.6	1.5
0.0	4.5	4.1	Transition economies <i>of which:</i>	5.8	13.0	3.9
-0.3	4.2	4.3	Commonwealth of Independent States	5.1	14.1	3.3
2.0	5.2	2.9	Developing countries	-0.4	6.8	4.0
0.5	3.7	-0.6	Africa	-5.4	-0.4	4.5
0.1	6.1	6.3	Sub-Saharan Africa	-10.4	1.1	2.1
2.5	3.0	2.5	Latin America and the Caribbean	-6.0	5.2	5.9
1.3	6.5	3.3	East Asia <i>of which:</i>	1.7	6.9	4.6
1.4	7.1	4.1	China	3.7	8.9	6.4
5.7	5.8	2.5	South Asia <i>of which:</i>	1.3	11.5	2.8
2.7	6.6	4.3	India	-1.8	11.7	3.1
2.6	8.9	4.6	South-East Asia	2.4	9.5	6.8
2.5	-1.2	2.0	Western Asia	-1.7	2.5	-4.1

Table 1. Growth in volume of merchandise trade, 2016-2018 (annual percentage change). Source: UNCTAD (2019).

The level of global merchandise trade, which includes imports and exports, fell to a 2,8% in 2018 compared to a rate of 4,5% in 2017. Import demand has decreased in developing and developed countries, leading to a reduction of the production of global capital goods, which are intensive in trade. Western Asia has suffered from a negative growth rate in volume of merchandise traded due to oil price issues, geopolitical tensions and political unrest. Furthermore, not only Europe and Asia have experienced a decrease in both imports and exports, as it is shown in table 1, but also countries such as Egypt, Indonesia, Pakistan, Sri Lanka and Turkey have implemented, in 2018, several restrictions and tariff increases, all of these factors affecting the volume of goods traded.



Graph 1. International maritime trade by cargo type. Source: UNCTAD (2019).

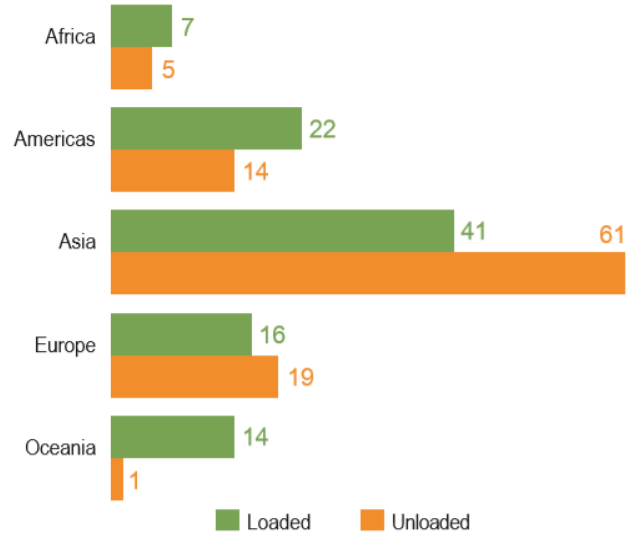
In table 2, we can see the share of developing countries in international maritime transport in terms of goods loaded (exports) and unloaded (imports) between 1970 and 2018. Developing countries are the main source of exports, loading a 58,8% of the total volume traded in 2018, and unloading a 64,8%. As a matter of fact, the volume of unloaded goods has followed an increasing trend, whereas the volume of goods loaded has remained quite constant over the past two decades.

Country group	Goods loaded					Goods unloaded			
	Year	Total	Crude oil	Other tanker trade*	Dry cargo	Total	Crude oil	Other tanker trade*	Dry cargo
Millions of tons									
World	2017	10 716.2	1 874.6	1 271.6	7 570.1	10 702.3	2 033.7	1 289.4	7 379.2
	2018	11 005	1 886.2	1 308.1	7 810.7	11 002.2	2 048.5	1 321.8	7 631.9
Developed economies	2017	3 709	152.7	491.2	3 065.1	3 795	979.1	494.7	2 321.2
	2018	3 821.7	157.7	511.2	3 152.7	3 822.9	946.5	495.8	2 380.5
Transition economies	2017	694.4	206.8	41.6	445.9	81.4	0.3	4.6	76.4
	2018	713.3	203.8	39.6	469.9	86.5	0.3	4.8	81.3
Developing economies	2017	6 312.8	1 515	738.8	4 059	6 825.9	1 054.3	790	4 981.6
	2018	6 469.9	1 524.7	757.3	4 188	7 092.8	1 101.6	821.2	5 170
Africa	2017	740.9	291.3	70.4	379.1	496.8	40.5	93.8	362.6
	2018	767.2	289.3	73.8	404	516.3	42.5	93.9	380
America	2017	1 371.8	225.2	71.9	1 074.7	617.2	47.5	141.4	428.2
	2018	1 403.7	219.3	78.3	1 106.1	652.5	51.8	149	451.8
Asia	2017	4 192	996.9	595.6	2 599.5	5 696.9	965.4	549.4	4 182.1
	2018	4 290.7	1 014.4	604.1	2 672.1	5 908.3	1 006.5	572.5	4 329.3
Oceania	2017	8.1	1.6	0.8	5.7	14.9	0.8	5.4	8.7
	2018	8.4	1.6	1.0	5.8	15.6	0.8	5.8	9
Country group	Goods loaded					Goods unloaded			
	Year	Total	Crude oil	Other tanker trade*	Dry cargo	Total	Crude oil	Other tanker trade*	Dry cargo
Percentage share									
World	2017	100	17.5	11.9	70.6	100	19	12.1	69
	2018	100	17.1	11.9	71	100	15.5	11.6	72.9
Developed economies	2017	34.6	8.1	38.6	40.5	35.5	48.1	38.4	31.5
	2018	34.7	8.4	39.1	40.4	34.7	46.2	37.5	31.2
Transition economies	2017	6.5	11	3.3	5.9	0.8	0	0.4	1
	2018	6.5	10.8	3	6	0.8	0	0.4	1.1
Developing economies	2017	58.9	80.8	58.1	53.6	63.8	51.8	61.3	67.5
	2018	58.8	80.8	57.9	53.6	64.5	53.8	62.1	67.7
Africa	2017	6.9	15.5	5.5	5	4.6	2	7.3	4.9
	2018	7	15.3	5.6	5.2	4.7	2.1	7.1	5
America	2017	12.8	12	5.7	14.2	5.8	2.3	11	5.8
	2018	12.8	11.6	6	14.2	5.9	2.5	11.3	5.9
Asia	2017	39.1	53.2	46.8	34.3	53.2	47.5	42.6	56.7
	2018	39	53.8	46.2	34.2	53.7	49.1	43.3	56.7
Oceania	2017	0.1	0.1	0.1	0.1	0.1	0	0.4	0.1
	2018	0.1	0.1	0.1	0.1	0.1	0	0.4	0.1

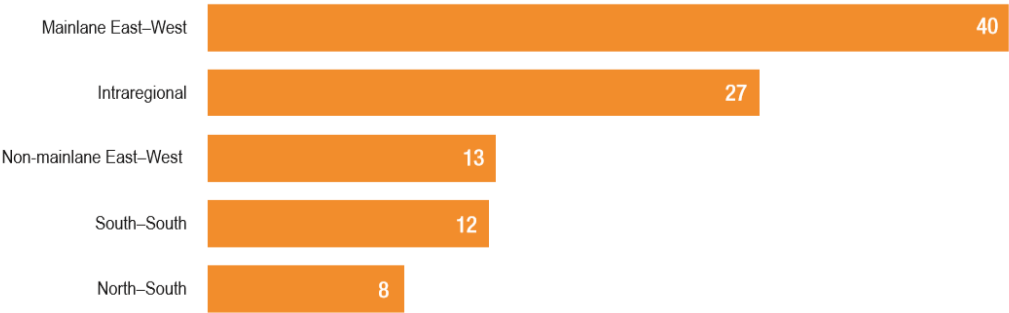
Table 2. International maritime trade volume and percentage share (type of cargo, country group and region), 2017-2018. Source: UNCTAD (2019).

While developing countries have focused on the export of raw materials and the import and export of finished and semi-finished goods, containerized trade is conducted mainly in Asia, specifically in China and neighbouring countries. Maritime trade with developing countries, including both imports and exports, has been slowly decreasing and the share of trade generated by transition economies has remained being quite small, accounting only for a 6,5% of the world exports and less than 1% of imports.

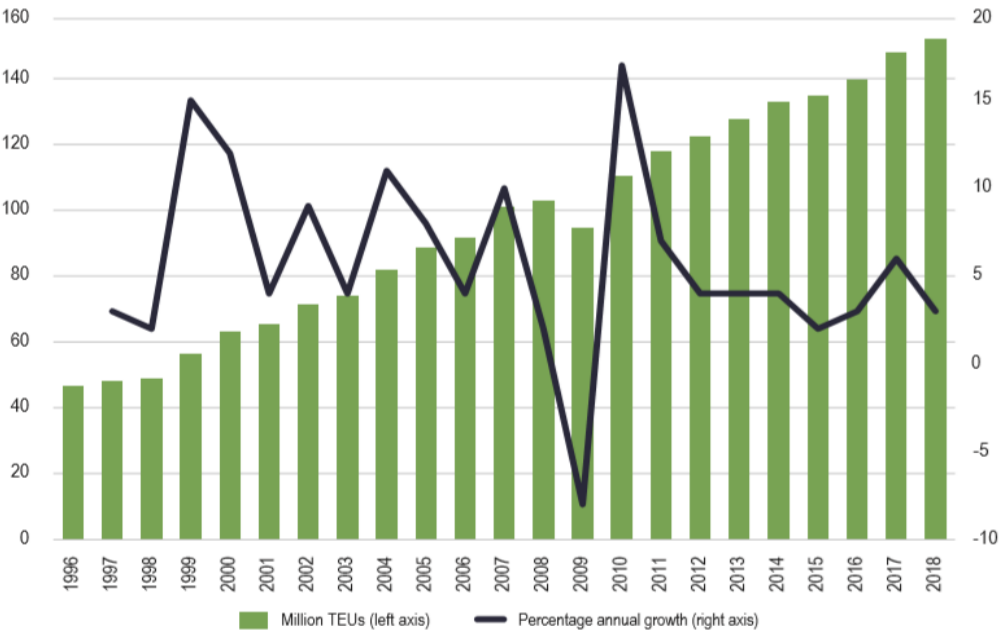
As shown graph 2, the main source of goods loaded and unloaded is China, loading a 41% of the total world trade volume and unloading a 61% of those goods. However, one of the main reasons that explains such high volumes is the fact that many finished goods are produced in several parts of Asia, and assembled in others, moving the semi-finished goods and raw materials from one country to another in the same region (see graph 3).



Graph 2. International maritime trade by region (percentage share in world tonnage), 2018. UNCTAD, 2019.



Graph 3. Global containerized trade by route (market shares, in percentage), 2018. Source: UNCTAD (2019).



Graph 4. Global containerized trade evolution (million 20-foot equivalent units and annual percentage share), 1996-2018. Source: UNCTAD (2019).

