

## ANALYSIS OF IMO 2020 AND THE ADAPTATION OF SHIPOWNERS OPERATING IN SPAIN

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### ABSTRACT:

Shipping sector has always been pointed as one of the most contaminant ways of transport and this can be debated extensively. Ships emit emissions that contribute to air pollution worldwide and IMO is concerned about the problems of shipping emissions and its hard working to make this sector cleaner and more environmentally friendly.

To achieve this goal, the specialized UN agency is engaged in new regulations. One of the most important ones, which is the backbone of this study, is the new global sulphur limit for maritime shipping that entered into force last 1<sup>st</sup> of January 2020. Its main objective is the reduction of vessel's emissions, especially SOX ones. Nowadays, all ships need to use bunkers with a sulphur content that does not exceed 0.5% m/m

The entry into force of the new global sulphur limit for maritime shipping imposed by the International Maritime Organization, last 1<sup>st</sup> of January 2020, has supposed a huge change for all shipowners and for the whole sector. Several solutions to cope with this appeared on shipowners tables, who faced an important challenge choosing the one that suits them the most.

This paper focuses on making a general overview about the existing academic research done on this topic. Its main objective consists in making a research to see how shipowners operating in Spanish ports have adapted their fleets and to obtain their feedback after these months since the implementation of the new sulphur limit.

Keywords: IMO 2020, sulphur emissions, sulphur cap, sulphur limit.

## 1 INTRODUCTION

Shipping sector has always been pointed as one of the most contaminant ways of transport and this can be debated extensively. Ships emit emissions that contribute to air pollution worldwide and IMO is concerned about the problems of shipping emissions and its hard working to make this sector cleaner and more environmentally friendly.

To achieve this goal, the specialized UN agency is engaged in new regulations. One of the most important ones, which is the backbone of this study, is the new global sulphur limit for maritime shipping that entered into force last 1<sup>st</sup> of January 2020. Its main objective is the reduction of vessel's emissions, especially SOX ones. Nowadays, all ships need to use bunkers with a sulphur content that does not exceed 0.5% m/m<sup>1</sup> (Zhu et al., 2020).

Last 28th of November of 2019, in a Conference on the impact of IMO 2020 regulation in the maritime sector, Mrs. Mercè Conesa, the president of the Port of Barcelona, stated that the industry of the port represents only the 7% of the total air pollution of Barcelona (AACB-BCN, 2019). This is an amazing fact can be used to defend the shipping industry in Barcelona.

The new global sulphur limit for maritime shipping that entered into force last 1st of January 2020, has supposed a huge change for all shipowners and for the whole sector.

The decision to choose an option was a big challenge for all shipowners. And nowadays, some of them are fine with the measures adopted while there are others facing serious problems. In that case, they are losing money every day and their investment return period is being delayed.

A lot of information can be found about IMO 2020, about the different options to cope with it or even some real examples about how some sea trade zones or companies were getting ready for the sulphur limit. Almost all existing papers were done before the regulation came into force and information about how things are going on right now is needed. This paper pretends to give information on the present times about this subject in a general way but also focusing on Spain.

Once the scope of this work has been narrowed down, the objectives of this work are as follows:

- Analysis about the existing literature on this subject.
- Overview about the IMO 2020 global sulphur limit.
- Overview of the different options to cope with it.
- Analysis about how shipowners operating in Spanish ports have adapted their fleets to comply with the new limit.

To achieve all the objectives, this paper is structured as follows: Section 2 makes an overview of the existing literature and is subdivided in some subsections to have a general idea about the main topic and be able to understand the impact of it. Section 3 presents the methodology used in this paper to obtain and analyze the information. Section 4 presents the results obtained and finally Section 5 concludes this thesis.

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<sup>1</sup> m/m, mass by mass.

## **2 LITERATURE REVIEW**

Nowadays, a lot of academic literature about the impact of maritime transport on the environment and in the economy can be found (Solakivi et al., 2019). Climate change is booming and there is many literatures that relates it with IMO 2020. As exposed before, there is plenty of information on the sulphur reduction, about the different options to cope with it or even some real examples about how some sea trade zones or companies were getting ready for the sulphur limit. There is a lack of academic literature about how things are going on after these months since the implementation of the new sulphur limit and also about the Spanish scenario.