When deeply analysing the growth per route regarding container shipping, trade has continued growing in the major East-West trade lanes at a 4,8% pace, being the Trans-Pacific route the most busy of all, followed by the Asia-Europe route and the Transatlantic route. Percentage changes in each route are visible in table 3.

	Trans-Pacific			Asia-Europe			Transatlantic		
	Eastbound	Westbound	Trans-Pacific	Eastbound	Westbound	Asia-Europe	Eastbound	Westbound	Transatlantic
	East Asia-North America	North America-East Asia		Northern Europe and Mediterranean to East Asia	East Asia to Northern Europe and Mediterranean		North America to Northern Europe and Mediterranean	Northern Europe and Mediterranean to North America	
2014	16.2	7.0	23.2	6.3	15.4	21.8	2.8	3.9	6.7
2015	17.5	6.9	24.4	6.4	15.0	21.5	2.7	4.1	6.9
2016	18.3	7.3	25.6	6.8	15.4	22.2	2.7	4.2	7.0
2017	19.5	7.3	26.8	7.1	16.5	23.6	3.0	4.6	7.6
2018	20.9	7.4	28.2	7.0	17.4	24.4	3.1	4.9	8.0
Annual percentage change									
2014-2015	7.9	-2.0	4.9	1.4	-2.6	-1.4	-2.4	5.6	2.2
2015-2016	4.4	6.6	5.1	6.3	2.5	3.6	0.4	2.9	1.9
2016-2017	6.7	-0.5	4.7	4.1	6.9	6.0	7.9	8.3	8.1
2017-2018	7.0	0.9	5.4	-1.3	5.7	3.6	5.8	6.8	6.4

Table 3. Containerized trade on major East-West trade routes (million 20-foot equivalent units and annual percentage change), 2014-2018. Source: UNCTAD (2019).

The potential introduction of additional tariffs on Chinese goods has derived in a 7% growth rate in the trade between United States and China through the East-Asia-North America route, as well as through the Trans-Pacific one. Consequently, exports coming from South-East Asian countries to the United States have significantly increased during 2018. The 6,4% growth of the Transatlantic route trade is also due to a high import demand from the United States.

Exhibit 2: Maritime transport. Environmental perspective

When analyzing the CO₂ emissions generated by country, Tatar has proven that most of them are generated by only seven flags, which are Panama (15%), China (11%), Liberia (9%), Marshall Islands (7%), Singapore (6%) and Malta (5%). The total fleet of those countries' accounts for a 66% of the world fleet, which his mainly due to the fact that shipping companies are free to register their fleet in the country they want and, consequently, register most of them in countries with lax regulations in terms of maritime transport, specifically in relation to environmental issues.

Referring back to the most frequented shipping routes determined by the UNCTAD, we can clearly see in figure 1 how CO₂ emissions concentrate in such areas.

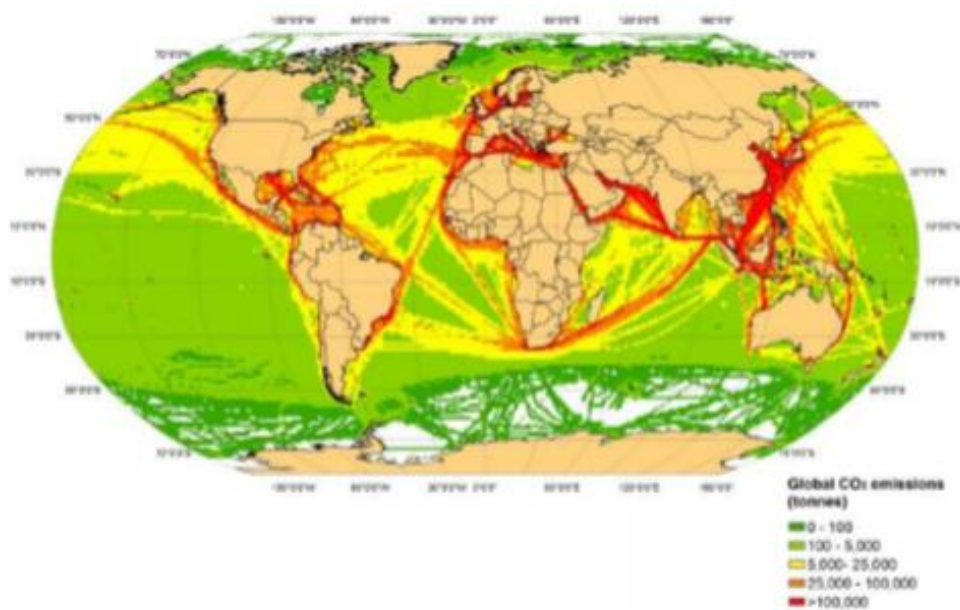


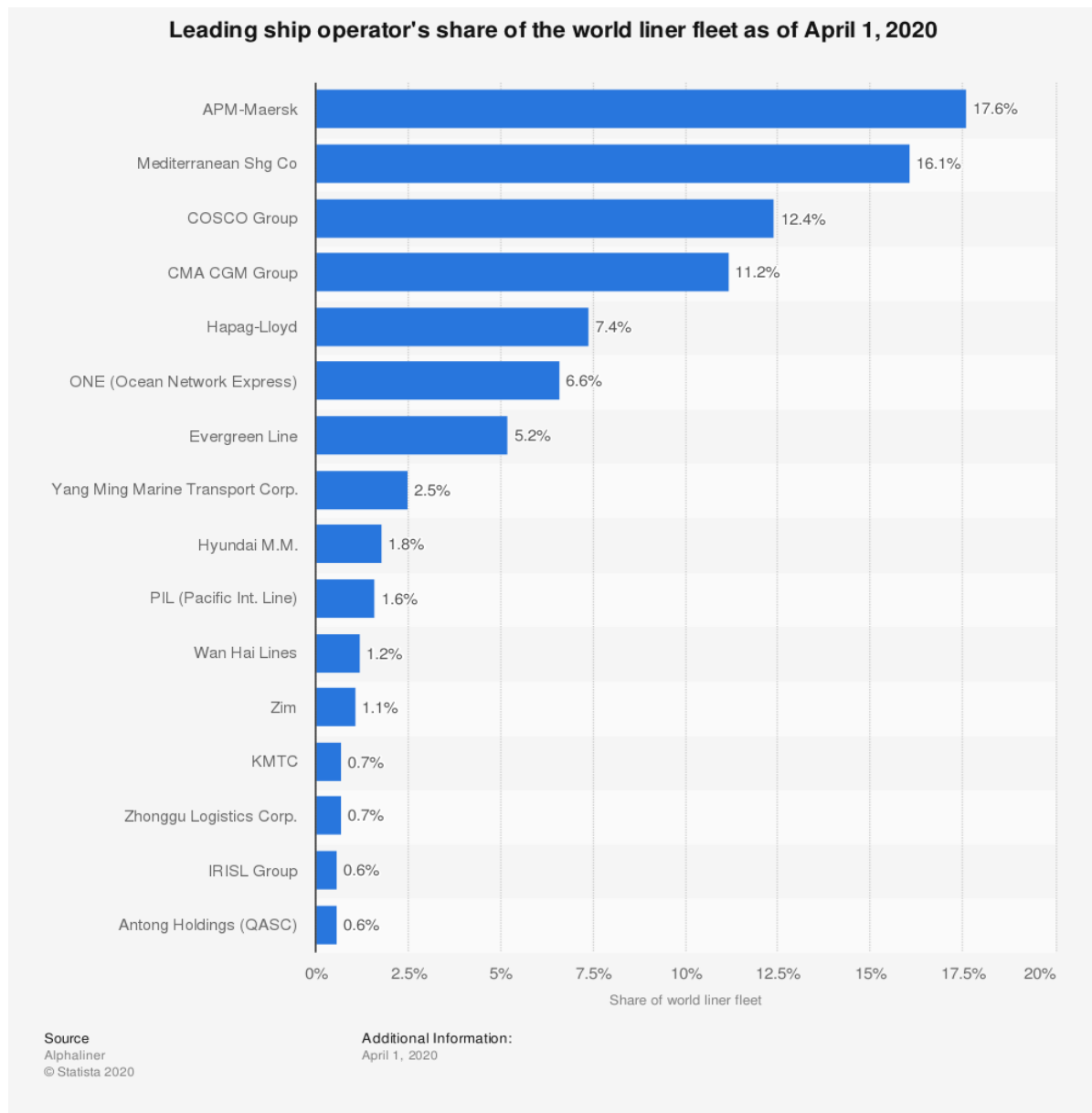
Figure 1. Global distribution of shipping CO₂ emissions in 2015. Tatar, 2018.

Exhibit 3: Container Shipping Companies

As data collected on the 1st of April of 2020 by Alphaliner, there are 6.141 active ships carrying a total of 23.675.824 TEUs, being the following the five shipping companies with a largest market share:

- **APM-Maersk.** It is an integrated logistics company that covers not only shipping services, but also in-land services related to other steps in the supply chain. It operates in 130 countries and the headquarters are located in Copenhagen, Denmark.
- **Mediterranean Shipping Company (MSC).** It is an international company that works in the sectors of maritime transport and logistics in 155 countries. Its headquarters are located in Geneva, Switzerland and it is part of the MSC Group, which also includes MSC Cruises.
- **COSCO Group.** It is a state-owned company of the Popular Republic of China operating in 105 countries. Its headquarters are in Shanghai, China. Due to the information restrictions of the Chinese government, information about the company and its environmental related actions is very limited. It is part of the Ocean Alliance.
- **CMA CGM Group.** Present in 160 countries, the company provides shipping and logistics services worldwide. Headquarters are located in Marseille, France. It is part of the Ocean Alliance.
- **Hapag-Lloyd.** It offers shipping services in 129 countries and counts with the most modern reefer container fleets in the world.

It is important to analyze how many of the global fleet is controlled by the 5 main shipping companies to understand their impact on the market. The group of the five mentioned companies holds 2.485 ships out of the total number of active vessels, which means they control a 40.47% of the world's ships. In graph 5 we can see the market share held by each container shipping company in the world.



Graph 5. Market share held by the main global shipping companies (percentage). Source: Statista (2020).

Exhibit 4: IMO 2020

Before the new regulation, IMO 2020, was applied and from the 1st of January of 2012, the limit allowed for sulphur content of ship's fuel oil was 3,50% m/m, which means the limit has been reduced in an 86%. Consequently, a significant change should be noted in terms of emissions in the following years. As claimed by UNCTAD, 2019, carriers can comply with the new IMO 2020 regulation by applying one of the following three main options:

Option 1. The most direct option is for carriers to switch to low-sulphur fuels such as low-sulphur residual fuel oil, very-low-sulphur fuel oil (VLSFO), or low-sulphur distillates such as marine gas oil (MGO). Apart from the obvious advantage of reducing the volume of emissions generated, applying this method doesn't require any substantial vessel nor engine modification, making it the easiest option to apply. However, it also brings the following consequences, mostly identified by Deloitte in a study conducted at the end of 2019:

- Low sulphur fuels are more expensive due to higher production costs.
- There is a lower supply of low sulphur fuels compared to its global demand.
- Some of the low sulphur fuels require changes to be applied to vessel's engines. While the use of MGO doesn't require any engine modification, VLSFO does.
- VLSFO can be produced through many different blending combinations, which may cause variations in its quality and specifications from port to port, making its use inconsistent.
- Ships using LSFO would have to shift to USLFO when sailing into an ECA.

Option 2. Carriers could continue to use cheaper high-sulphur fuel oil and install scrubbing equipment to remove sulphur from the ship engines' exhaust system. Currently, only 3.000 out of the approximately 60.000 shipping vessels in operation have installed this type of system. Moreover, a hydrotreater could be installed, which is another type of scrubbing system (Deloitte, 2019). Some of the reasons behind it are also consequences:

- Scrubber systems are expensive, given they can cost up to \$5 million and can require between 6 and 9 months to be installed.
- Large ships may need to install more than one system.
- Scrubbers require maintenance due to the corrosive gases that it emits and may also generate waste disposal, polluting the oceans.
- There is a limited number of suppliers which may not be able to meet the growing demand.
- The system can't be used in ECAs, where the sulphur limit is of 0,1%.

However, the system also brings several benefits:

- Assuming a total 15% of non-compliant ships and that the scrubber-fitted ships will continue using HSFO, the demand for HSFO will likely drop a 74.4% from 2019. Such a significant drop in demand could cause HSFO prices to fall significantly, helping to offset the initial investment.
- The engine itself doesn't require any modification.

Option 3. Carriers can also use cleaner alternative fuels such as liquefied natural gas (LNG) or methanol. Nowadays, only 300 ships use LNG as its main source of power, due to the challenges it implies:

- LNG requires a specific engine for the ship and staff training, increasing costs and requiring great investments, difficult to apply in the short-term.
- A lot of physical space is required when installing an LNG engine, which could occupy a 3% of the space designated to TEUs, reducing the ship capacity.
- If demand of LNG increases as much as expected, in the words of UNCTAD, we could expect its price to rise about a 50%.
- The price on LNG may vary significantly depending on the geographic region, being North America one of the regions with lowest prices.
- Other alternative fuels, as biofuels and hydrogen, are still being studied and the research on them hasn't been completed.
- It slightly increases the level of methane emissions, which is another GHG.

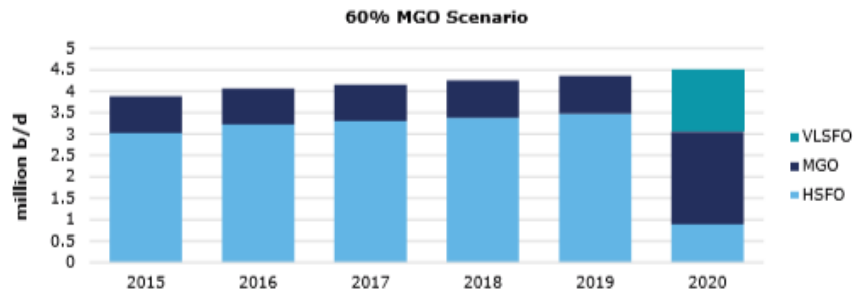
Despite of the difficulties, it is probably the option with better environmentally friendly results:

- LNG emits a 20% less of greenhouse gas emissions
- It generates no SO_x emissions
- NO_x emissions are reduced between 85-90%
- It can be used when sailing in ECAs.
- Require less maintenance than ships using oil and are linked to higher vessel longevity.
- It is more efficient than HSFO.

Advantages and disadvantages have been defined by several organizations and authors, which are the International Maritime Organization, Deloitte, the UNCTAD, Jaffe and Walker et al.

Exhibit 5: LNG study results

The study conducted by Deloitte has identified two potential scenarios regarding the volume of MGO and VLSFO used, in order to create demand forecasts for each fuel. In the first scenario (graph 6), a 60% of MGO fuel used is assumed, while in the second one (graph 7), a 40% of volume is considered. The two hypothetical cases portrait a heavy drop in HSFO volume:



Graph 6. Bunker fuel consumption by year for 60% MGO scenario. Deloitte, 2019.



Graph 7. Bunker fuel consumption by year for 40% MGO scenario. Deloitte, 2019.

Due to the growing demand for MGO and VLSFO and the fall in the HSFO use, we can expect prices to increase for the low-sulphur fuels, but allowing vessels to shift from one to the other without paying a significant premium assuming a 15% non-compliance rate. Nevertheless, the price difference can also be offset by lowering the speed at which vessels travel, leading to a lower consumption of fuel as well (Deloitte, 2019).

Therefore, the application of the IMO 2020 regulation as well as other environmentally driven regulations will impact the shipping industry in many different aspects, being the adjustment of costs the most obvious one. Container shipping is expecting a \$10-15 billion increase in fuel costs, which will be likely absorbed by customers through the supply chain. It is argued that if these costs are not passed on to shippers, profit margins in the container shipping industry would be reduced and may lead to bankruptcies of the most financially vulnerable carriers (UNCTAD, 2019).

It is important to note that not only vessels will have to adapt to the new IMO regulation, but also refineries and ports. In accordance with what Deloitte mentions in the study, “the top ten ports in the world handle 60% of the bunkering market of 400 major ports globally”. Therefore, we can expect that while the major ports will have enough quantities of compliant fuel, the other smaller 390 ports might not be able to achieve it. Nevertheless, ports were currently purchasing only two types of fuel, which were high-sulphur fuel oil and marine gas oil, while from January 2020, they might also have to offer VLSFO, requiring more storage space.

All in all, ships are dependent on the fuel offered by ports, ports are dependent on the supply of the refineries and refineries determine their supply by analyzing demand, which is very uncertain at the moment. As a consequence, ships want to wait as much as possible when deciding which fuel to use, since it will depend on its price, and ports and refineries will not start planning how much of each fuel to buy and produce until they have real data on the demand. If the decisions are made too late, we might find cases of non-compliance with the regulation, as specified by Deloitte.

Considering all the options that the IMO proposes for shipping companies, we can expect that, while in the short term most of them will switch to low-sulphur fuel, in the long-term they could eventually start using LNG, since it emits a 21% less of CO₂ than fuel oil (Deloitte, 2019).

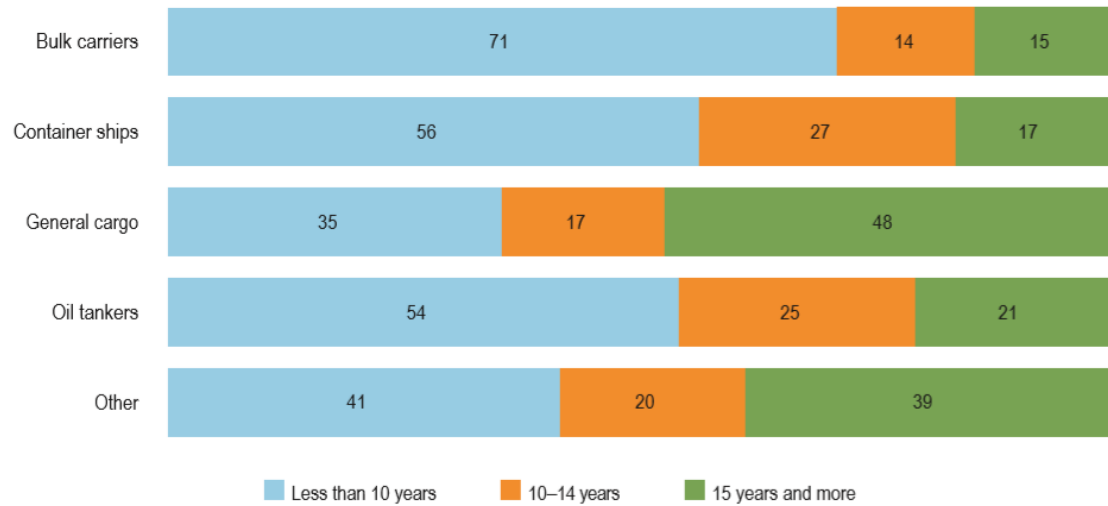
The International Maritime Organization appointed the company DNV.GL, a global certification entity, with the aim of studying the feasibility of Liquified Natural Gas as a fuel for international shipping vessels in the North American Emission Control Area (ECA)¹²². As the paper states, if the use of LNG as a fuel is to consider, is mainly due to the fact that emissions of NO_x are reduced between an 85% and a 90% and the ones of SO_x and particles are inexistent.

For these reasons, it is rational to expect that the main shipping companies of the world will start to invest in LNG studies and trials, provided it is one of the best solutions available in the long-term.

¹² Findings are further explained in the *Studies on the Feasibility and Use of LNG as a Fuel for Shipping* (IMO, 2016).

Exhibit 6: Age of the fleet

Focusing now on the age of the world fleet, we can see in graph 8 that cargo ships and “other types” of vessels are the ones which have been used for longer time, meaning that fleet renewal in these sectors is not very common.



Graph 8. Age distribution of the merchant fleet (percentage of dead-weight tonnage) as at 1 January 2019.
Source: UNCTAD (2019).

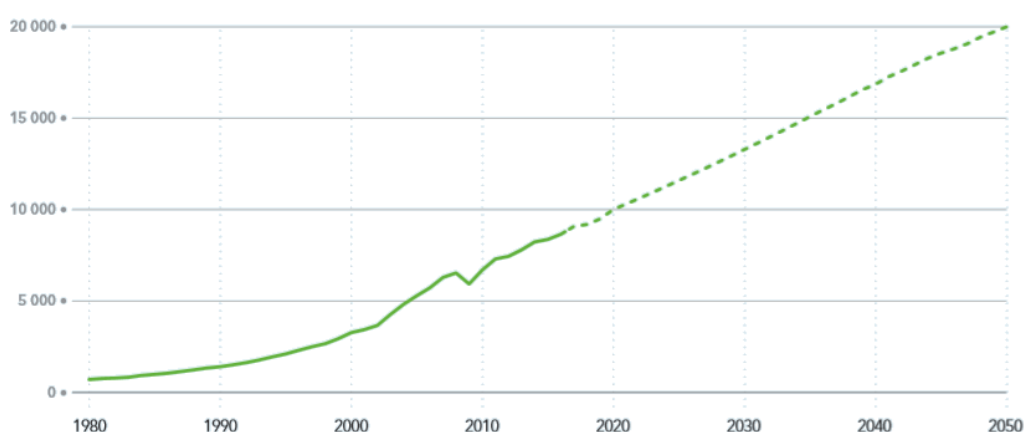
The UNCTAD estimates that the number of older vessels scrapped will increase, given they are less fuel-efficient, and it wouldn't be profitable to keep them while complying with the IMO 2020. This will cause a decrease of a 0,7% in the container ship fleet in 2020.