This section is subdivided as follows: background about IMO, background about IMO 2020, background about alternatives to cope with it and background about studies focused on the impact of the new limit in human health and in the environment.

Some grey literature has also been used regarding IMO information from their website and also from some maritime professional news sources.

To understand IMO origins and why nowadays one of its most important goals consists in making this sector cleaner and more environmentally friendly, it's necessary to have a look back in time. Some authors have made studies about how IMO has been evolving over the years.

(Mitroussi, 2001) stated that IMO culture could be defined as a safety culture and his findings, says that IMO's concept of safety has gone through a number of different phases responding every time to the industry's needs. Analyzing this idea, we can see that IMO started focusing on safety issues for particular vessels, then moved to safety for human lives, then to other issues and right now is focused on the environmental impact of ships. This subject is the actual need of the shipping industry and the UN agency is hard working on it. Due to the actual social pressure on this issue, IMO has set full ahead course toward it.

(Tarelko, 2012) talked about "Origins of ship safety requirements formulated by IMO". This author made a distinction between reactive and proactive actions of this organization to face safety requirements of the industry. On one hand, after big accidents and pollution incidents, reactive actions were taken from IMO, which designed new regulations. On the other hand, proactive actions take place to be ready for a future situation. IMO has to adopt more proactive actions instead of reactive ones, because in that one, the problem has already happened and there is no way to go back in time. Analyzing Tarelko findings and putting them in the sulphur cap context, IMO has been working to provide guidance and information about the ways to comply with sulphur cap before it was implemented and it's constantly working in proactive actions to keep reducing shipping emissions.

### **2- Background of the IMO 2020**

(Cullinane & Bergqvist, 2014) made a research related to ECAs<sup>2</sup> before the latest reduction to 0.10% (1000 ppm) came into force on the 1<sup>st</sup> of January 2015. They analyzed the implication of IMO in shipping emissions and made a general overview of the abatement technologies and alternatives for complying with ECAs. Their paper contains important knowledge and

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<sup>2</sup> ECAs, Emission Control Areas.

information to help private sector decision-making when ECAs were about to entry into force, but this info could also be used for IMO 2020 regulation due to similarity in the existing abatement options. Finally, they concluded that modal shift effects resulting from the ECA regulations will be so limited and they stated that more ECAs should be designated due to their benefits.

(Zis & Cullinane, 2020) made a great literature review about the existing academic studies about this topic spanning all the related themes. They analyzed why sulphur oxides are an important issue and the paper adopted by IMO during the previous years on it. One of the most interesting section of their paper is the one focused on inspection methods and levels of enforcement. The authors concluded that the IMO's implementation of a carriage ban on HSFO<sup>3</sup> is a clear step forward, but they also stated that a global uniform penalty scheme is needed.

Another interesting research on control methods was done by (Deling et al., 2020), that studied the amendments to MARPOL<sup>4</sup> Annex VI done by IMO to implement the ship fuel consumption data collection and reporting scheme. This paper analyses IMO mandatory requirements on this topic and explained the three available methods for collecting fuel consumption data based on real practices and experiences on board vessels. In addition, it explains important precautions and suggestions for making the collecting of data process as accurate as possible.

Not everybody agrees with the benefits of this new regulation, and some studies question if it's really worthwhile or not. (H. E. Lindstad & Eskeland, 2016) stated in their research that the direction chosen by IMO to reduce SOx and NOx in shipping might bring some risks consequently. The study is based on three aspects to justify his point of view. Firstly, it says that extending to global sea trade the regulations that were in ECAs gives negligible or negative environmental benefits, and raises global warming impacts. Secondly, it focuses on the fact that scrubbing and tuning solutions will play a dominant paper and they reduce energy efficiency. Thirdly, if shipowners choose that kind of solutions, the shipping sector will lose the opportunity to develop future cleaner fuels and improve their energy efficiency. Finally, he states that distinguishing local environmental benefits from global ones is important in general, and his research concludes that in the case of shipping, this distinction better serves the needs of the local environment, the global climate, and conserves on abatement costs.