Exhibit 7: Maritime trade forecast

Cargo type	Trade (billion tonne-miles/yr)			
	2015	2030	2040	2050
Crude Oil	8 990	11 240	9 880	7 500
Oil Products	2 910	3 910	3 560	3 000
Natural Gas	1 420	2 900	3 210	3 570
Bulk	26 620	34 690	37 130	39 100
Container	8 290	13 290	16 910	20 100
Other Cargo	5 090	7 600	8 950	10 370
Total	53 330	73 620	79 650	83 650

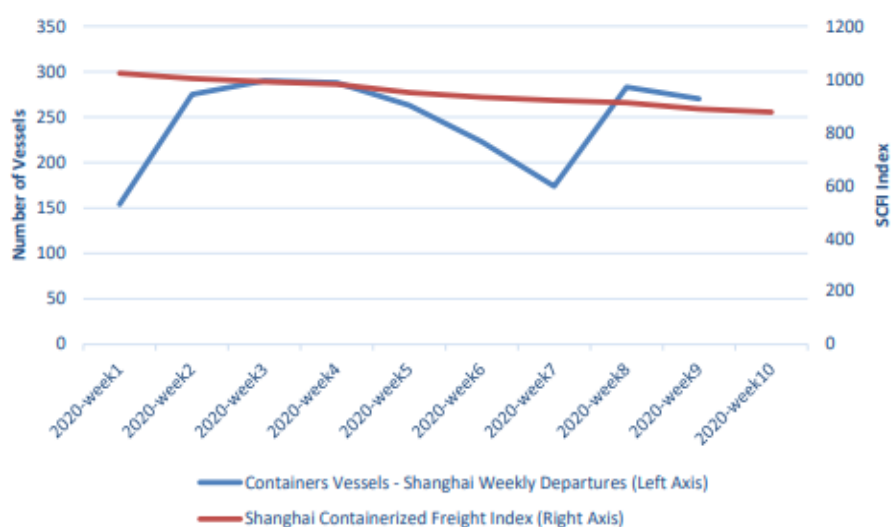
Table 4. World maritime trade forecast between 2015-2050 (tonne-miles). Source: DNV GL (2017).

As the company DNV GL forecasts in graph 9, container shipping will grow in all regions, but the increase of volume will be specifically significant in the Indian Subcontinent. China is expected to maintain its growth and South East Asia and Sub-Saharan Africa are bound to grow at a quicker pace than the average.



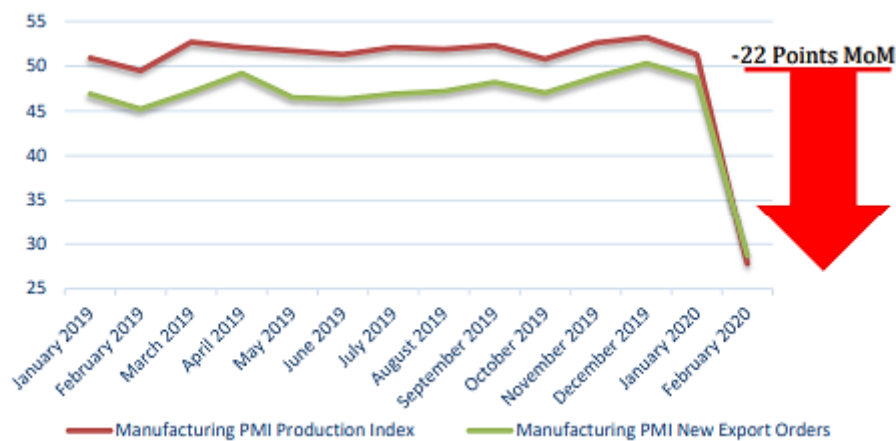
Graph 9. Global container maritime trade (Billion tonne-miles per year). Source: DNV GL (2017).

However, the coronavirus pandemic has led to a huge reduction of vessel departures from Shanghai. During the first two weeks of February, the decrease was very pronounced even though vessel traffic increased again during the last two weeks of the month. Nonetheless, the Containerized Freight Index is still decreasing, as shown in graph 10.



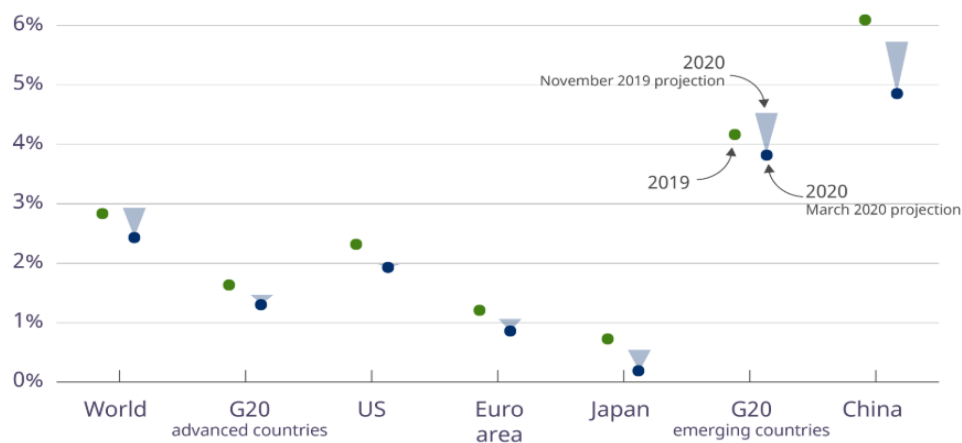
Graph 10. Container shipping indicators of Shanghai. Source: UNCTAD (2020).

The purchasing manager's index dropped from 51.1 in January to 40,2 in February, as proven in the graph 11.



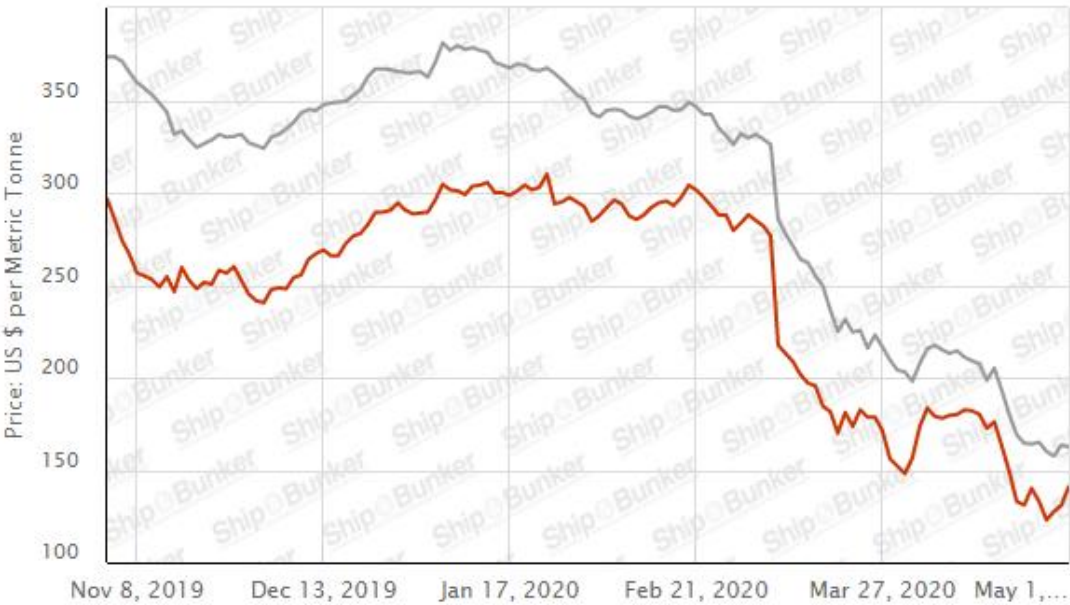
Graph 11. China's Purchasing Managers Indices. Source: UNCTAD (2020).

As it has been proven, GDP levels have a significant impact on the volume of goods traded, and as the Organization for Economic Co-operation and Development (OECD) projections show in graph 12, every country will suffer from a reduction on their 2020 GDP, which will be specifically important in emerging countries and China, where most part of containerized trade takes place. Therefore, we can expect container trade to undergo a relevant decrease in terms of volume during 2020.



Graph 12. GDP growth projection for 2020 in comparison to 2019 GDP. Source: OECD (2020).

Exhibit 8: Fuel price changes over time



Graph 13. Price evolution between November 2019 and May 2019 of HSFO in Rotterdam port, expressed in USD per Metric Ton. Source: Ship & Bunker (May 2nd, 2020).



Graph 14. Price evolution between November 2019 and May 2019 of VLSFO in Rotterdam port, expressed in USD per Metric Ton. Source: Ship & Bunker (May 2nd, 2020).

Exhibit 9: Shift to LSFO per company

Shipping companies have decided to apply different price adjustment mechanisms to their fleets, as well as different application dates. Table 5 provides information on the mechanisms applied by each of the carriers, as well as details on the LSFO shift.






Shipping companies	Number of vessels using LSFO	Price adjustment mechanism	Date of application
 MAERSK	Majority of fleet, around 700 vessels	Environmental Fuel Fee (EFF) Bunker Adjustment Factor (BAF)	1 st of January 2020
	80% of fleet, around 400 vessels	Bunker Recovery Charge (BRC)	1 st of January 2019
	Around 99% of fleet	Bunker Adjustment Factor (BAF) Fuel Adjustment Fee (FAF)	1 st of May 2019
	About a 90% of the fleet	Low Sulphur Surcharge (LSS) for short term contracts and Bunker Adjustment Factor (BAF) for long-term ones	LSS from 1 st December 2019 BAF from 1 st January 2020
	Majority of fleet	Marine Fuel Recovery (MFR)	1 st of January 2019

Table 5. Data on the application methods of the change from HSFO to LSFO per company. Source: Own elaboration based on corporate websites of Maersk (2020), MSC (2020), COSCO (2020), CMA CGM (2020) and Hapag-Lloyd (2020).