This regulation has brought much controversy as seen in some of the papers read. Another example that questions the sulphur cap, is the research performed by (Halff et al., 2019). In this paper, the authors analyzed the possible impacts of this new regulation. They study the actual scheme, the past and future changes in shipping markets, the likely implication in refineries and they question if oil use in maritime transport will be reduced. This research concludes that there has been a lack of financial support and incentives of the governments or related organizations for SOx regulatory compliance and that a global uniform penalty scheme is needed.

(H. Lindstad et al., 2015) also argued about the new sulphur limit analyzing the possible damages occurred after the implementation of the reduction. The authors concluded that IMO should reconsider their decisions regarding this issue and that it is worthy to continue burning dirty fuels at high seas because of its limited ecosystem impact, low cost and climate cooling benefits.

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<sup>3</sup> HFO, Heavy Fuel Oil.

<sup>4</sup> MARPOL, International Convention for the Prevention of Pollution from Ships.

### 2.1. Background about alternatives to cope with IMO 2020

(Zetterdahl et al., 2016) performed a study on board a ship in the Baltic Sea, which is considered a SECA<sup>5</sup>. They analyzed how emissions of this vessel changed after the reduction to 0.10% (1000 ppm) the 1<sup>st</sup> of January 2015. Before the reduction, the vessel was burning HFO and then it switched to LSFO<sup>6</sup>. The authors concluded that this is a good option to cope with the reduction and that it helps to reduce the emissions from vessels.

LNG<sup>7</sup> and MGO<sup>8</sup> are two of the existing abatement options and (Yoo, 2017) carried out an economic assessment of LNG as a marine fuel for CO<sub>2</sub> carriers<sup>9</sup> compared to MGO. They analyzed both options and concluded that in this specific case, LNG is more cost-effective than MGO for CO<sub>2</sub> carriers. They highlighted that this really depends on price volatility and stated that future developments in the LNG fuel system and bunkering supply chain will make it more competitive in the bunker market. Even though it's a paper for a specific type of vessel, it has provided much information for the analysis of these two abatement options.

(Merien-Paul et al., 2019) conducted a case study focused on the comparison between HFO and LNG. Real data from a bulk carrier was used and authors studied the effect that each fuel type has on energy/operational demand and compared the estimated emissions of each option. This paper also recommends LNG as a marine fuel and shows that the use of this fuel has more advantages than burning HFO.

As stated before, (Zis & Cullinane, 2020) made a great literature review about the existing academic studies about this topic and they also analyzed the main abatement options. After making a general overview of the different alternatives, they concluded that the choice of the most appropriate option will continue to be a highly debated and studied topic for years to come. The authors also dropped some sentences about the uncertainty of fuel prices in 2020, which might affect decisions adopted by shipowners.

A recent paper done by (Ji, 2020) gives a general overview of the existing alternatives and affirms that shipowners will bear high costs. Additionally, the author reports that there are concerns that sulphur cap regulation might inadvertently convert air pollution into water pollution when wastewater is not treated properly and is illegally discharged.

(Zhu et al., 2020) elaborated a paper to try to help shipowners chose an abatement option. They applied the cost-benefit analysis to try to find a more economical sulphur reduction approach. The authors used a 19.000TEU<sup>10</sup> container as a case study and specially analyzed HFO and MGO as a LSFO. Their research concluded that scrubbers look more attractive in most cases, but it really depends on price volatility. According to them, the popularity among shipowners of installing scrubbers resides in the price spread between HFO and LSFO.

(Solakivi et al., 2019) in their research analyzed how shipowners operating in the Finnish seaborne trade have adapted their fleets when SECA's came into force in 2015. After doing an extensive analysis about the vessels operating in this area, they identified two trends. On one hand, young vessels involved in regular traffic inside this SECA, especially RO-RO<sup>11</sup> vessels,

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<sup>5</sup> SECA, Sulphur Emission Control Area.

<sup>6</sup> LSFO, Low Sulphur Fuel Oil.

<sup>7</sup> LNG, Liquefied Natural Gas.

<sup>8</sup> MGO, Marine Gasoil.

<sup>9</sup> CO<sub>2</sub> carriers are vessels used for the transport of captured CO<sub>2</sub> that will be stored normally into underground storages (Yoo, 2017).

<sup>10</sup> TEU, Twenty-foot equivalent unit.

<sup>11</sup> RORO vessel, Roll on – Roll off vessel.

preferred scrubbers as an abatement option. On the other hand, vessels operating outside this area and that just make some port calls at Finnish ports, opted for burning cleaner fuels. This paper also stated that these results would indicate that scrubbers could be the dominant solution in 2020.

(Halff et al., 2019) in their research about the impact of this new regulation also made a general overview of the existing abatement options and the ones that will come. The authors stated that electric ship engines are not generally considered a good option and that more developments in this option will appear in the future.

As expressed previously, there are many studies that talk about the options to cope, but there is a lack of the ones that provide real data about shipping companies' decisions adopted to cope with IMO 2020. (Kim & Seo, 2019) performed an empirical analysis about the alternatives that Korean shipping companies considered. This study is focused on low sulphur fuels, scrubbers, and LNG options. They performed surveys to these companies and fixed nine criteria to study their responses. Results showed that investment and operating costs were the most important factors for these organizations and that company's size also affected the decisions. They also pointed out the lack of financial support and incentives of the governments or related organizations, as other authors revealed. This study has been used as a model for the creation of this analysis.

Another alternative to cope with IMO 2020 is the use of methanol as fuel for ships. (Svanberg et al., 2018) made research about this alternative fuel, specially focused on bio-methanol. The authors analyzed the existing literature of this topic and provided an overview of the entire supply chain of renewable methanol in the maritime sector. This paper concluded that there aren't major challenges in its supply chain and that investment and operational costs will be lower soon.

Hydrogen and ammonia fuels are also two options for shipowners. (McKinlay et al., 2020) analyzed these two options in their research and compared them with the rest of the existing alternatives using data from an LNG tanker. In summary, authors concluded that both options have positive characteristics, but there are some important challenges that require further research before considering them a viable option or not. This paper also talks about batteries and states that they aren't a feasible option for long distance shipping due to its size, weight and price.

## **2.2 Background about studies focused on the impact of the new limit in human health and in the environment**

(Wan et al., 2016) introduced the concept of "Green Shipping". These authors identify that there is a pollution problem in the shipping industry and explains that three main steps should be taken to achieve a green shipping industry. These consist in cleaner practices, especially on ship scrapping, emissions control, and port management. They stated that the implementation of these recommendations could save thousands of lives each year, ensure cleaner coastal air and reduce ecological damage from shipping. In the emissions stage, they pointed out that IMO should apply stricter emissions regulations and already predicted an increase in scrubbers demand if these standards came into force.

Regarding the impact on human health and the environment, (Sofiev et al., 2018) conducted a great research evaluating the impacts of low-sulphur fuels in population health and climate. They analyzed two possible scenarios, one without applying the new sulphur reduction and the

other one applying it. With this, they saw how pollutants will decrease and consequently benefit people and the environment. They concluded that IMO 2020 will reduce annual premature morbidity and mortality significantly and that coastal areas will benefit more than others. The authors also stated that more policies are needed to reduce GHG<sup>12</sup> and air pollution from shipping.

(Ji, 2020) paper clearly confirms that the new sulphur cap is a clear step forward for planetary health. According to his findings, IMO 2020 will ensure cleaner coastal air, reduce ecological damage, and save human lives because ship-related premature mortality and morbidity will be reduced. John S Ji informs that the most beneficiaries of this regulation will be populations living near the ports and coasts, but also adds that the reduction of SO<sub>2</sub> contributes to global warming if CO<sub>2</sub> is not concurrently reduced.

(Deling et al., 2020) research is focused on ship fuel consumption data collection and reporting scheme, but in addition it includes information about how human activities and specially shipping sector impacts on the environment. It states that it is indispensable that the international shipping industry shall take necessary actions to effectively limit and reduce the GHG emissions.

Nowadays it's easy to find shipping emissions inventories, but some of them show values that differ from the others and this can make readers doubt. (Russo et al., 2018) studied and compared five inventories in the European area focused on the international shipping sector and its principal pollutants (SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>10</sub>). They concluded that the "STEAM" inventory is the most reliable because it is based on AIS<sup>13</sup> data from ships. After the investigation authors stated that in general, shipping emissions approximately accounts 11%, 16% and 5% of the total amount of SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>10</sub> emissions respectively.