Exhibit 10: Effects of speed reduction on CO₂ emissions

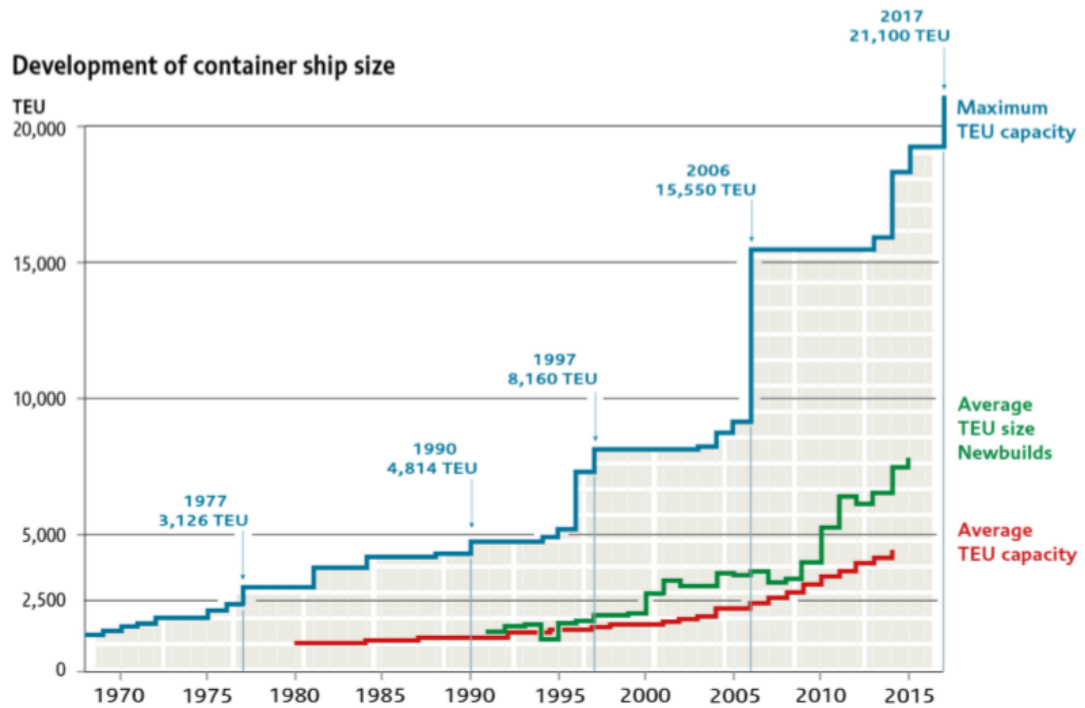
In the following table we can see the effect of different speed reduction levels over the reduction of CO₂ emissions according to the type of fleet:

	10% speed reduction	20% speed reduction	30% speed reduction
Container fleet	13%	23%	32%
Dry bulk fleet	15%	28%	38%
Crude & product tanker fleet	10%	18%	24%
Total	13%	24%	33%

Table 6. Relative CO₂ emission reduction potential for alternative speed regimes. Source: GL Reynolds (2019).

Exhibit 11: Vessel size evolution

As reflected in graph 15, since ultra large container ships were introduced in 2008, which capacity is bigger than 10.000 TEUs, shipping companies have been increasing their vessels capacity year after year.



Graph 15. Evolution of container ship size between 1970 and 2017. Source: Merk (2018).

Exhibit 12: Types of scrubber systems

As stated by Marine Insight, there is not a unique system, since there are different types Exhaust Gas Cleaning Systems (EGCS) available in the market:

- Wet scrubbers. Water with, in general, chemical additives such as caustic soda and limestone, is sprayed to the exhaust gas to remove SO_x . Once SO_x passes through the scrubbing liquid, sulphuric acid is created, which would be corrosive if it was not neutralised with the seawater, which is alkaline. Before the dirty water is returned to the sea, it is treated to eliminate any acid mist or sludge. There are two types of wet EGCS:
 - Closed loop. Fresh water with added chemicals is used to clean the exhaust gases. This type of water can be brought in tanks or produced by using a freshwater generator on board. It can use half the volume of water required for open-loop systems, but more tanks are necessary.
 - Open loop. The medium used to clean the gas is only seawater, and no other added chemicals are required to neutralise SO_x . Those systems can't be used with high temperature water, fresh water or water with low salinity, such as the Baltic Sea. The volume of liquid needed is very high, so vessels must be equipped with large capacity pumps.
 - Hybrid scrubbers. They can use the open or closed mode depending on the situation, or even both systems at the same time. They are often used in open loop mode in the sea and in closed loop mode in ECA zones.
- Dry scrubbers. Materials like pellets of hydrated lime are used to remove the SO_x from the exhaust gases of the engine. When calcium reacts with the sulphur oxide, calcium sulphite is created, which is treated to become a substance called gypsum, useful as a fertilizer or construction material.

Exhibit 13: MSC scrubber retrofits

During 2018, more than 56 orders of EGCS were conducted by MSC, and many more were scheduled for 2019 and 2020. Nonetheless, as Wackett (2020) explains, the increasing demand for scrubber installations before the 1st of January 2020 caused a delay in many of them, causing many ships to be anchored in the Chinese yards.

The coronavirus outbreak has made the situation worse, provided the Chinese governments have allowed yards to declare *force majeure* in their scrubber retrofitting contracts, making it impossible for carriers to claim for any delay in its delivery. Only in February, 33 out of the 111 vessels docked and waiting for a scrubber retrofit were owned by MSC, which means that the impact on their IMO 2020 plans will for sure be high.

One example is MSC Joanna, a vessel expected to be retrofitted with an EGCS in a Chinese Shipyard during the beginning of 2020. Its installation has been postponed several times during this year, which should have forced the vessel to shift to the use of LSFO so as to comply with the IMO 2020. However, the ship was discovered carrying, not using, more than 700 MT of HSFO without having a scrubber installed, which has led to a ban to use any UAE port during one-year time (World Maritime News, 2020).

According to an MSC statement, the vessel was carrying HSFO in a sealed tank so as to test the use of the scrubber system which is now scheduled to be installed in June 2020.

Exhibit 14: Scrubber retrofits by shipping company

Maersk has decided to operate around 10% of its fleet with open-loop scrubbers, even though their main focus relies on the use of emission-free fuels.

As stated by Valmet in 2019, the system supplier, COSCOs plans for 2019 were to install open-loop scrubbers to 10 vessels. The company is able to install the equipment avoiding reductions in the cargo capacity.

CMA CGM has announced they will be installing Advanced Air Quality Systems to around 4% of their fleet, a type of hybrid scrubbers that will allow them to filter the residues of the residual water at dock.

Hapag-Lloyd will also invest around 10 million dollars in each of the 10 vessels that will be equipped with hybrid scrubbers during 2019. The objective pursued is to identify its advantages and disadvantages by having real performance numbers so as to decide which will be the best strategy to focus on in the future (lhms, 2019).

Exhibit 15: Maersk research initiatives

The fuel made out of used cooking oil, which has been certified by the Sustainability & Carbon Certification body, has allowed a CO₂ reduction of 84% from its production to its sourcing. Furthermore, when the fuel is burned, no CO₂ emissions are generated. During 2019, the fuel was used on a pilot trip in a Triple-E ship from Rotterdam to Shanghai, and since results were positive, a new line of ships using this fuel was launched, called Maersk ECO Delivery.

Apart from having developed the Eco-Delivery line, the firm is also collaborating with Lloyds Register, the University of Maritime Advisory Services and the Technical University of Denmark (DTU) with the aim of researching about three new decarbonised fuels they have developed jointly and may be used in the future. The fuels are alcohol, formed by ethanol and methanol, biomethane and ammonia and they will be studied in detail so as to further develop the one which results better.

Further to this, Maersk has formulated an additional fuel, a bioethanol formed by lignin and ethanol called LEO. The difference of LEO with respect to the other fuels being investigated is that, if the trials that will begin on 2020 are successful, it could be used in the short-term. The coalition for developing LEO is formed by Wallenius Wilhelmsen, the University of Copenhagen and major customers, such as BMW Group, H&M Group, Levi Strauss & Co. and Marks & Spencer.

Exhibit 16: CMA CGM alternative fuels strategy

The CMA CGM Alexander Von Humboldt's travelled, in September and October of 2019, from Northern Europe to Asia by using the new biofuel created together with IKEA. Moreover, in March 2019, the CMA CGM White Shark was able to successfully refuel in the Port of Rotterdam. Given the two trials presented great results, the company has decided to partner with Shell so as to use marine biofuel, composed by 80% LSFO and 20% of biofuel, in a significant percentage of their fleet. The firm will supply CMA CGM with thousands of tons of the biofuel, enough to travel 1 million kilometres.

Moreover, CMA CGM has been the first shipping company to invest in LNG technology in ultra large container vessels. Nine of the 20 LNG-fuelled ships ordered, have 23.000 TEU capacity, following the trend of increasing the fleet size. Five will have 15.000 TEUs capacity and 6 of them 1.400 TEUs. The first of the 9 bigger vessels, called CMA CGM Jaques Saadé, was launched on September 2019 and it is the bigger vessel in the world to work with and LNG engine.



Figure 2. CMA CGM Jaques Saadé, fuelled by LNG. Source: CMA CGM website (2020).

In order to assure the LNG supply in the vessel's routes since 2021, the carrier has partnered with Emmanuel Macron so as to define the port of Marseille-Fos as the main bunkering hub for Mediterranean and Asian routes. The fuel will be provided to the port thanks to an agreement with Total Marine Fuels Global Solutions, which will also install a complementary bunkering facility in Singapore.

Exhibit 17: Hapag-Lloyd's Sajir project

As explained by the company, the ship, able to transport 15.000 TEUs, is going to be modified in the Huarun Dadong Shipyard, near Shanghai, China. Both the conventional and the auxiliary engines will be converted into dual-fuel systems so as to allow the vessel to burn both LNG and LSFO, and they will occupy the space of 290 TEUs.

Once the ship becomes active again, results will be analyzed, and if they are as positive as expected, the other 16 LNG-ready ships will be modified as well. The target of the project is to reduce CO₂ emissions by 20% and decrease PM and SO_x gases by more than 90% during its voyage from Asia to northern Europe, crossing the Suez Canal. The process is expected to last 105 days and to cost USD30 million, an amount that the firm expects to recover in four to seven years. Additionally, before the ship is ready to be sailed by mid-2020, the crew, which will be German, will receive intensive training about LNG systems and risk management (lhms, 2019).

Exhibit 18: Fuel reduction initiatives

MSC has developed the “Eco retrofit” program, by which the firm has adapted more than 200 ships so as to retrofit them with more efficient bulbous bows and propellers, leading to a fuel reduction of 55.000 tons only in 2018. Further to this, an air lubrication system was installed during 2019 in one of the firm’s mega-container ships, which creates air bubbles beneath the vessel with the goal of reducing water friction by around a 10% and, thus, a decrease of 10-15% in CO₂ emissions. If the trial proves successful, the system will also be installed in six other 23.700 TEU ships.

COSCO Shipping Lines has also opted for installing a bulbous bow and modified propellers to 17 of their ships, ten of which can hold 4.250 TEUs, three with a capacity of 10.000 TEUs and four of 13.000 TEUs, with the aim of minimizing the water resistance of the wave and, thus, decreasing fuel consumption by about a 7 to 10% depending on the shape of the vessel transformed. The best results have been obtained with the largest ships transformed. The project was partially funded thanks to a support fund by the Chinese government.

Similar to this, CMA CGM has also adapted the prows of more than 60 ships and has increased the diameter of the propellers to improve their performance and reducing GHG emissions by 4%. Twisted edge rudders also contribute to the improvement of the aerodynamics of their ships and new-generation engines are being installed in the new ship purchases to achieve an oil reduction of a 25%.

Hapag-Lloyd has developed its own prow and propeller design, which have already been installed in 24 of their ships. Thanks to the new design, crafts will be able to almost eliminate the wave created by the prow, significantly reducing the water friction and decreasing the amount of fuel consumed to sail at the same speed.

Exhibit 19: Summary of IMO 2020 measures

In table 7 we can see the different measures that each shipping company is currently applying, allowing an easier comparison between companies.