Green port initiatives to make them more sustainable are an actual theme in all ports around the globe. In the case of Spanish ports, (Gonzalez-Aregall & Bergqvist, 2020) made a case study of Barcelona. The authors analyzed the environmental impact of the port in the city and the green initiatives adopted by the port. They specifically highlighted those actions adopted concerning alternative fuels for marine vessels had a positive effect on reducing atmospheric pollutants in cities around the port.

### **3 Methodology and data**

This section explains the methodology followed during the paper so as to be able to achieve all objectives set.

Firstly, a review of the existing literature about this new regulation and sulphur emissions from the shipping sector has been conducted. Articles, scientific papers, studies and also grey literature such as news and reports have been used to see the existing trends, hypothesis and authors' conclusions. Having a general overview of all these sources of data has made possible to develop this study and understand the results of the survey performed to see how shipowners have adapted their fleets.

There is plenty of literature about maritime emissions, but not all of it is focused on IMO 2020 and sulphur emissions from ships. For this reason, a reduction of the number of papers to the most relevant ones for this study has been performed applying keywords during the search of

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<sup>12</sup> GHG, Greenhouse Gases.

<sup>13</sup> AIS, Automatic Identification System.

data. The main keywords used were: “IMO 2020”, “Sulphur emissions”, “Sulphur cap”, “Emission control areas” or “Sulphur limit” among others.

Secondly, to obtain real data about the feedback from shipping companies operating in Spain, exploratory research has been performed. An empirical analysis has been done via a survey to obtain the information.

## **1.1. Survey design**

### **1.1.1. Questionnaire design**

The survey performed in this analysis was created with “*Google Forms*”. It was composed of twelve questions and at the end there was an optional question for the participants that wanted to give any extra information about the topic. The questions were designed according to the main problems or trends identified about IMO 2020 in the literature review and with the aim of seeing what companies considered when choosing an abatement option and what is their feedback after these months since the reduction came into force. An example of the survey performed is presented in Annex A.

The study performed by (Kim & Seo, 2019) has been used as an example for this analysis. In their research, the authors sent their survey to 85 Korean shipping companies and in 3 months they obtained 15 usable answers.:

- Pessimistic scenario: Getting between 4-5 answers.
- Realistic scenario: Getting between 9-12 answers.
- Optimistic scenario: Getting more than 12 answers.

### **1.1.2. Sample design and selection of respondents**

All respondents from the different companies that participated have important jobs in their companies and have plenty of experience within the shipping sector. All of them are ranged from CEOs to operations managers. This means that the information that has been collected is of high quality and that gives consistency to the study.

All shipping companies selected operate in Spanish ports and are well recognised in the shipping sector. Some of them are from Spain and the others are from different countries.

The sample was fixed mainly for liner companies because an existing contact network in the Port of Barcelona could provide a higher return rate. Almost all liner companies make port calls in Barcelona and in other ports in Spain, for this reason they usually have offices here and this point made easier to contact the respondents.

Due to the fact of the uncertainty if companies would answer or not and to do not lose valuable information to see how IMO 2020 impacted shipping companies, the answers received from other type of companies have been accepted and included in the study.



### 1.1.3. Field work

The survey was shared via email or “*Linkedin*” to all participants selected.

Initially, it was a little bit difficult to determine which ones to contact or not because of the uncertainty about what type of companies will provide a higher return rate. For this reason, question one, which asks vessel types of the companies has many different options and an open space for writing in the case that a company that is answering the survey and has another type of vessels in its fleet, could finish the questionnaire. This strategy was adopted because two organizations accepted to collaborate sending the poll to their members and probably other companies that do not operate in liner traffics could participate. This opportunity to get valuable information from other type of companies outside of the main sample fixed couldn't be missed. For this reason, some of the answers received aren't from liner companies and in some cases are from shipowners that also have ships that operate as tramp vessels.

The two organizations that have cooperated are ANAVAS<sup>14</sup> (Basque Shippers Association) and the Ship Agents Association of Barcelona<sup>15</sup>. Five of the answers were obtained thanks to them and the rest from contacting directly with the companies via email or contacting with the respondents through “*Linkedin*”. ANAVE<sup>16</sup> (Spanish Shippers Association) was also contacted to collaborate as the other ones did, but finally it could not be possible due to its high volume of work helping shipping companies to solve other problems related with Covid-19.