	Measures in the scope of IMO 2020	
	Management measures	Technology measures
 MAERSK	<ul style="list-style-type: none"> • Use of LSFO (75% fleet) • EFF and BAF mechanisms • Speed reduction programs in cetaceans' areas 	<ul style="list-style-type: none"> • Use of open-loop EGCS (10% fleet) • Development of new fuels • EcoDelivery vessel line (15% fleet)
	<ul style="list-style-type: none"> • Use of LSFO (50% fleet) • BRC mechanism • Speed reduction awards • Improve cargo efficiency • Purchase of large vessels 	<ul style="list-style-type: none"> • Use of hybrid EGCS (50% fleet) • Eco retrofit: new bulbous bows and new propellers • Air lubrication system • Cold ironing system
	<ul style="list-style-type: none"> • Use of LSFO (99% ships) • Replace BUC for BAF mechanism 	<ul style="list-style-type: none"> • Use of open-loop EGCS (10 ships) • New bulbous prows and propeller design (17 ships)
	<ul style="list-style-type: none"> • Use of LSFO (95% fleet) • LSS and BAFF mechanisms • Speed reduction awards • Prioritize large vessel orders 	<ul style="list-style-type: none"> • Use of hybrid EGCS (4% fleet) • Retrofit of LNG (20 ships) • Use and development of new biofuel • New bulbous prows and more efficient propellers • Cold ironing system • Eco-containers
	<ul style="list-style-type: none"> • Use of LSFO (89% fleet) • MFR mechanism • Speed reduction awards 	<ul style="list-style-type: none"> • Use of hybrid EGCS (10 ships) • LNG pilot project: Sajir • New prow and propeller corporate design • Use of OPS (22 ships) • New design for reefer containers

Table 7. Summary of IMO 2020 measures. Source: Own elaboration based on corporate websites of Maersk (2020), MSC (2020), COSCO (2020), CMA CGM (2020) and Hapag-Lloyd (2020).

Exhibit 20: Ballast water

As table 16 shows, the types of ships which have a higher percentage of ballast water treatment system installed are LNG carriers, bulk carriers and container ships.

Vessel type	Percentage of vessels fitted with ballast water treatment systems	Percentage of vessels fitted with scrubbers	Percentage of vessels compliant with tier III regulations to reduce nitrogen-oxide emissions
Bulk carriers	23.32	4.03	0.05
Chemical tankers	10.72	1.15	0.86
Container ships	18.88	5.05	0.19
Ferries and passenger ships	1.36	2.13	0.57
General cargo ships	2.16	0.65	0.21
Liquefied natural gas carriers	28.76	1.45	1.45
Offshore supply vessels	2.37	0.03	0.96
Oil tankers	11.99	3.71	0.46
Other/not available	2.82	0.30	0.19
Total	7.66	1.58	0.53

Table 16. Selected environmental indicators by vessel type, 2019. Source: UNCTAD (2019).

The ballast water movements follow the lifecycle illustrated in figure 3.

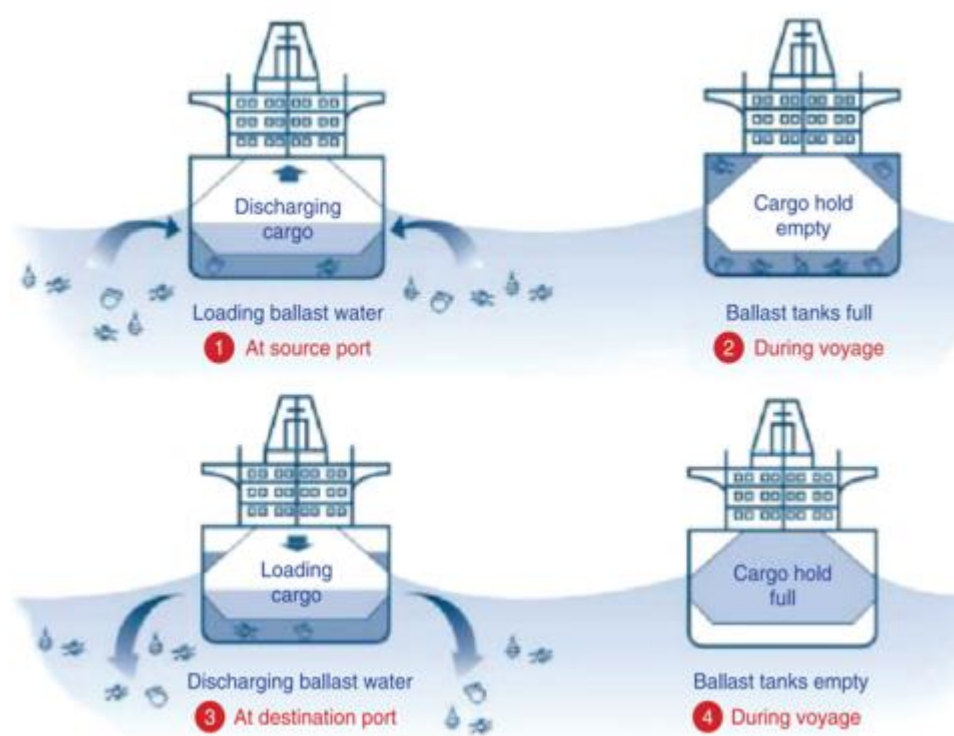


Figure 3. Ballast water cycle and transfer of invasive species. Source: Stalls et al. (2019).

Exhibit 21: Effects of scrapping industry

Nowadays, the ship scrapping industry is mainly located in Asia, being Bangladesh, India, Pakistan, Turkey and China the countries with higher volumes of vessels scrapped. Europe only accounts for a 3% of the global ships scrapped (European Commission, 2016). If the industry is concentrated in developing countries is because of the low labour costs and, in some cases, the weak regulations regarding the environment. Taking into account that shipping companies are selling their old vessels to Asian scrapyards and the materials obtained after dismantling them can be reused or sold nationally, it is a win-win situation for both parties. Moreover, the industry is providing employment to a lot of local people (UNCTAD, 2019).

According to a study conducted by the European Commission in 2016, in multiple occasions ships are left aground in some beaches before being dismantled. Many materials are released to the environment, such as oil, asbestos and toxic paint, causing harm to the nearby communities as well. Moreover, workers in charge of the scrapping process usually lack protective material, leading to many fatalities. The study has proven that the industry is polluting the air by emitting toxic chemicals above the limit of cancer risk, leading to high rates of illnesses among citizens.

As mentioned in the study, between a 40-50% of the marine waste generated by the industry is made up of plastics that eventually break down in smaller pieces, becoming microplastics. The issue is that they can't only end up being part of our food chain but can also transport organic pollutants and dangerous chemicals, which may cause adverse effects to both animals and humans.

Provided that between a 60-100% of the materials removed from the ships are recycled when they are dismantled, the environmental impact of changing the scrapping method from a dismantling process to a full recycling is not that notorious. However, even though all methods cause negative impact to the ecosystems, other scrapping systems such as abandonment or sinking harm the environment more. Furthermore, reusing or recycling helps to mitigate those negative effects and improves the environmental sustainability of the industry (European Commission, 2016).

Exhibit 22: Ocean Cleanup Initiative with Maersk contribution



Figure 4. Maersk Transporter. Source: The Ocean Cleanup Website (2020).

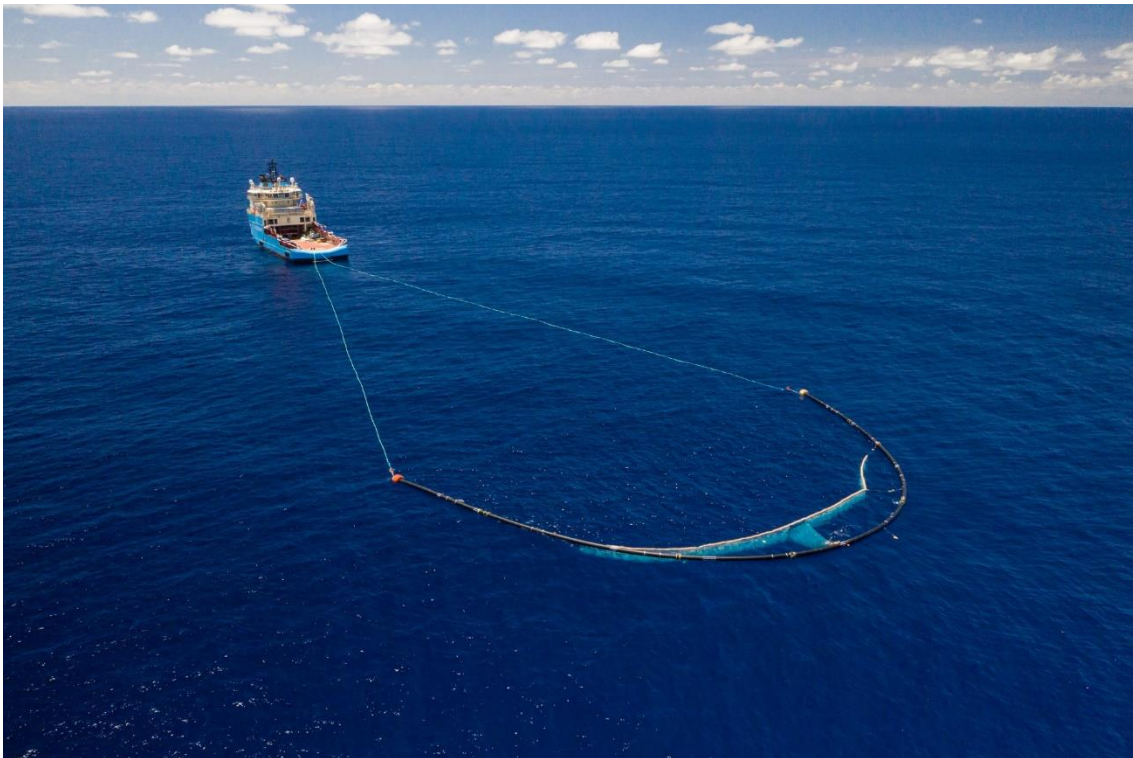


Figure 5. Maersk Transporter carrying the plastic collecting net. Source: The Ocean Cleanup Website (2020).

Exhibit 23: Summary of measures beyond IMO 2020

In table 8 we can see a summary of the measures applied by each company that go beyond the IMO 2020. As it is reflected, most the actions companies are taking are managerial.





Measures beyond the scope of IMO 2020		
	Management measures	Technology measures
	<ul style="list-style-type: none"> • Ballast water treatment systems • Will not use the NSR after trial • Ship Recycling Transparency Initiative • IMO Hong Kong Convention 	<ul style="list-style-type: none"> • Launch of high-tech buoys • Partnership with The Ocean Cleanup • Collaboration with researchers • Sustainable Ocean Principles • Plastic collection from sea
	<ul style="list-style-type: none"> • Ballast water treatment systems on newbuilds and external ballast unit for existing ships • Development of educational programs with Marevivo • Participation in Wildlife conservation programmes • IMO Hong Kong Convention • Emissions calculator on intranet • Hasn't tried NSR 	
	<ul style="list-style-type: none"> • Corporate initiatives to assure ballast water is discharged away from coasts • IMO Hong Kong Convention • Currently using the NSR 	
	<ul style="list-style-type: none"> • Ballast water treatment systems • Will not use the Northern Sea Route • Ship Recycling Transparency Initiative • IMO Hong Kong Convention • Emissions calculator on intranet • Hasn't tried NSR 	<ul style="list-style-type: none"> • Waste policy: Green Ship Program

Table 8. Summary of measures beyond the IMO 2020. Source: Own elaboration based on corporate websites of Maersk (2020), MSC (2020), COSCO (2020), CMA CGM (2020) and Hapag-Lloyd (2020).

It is interesting to see how COSCO is the company applying less measures regarding container shipping, even though several initiatives have been taken in COSCO's ports, warehouses and different operations.

Exhibit 24: Gerard Pujol interview

Gerard Pujol was an ESCI-UPF student a few years ago and is currently working in the Import and Crosstrade department of CMA CGM. The contact was achieved thanks to the university, provided he has participated in several speeches to students and maintains direct contact with the school. The following interview was conducted on the 22nd of April 2020 through Skype, given the impossibility to meet face to face:

1. How would you say that the IMO 2020 has affected CMA CGM?

Before I start explaining, I would like to check the website www.marinetraffic.com for you to understand the real impact that the regulation will have. As you can see, here it is a map at real time of the vessels sailing all around the world. Imagine now that all of them start reducing the emissions they generate; the impact is huge.

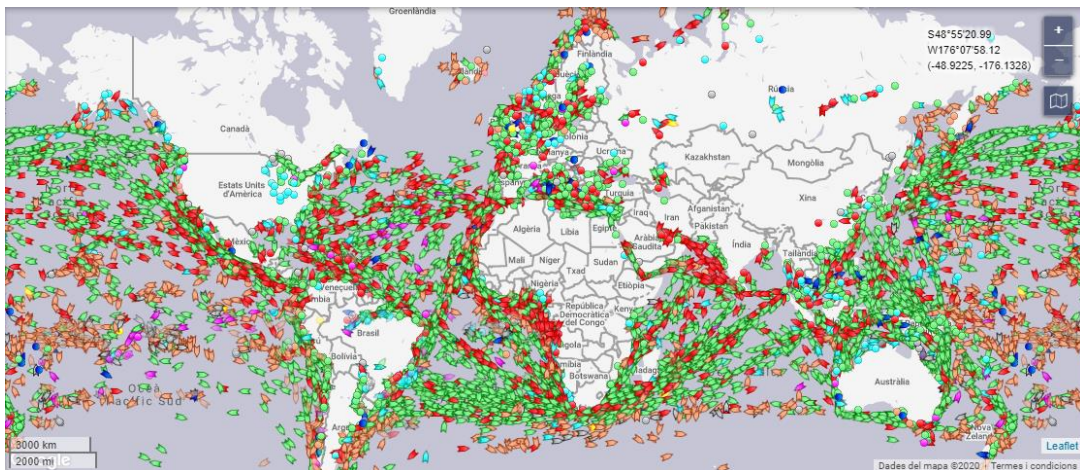


Figure 6. Worldwide vessels sailing on the 16th May of 2020 at 11:36 a.m. Source: www.marinetraffic.com

By the way, maybe you are not aware that, while emissions are very polluting, there is another major source of pollution, which is ballast water. When ships enter into a port, they discharge the water they have in some water tanks to reduce the surface which is underwater. The impact for the ecosystem is very bad, because invasive species from different parts of the world are discharged to others, affecting the whole biodiversity of the area. As far as I am concerned, there is no strict regulation about it. Some time ago I was working with Australia, and as you know, there is a very strict policy about bringing foreign species into the country, especially in the airports. Paradoxically, they do not have any regulation regarding ballast water. Bear in mind that the water discharged may come from, let's say China, and the same ship will also charge water from Australia and discharge it in the Mediterranean Sea.

2. As the rest of the shipping companies, CMA CGM has decided to opt for the use of LSFO in most of its fleet. Is there a reason behind it?

The sector has to start reducing emissions from the 1st of January of 2020. The IMO has proposed three different options to do it, and the most common one is to start using LSFO. When the regulation was announced, the price for the fuel was unknown and could only be purchased in 3-4 parts of the world, which was creating a lot of uncertainty. CMA CGM usually refuels its ships in Singapore, Rotterdam and Marseille-Fos, and the price for the LSFO estimated in the ports was expected to initially be 2,5 or 3 times more expensive. The difference between HSFO and LSFO reached a point of 600\$/mt, and it was at that point that the price recovery mechanisms were developed. Around a 95% of the fleet is currently using LSFO because the vessels don't require modifications and there is no way to stop all vessels available to install scrubbers or LNG systems. By the way, do you know how the IMO controls if ships comply with it or not? When ships enter into a port, they can randomly be selected for an inspection. To see if they are compliant or not, samples are taken from the fuel used and if the percentage of sulphur is greater than 0,5% m/m, the ship is banned. The fines for not complying with the regulation are millionaire. I don't think that, by the moment, any company has been fined for not using the right fuel.

3. Has the drop of the oil prices affected the shipping industry?

Coronavirus has changed the situation completely, because those differences are no longer existent. Even though prices of the fuel always fluctuate, the drop of the prices we have experienced these weeks is something we haven't seen in years. The problem is that fuel is purchased months before it is being used, normally around 3-4 months. Therefore, the fuel that is being used right now was purchased at higher prices, forcing companies to still charge clients high fees to recover the costs. In the case for CMA CGM, we have decided to eliminate the price recovery mechanism we were using from the 1st of May, because we are currently buying LSFO at lower prices than the cost of HSFO. It makes no sense to charge an extra fee to clients if the cost of the fuel is no longer higher. The price might go up again later, so the recharge will be cancelled between May and July. Afterwards, we will see how prices vary.

- 4. I have been able to read that the firm is using scrubber systems in some ships, but information is a little bit scarce. Could you give me more details about it?**

The problem of scrubber systems is, firstly, its cost, which can be up to 1 million euros, and it also takes up a lot of space. If you have a ship with capacity for 5.000 TEUs and the scrubber system occupies the space for 100 TEUs, the ship is losing this capacity from that moment during the rest of its life. Therefore, it is not a system that we as a company are very keen on. Furthermore, to install it, the ship has to be docked for around 3-4 weeks. However, we have decided to invest in the equipment of scrubber systems in around a 4% of the fleet to see how it goes. Now and due to the COVID-19, all of the retrofits that were planned for the following months have been cancelled. MSC is the only company that has decided to invest in scrubber systems as the main option.

- 5. CMA CGM is one of the companies which has invested the most in LNG systems, having purchased 20 ships powered with LNG for 2022. Am I right?**

Yes, we have decided to invest in LNG engines rather than scrubbers as a main option, but since it is more expensive, we are doing it at a slower pace. At the moment, only 1% of the fleet is fueled by LNG, but it is the option we will be going for in the future. Just for your information, CMA has recently purchased a ship whose name is the same as the founder of the company, and it is the biggest vessel we have at the moment, and it is powered by LNG. You can look for it on the internet under the name CMA CGM Jaques Saadé.

- 6. I find the eco-containers with bamboo flooring very interesting.**

The majority of containers have wood floors, and every certain time, they have to be changed. Many years ago, CMA decided to invest in a material which is more expensive but more resistant and eco-friendlier. More innovations are taking place regarding containers, since one of the most expensive things for companies is to move empty containers. To solve that issue, foldable containers are being tested, because they would allow incredible cost and space savings. A company located in Valencia is trying to bring it to the market, and even though at the moment they are not succeeding a lot, CMA CGM is collaborating with a start-up in Lebanon to develop them as well. With the space of one container, 20 folded containers could be transported, impacting on the efficiency incredibly. The environmental impact would

be reduced as well. Bear in mind that most of the measures that contribute to the environment are implemented to save costs.

- 7. CMA CGM participates in several speed reduction programs, especially to avoid harming the cetaceans and also to reduce emissions generated. Could you explain something else about it?**

Vessels reduce the speed for two main reasons: because there are whales that could be harmed in the area, or because they have time enough to reach the destiny on time and speed can be reduced to save fuel. It is true that reducing the speeds allows a lower level of emissions, but the reason behind it is to cut fuel costs.

- 8. Hapag-Lloyd counts with an emission calculator on their website. I haven't seen anything similar in CMA CGM website. Do you have a calculator? And if you do, are clients really taking into consideration?**

We have a calculator, but it is in the intranet, not publicly available. Clients can check the emissions their service will be generating when they log in the website. Even though the majority of clients prioritize the cost of the service, I can assure you that we have some clients who really pay attention to the emissions generated, for example, Decathlon. If the emissions are higher than their limits, they will look for another company that offers lower emissions regardless of the price, which is usually related to the age of the vessel. There are more companies that do the same, but the one I have directly treated with is Decathlon. I guess it is all about rising awareness regarding the environment and the need to protect it.

- 9. In relation to the previous question, how old are the vessels of CMA CGM on average?**

In the past decade, the shipping industry has been concentrating a lot, since there used to be a lot of small carriers. Nowadays, there are 4-5 shipping companies which are very big, and which have been acquiring the smaller companies. In the case for CMA CGM, it has purchased several companies who had older vessels and that have not been scrapped yet, even though container ships are rarely older than 10 years, because they were very small and today it is very important to gain efficiency and to reduce costs by using bigger ships. I don't know the exact average age of the fleet, but I can tell you few ships are older than 10 years. Depending on the route vessels follow, it could happen that smaller ships are required, and thus, they will probably be older. I am currently managing the export line between Spain and Middle East and

Indian Subcontinent, and out of the approximately 30 ships we have, only 2 are older than 10 years. However, ships that go to Russia, for example, are smaller and older.

10. Do you know for how long can it take to build one of the ultra large vessels?

It normally takes between 2 years in average, but it also depends on the company and the technology or specifications of the ship.

11. I have read that CM CGM is conducting a lot of partnerships with several ports and countries to help them become greener and more sustainable.

The son of the founder is changing the company completely, and it is making a lot of efforts to foster and improve the environmental situation in the ports we regularly use. For example, many of the vessels of the fleet have European flags, and not flags from fiscal heavens. It is only a curiosity, but the company cars we have are all hybrid as well, which can be charged in our offices. It wouldn't make sense to be sustainable in the sea and not on the road. I consider CMA CGM to be de "Apple" of the shipping companies, since it is more expensive than the rest. However, we try to offer higher quality and added value, such as caring for the environment.

12. And the last question; how has the COVID-19 affected the industry? I imagine that companies that had plans of purchasing new ships, for example, will cancel them or delay them. Am I right?

Since the economy has been stopping country by country, we have seen how demand from China drastically decreased at the beginning and while now it is recovering, the demand in Europe is very low. There are a lot of blank sailings as well. The truth it is affecting the industry very negatively and many of the services offered are being cancelled because of the low demand, which makes it impossible for ships to be fully loaded. For example, we normally send nine different ships from Spain to Asia, and at the moment all of them have been cancelled. Some of the numbers being discussed at the moment talk about a 30% of the fleet being docked. I guess that in the following months, companies will be forced to stop investing in sustainability, since surviving will become a priority. That is why many companies will not be purchasing new ships this year, which will probably lead to older fleets in a couple years.

Exhibit 25: Ignacio Amaro interview

Ignacio has been working as the Iberia Operations Manager at Hapag-Lloyd for 15 years. The contact was achieved thanks to Argimiro Ruiz, a friend of mine and worker of the company. The interview was conducted through a telephonic call on the 30th of April.

1. **While every shipping company is complying with the IMO 2020, there are several ways in which it can be done, and each company seems to be applying different measures. ¿Do you agree with it?**

Even though it is true that every shipping company is applying different measures to comply with the IMO 2020, all of them are using the same criteria when choosing which option to choose, which is the size of the vessel and routes or distances it follows. For example, it is not the same to install a system in a vessel that moves from Spain to Italy than from Spain to China, since the cost of the route and the fuel spend will become higher with distance.

2. **I would like you to explain which are the measures that Hapag-Lloyd has applied in order to comply with the IMO.**

The IMO 2020 was created with the intention to reduce the level of emissions generated worldwide, but since the Mediterranean Sea may become an Emission Control Area in a near future, the regulation could be even stricter for us. With the new regulation, we are required to use a fuel with a maximum level of sulphur of 0,5% m/m, which is much more refined and thus, more expensive. According to Hapag calculations, if the price of HSFO was around 300\$/T in Rotterdam – port where Hapag-Lloyd refuels – the price of LSFO was almost double. This tremendous cost was obliging carriers to pass part of the cost to consumers through price adjustment mechanisms. We have always used the BAF mechanism to adjust to the fuel price variations, but from now on, we have designed another mechanism, called Marine Fuel Recovery, by which the client can see the cost of the fuel at the moment of checking the price of the service required. Despite of its price, it is a great option to apply, because the vessel doesn't require any type of modification.

When it comes to the 2nd option, which is LNG, it is important to now that, not only many of the ports do not have LNG availability but it also takes up a lot of space from TEUs, which means that in order to adapt a ship that has to do a transoceanic route, the deposit would have to be so big that the cargo space would be excessively reduced. Furthermore, ships must be modified and retrofitted with much bigger tanks, forcing vessels to stop sailing for months. It would be a great option for companies such as Grimaldi, which travel shorter distances and thus, do not require great LNG tanks.

The third option are scrubbers, which act as a burner that filters the smoke of the chimney and turns it into ashes, avoiding that the sulphur gases are released to the environment. However, the residues that they generate can be thrown to the sea by law, which makes it very paradoxical. We can't emit it to the air, but you can throw it to the sea.

As a curiosity, a scrubber retrofit requires about USD10 million. Hapag-Lloyd estimated that transforming the whole fleet so as to use scrubber systems would have an approximate cost of around USD1.000 million. Therefore, the cost could not be supported by a carrier.

At the moment, the company is working with the three systems so as to test which one will be better in the long term. Most of the vessels are using LSFO but some trials are being undertaken to test both LNG and scrubber systems. We still don't have a clear alternative for the future.

- 3. In relation to what you have explained about the MFR and the drop in the price of fuel due to the coronavirus outbreak, have you taken any measure so that clients do not have to pay that extra cost?**

Bear in mind that fuels are purchased months before it is used in very large quantities, since they are bought to refuel the whole fleet. In this case, since the application of the mechanism is immediately and automatically calculated in the intranet, it adjusts to the market conditions, reflecting a 0 cost in the current situation.

- 4. I have been able to read in Hapag-Lloyd's corporative website that several investments in LNG and scrubber systems were being conducted or were expected to take place during 2020. With the coronavirus directly affecting the demand for container trade, I have the strong belief that all those investments, not only the ones conducted by Hapag but by all carriers, will have to be aborted or postponed. Do you agree with me?**

Every carrier has been strongly affected by the current crises, there is a lot of generalized fear and economic uncertainty. Experts forecast a recession worse than the one we had during the 2008 crises and, thus, companies are now focused on survival, not on experiments. Furthermore, blank sailings are increasing a lot since many ships are inactive due to a lack of demand. In order to get some more liquidity, shipping companies are also giving the chartered vessels back to the shipowners, reducing the number of inactive vessels in the fleet and saving the costs of the rent. As a consequence, the market will be now filled with vessels able to be chartered and that will probably remain docked for a long time. As you can see, the situation is not the best to be experimenting at the moment, so they will be sent to a 2nd or 3rd level. In fact, we can be quite happy since the financial results of last year were the best of the sector, mostly due because no investments were made. Thanks to that, we are in a

good economic situation, in which there is a higher margin to cope with the situation without suffering many financial issues. Other carriers which last year invested a lot of money, might find it harder today to bear with the crises, since their financial mattress is not as prominent. It is obvious that none of the big carriers will go bankrupt, but it will be a difficult year.

5. How would you describe the structure and age of the company's fleet?

At the moment the company counts with exactly 237 container ships. Around a 50% of our fleet is owned by the company while the rest is chartered. In the last years, it has become quite large due to the purchase and mergers with smaller shipping companies in the previous years. The last one was a merger with the United Arab Shipping Company (UASC) because they had recently purchased a series of container ships with capacity for 18.000 TEU's and it offered a quick and easy opportunity for us to increase our ultralarge vessel fleet. Years ago, Hapag also had cruise ships but that side of the business was acquired by TUI and now we only work with container ships.

6. One of the measures that Hapag-Lloyd has applied to reduce the fuel consumption is to change the design of the prow of the vessels to make them more aerodynamic. Is that right?

Yes, the company has developed two owned designs: one for the ship's bulbous bow and one for the propellers. The aim of the designs is to be able to sail at higher speeds with a lower fuel consumption. Propellers have been redesigned to create a higher propulsion capacity.

7. A great part of the fleet has also been retrofitted with a mechanism to be connected to the port electricity. Am I correct?

Yes, in fact all newbuilds already count with this system but it can only be used in some ports which are prepared for it. The first port that was able to connect the ships onshore was the port of Los Angeles. If I am not mistaken, Barcelona's port will be able to do it by 2025. The main problem is, thus, the port availability, because the retrofit of the system is quite easy and simple to do.

8. Some companies have decided to test the use of the Northern Sea Route. Has Hapag try it?

I personally think – just as an opinion- that even though the NSR reduces transit time in around 1 week, the environmental concerns around the use of the route are gaining a lot of importance, and increasing the transit would increase the melting of the ice even more. Therefore, I don't think it is a viable option and I am sure that some regulations to prohibit or regulate its use will appear in the future.

9. How would you say the drop in the oil prices is affecting the sector apart from in the cost of LSFO?

Since the fuel is very cheap at the moment, shipping companies are making their routes longer by sailing all around Africa rather than paying the high price of crossing the Suez Channel. That way, even though transit routes are larger, the cost of the fuel used is still lower than the cost crossing the channel.

10. I have seen there is an emission calculator in the corporative website available for everyone. Are there clients that really value the number of emissions that are being generated?

There are two answers for this question. The first one is that, in general, almost every client prioritizes the cost of the service rather than the emissions, probably because they are not very aware of the environmental impact of the industry. What is true is that, there are great clients that do give it importance, such as Decathlon, Ford – a sector that is also quite linked to the environmental concerns – and IKEA.

Exhibit 26: Claudia Parera Interview

The interview with Claudia was also possible thanks to Argimiro, given they have worked together for several years. She has been working in shipping companies for more than 25 years, including Maersk, MSC and Hapag-Lloyd. The interview was conducted on the 9th of May.

1. Since you have worked in several shipping companies, could you explain how do price adjustment mechanisms differ?

Each company applies the mechanism in a different way, since reference prices and ratios vary among companies. Furthermore, firms can decide whether the price will vary with per each shipping line, per country or per route. It is important that you know that the prices of the services offered are estimations, since there are many factors that can affect them. Some examples are the commercial war between EEUU and China, the price of the oil or the level of water in the rivers. The price mechanisms are designed to explain the reasons behind price variations and are summed up to the price of the service with a separate concept, such as “oil fee”. That way, clients know what they are paying for each part of the service. The usual clients usually establish certain contracts to avoid uncertainty and to reduce the impact of the variable costs, which do not depend on the company but rather on external circumstances.

2. How have you perceived the effects on the drop of the price of LSFO on the carriers?

Since companies purchase the fuel between 3-6 months prior to its use, even though the price has been falling in the last weeks, it was purchased when it was more expensive. As a consequence, prices can't be dropped as much for the clients, because companies would be losing money. Most of them are opting for decreasing the price a little bit now and keeping it as low in the following months, since they will have purchased it at lower prices. That way, clients will not perceive significant price differences and they will be coping with the cost more easily, rather than having cost peaks. Apart from that, fuel is so cheap at the moment that ships are sailing all around Africa rather than using the Suez Channel, which is very expensive.

3. Which have been the effects of the coronavirus outbreak for shipping companies?

The volume of goods traded has been dramatically reduced and, at the same time, oil prices have drastically decreased. That has caused that the number of blank sailings increases as well. Imagine there are two different routes and none of the two vessels is full. What happens is that the sailing cost increases but the returns for the transport service decrease. In this case, it is much better to join the cargo of the two vessels into one, even though its route might need to be modified to as to unload in more ports or in different ones. You are only

paying the fleet cost for one ship while the other one is docked, even though having it docked in the port costs money as well. While big companies will probably be able to cope with those costs, smaller carriers might have trouble.

- 4. I have read there have been many delays on the installation of scrubber systems, probably due to an unexpected demand for them. Do you know why has this happened? Have companies planned the retrofits too late?**

The main problem has been that information about the options was very limited until almost the date of the entry into force of the IMO 2020. Imagine everyone decides to install LNG systems; the use of fuels would be almost inexistent, and the vessels using it would have trouble in being supplied. The same happens with components of certain technologies, if there is no demand for them, the few companies that opt for it would have supply problems. In the case for the IMO 2020, we were not sure about which option would companies opt for almost until the beginning of the year. MSC has opted to invest in scrubber systems probably because they were unsure about the prices of the fuel, and the lack of demand certainty has probably created an overdemand for the systems during the beginning of 2020, causing the delays. Bear in mind that scrubber systems are only profitable in big ships, because they require great investments. That is why even though MSC has invested a lot in scrubbers, the smaller ships are still using LSFO.

- 5. Do you think that, now that several ships are docked for the coronavirus crisis, the retrofits will be less disruptive?**

Totally. While some companies will have to postpone them or abort them due to a lack of financial resources, bigger companies will probably be able to install the scrubber systems and conduct LNG retrofits more easily, because those ships are not being used at the moment. They don't need to be docked on purpose. It is a way of taking advantage of the time lost.

- 6. There are carriers that offer emission calculators so as that clients can see the environmental impact that their service causes. Do you think it is something that consumers value?**

I think the majority of consumers care more for the price we offer than for its environmental impact. However, every time more and more companies are setting emission limits and prefer to work with sustainable companies to improve their corporate image. I also know that some companies, such as MSC, share certain discounts for those clients who are more sustainable, as a way to foster the use of eco-friendly initiatives during the supply chain.