Survey was sent to 76 shipping companies between 18<sup>th</sup> May and 15<sup>th</sup> June 2020 and 20 responses were received in total, which represents a total return rate of 26.3% (20/76). This represents that the survey has been a success because it is within the optimistic scenario initially marked.

## 1.2. All results obtained are analysed in section Overview about the IMO 2020 global sulphur limit

### 1.2.1. Origins of the reduction

Shipping sector is really important for global seaborne trade, but ships emit emissions that contribute to air pollution worldwide such as sulphur oxides (SOX), nitrogen oxides (NOX) and particulate matters (PM) (Zhu et al., 2020). This pollution problem resides in the fact that according to (UNCTAD, n.d.), (Solakivi et al., 2019) and (Deling et al., 2020), global seaborne trade accounts for around 80 per cent of total world merchandise trade.

An easy comparison is commonly heard or quoted, saying that a few number of ships emit more harmful pollutants to the air than all the cars in the world. Studying this statement deeper, it doesn't consider all the cargo that can be carried by those ships and the consequent efficiency obtained. Looking at it with other eyes, if the big amount of cargo that can be moved by a ship is related to the emissions per ton of cargo, we can conclude that shipping has lower emissions levels compared to other ways of transport (IMO. b), 2020) and (Cullinane & Bergqvist, 2014). This is the key on how ships can carry so much cargo so efficiently.

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<sup>14</sup> ANAVAS “Asociación de navieros vascos”: <http://www.anavas.es/>

<sup>15</sup> *Associació d'Agents Consignataris de Barcelona*: <http://www.consignataris.com/es/>

<sup>16</sup> ANAVE “Asociación de navieros españoles”: <https://www.anave.es/>

IMO has always been working to reduce pollution from ships. Air pollution topic was included in MARPOL Convention when it was updated in 1997. At that time, Annex VI was added to MARPOL, which received the name of “Regulations for the Prevention of Air Pollution from Ships” (Cullinane & Bergqvist, 2014). This has been revised on several occasions during the past years, adding new rules and modifying air emissions limits.

Emission Control Areas were also established. Initially they were designed to focus only on sulphur emissions and for this reason they are called SECA’s. They are also known as ECA’s because NOx emissions are also controlled on them (Zis & Cullinane, 2020). These areas aren’t the main topic of this analysis, but they are the precedents of IMO 2020. In these spaces, sulphur limits were applied firstly and companies operating there adapted their fleets to comply with the limits established.

*4.3. Analysis about how shipowners operating in Spanish ports have adapted their fleets to comply with new limits.*

**Results**

Sulphur limits inside and outside of ECA’s have been reduced over the years. The next table shows a summary of how limits have evolved until nowadays. As can be seen in the table, limits have been reduced drastically almost eliminating completely sulphur emissions.

**Table 1:** Progression of sulphur limits in and out of ECA’s (% sulphur content)

Areas	Year				
	2005-6/2010	7/2010-2012	2012-2015	2015-2020	2020-
Within ECA	1.5	1	1	0.1	0.1
Outside ECA	4.5	4.5	3.5	3.5	0.5

Source: (Zis & Cullinane, 2020)

With the new regulation, all ships need to use bunkers with a sulphur content that does not exceed 0.5% m/m when they are operating outside a designated ECA’s (Zhu et al., 2020). The sulphur cap has been questioned by many authors and by most of the actors in the shipping business (H. Lindstad et al., 2015), (H. E. Lindstad & Eskeland, 2016), (Halff et al., 2019) and (Zis & Cullinane, 2020). The necessity of this regulation, the benefits of it, the control and enforcement and the lack of incentives have been the main topics were authors have been arguing.

IMO announced for the first time in 2008 the future rules that will be implemented to reduce the sulphur content in fuels. There was a little bit of uncertainty between shipping companies because there was the possibility that sulphur cap could be deferred and finally come into force in 2025 instead of in 2020 because there were doubts that there will be enough low sulphur fuel oil for ships (Halff et al., 2019) and (IMO, 2019b). The final decision was fixed maximum by the end of 2018 but finally IMO’s Marine Environment Protection Committee (MEPC 70), decided in October 2016 that regulation will come into force the 1<sup>st</sup> January 2020. This decision was supported by the "Assessment of fuel oil availability" study that gave positive results regarding bunkers availability in the future (IMO, 2019b).

All the existing uncertainties made some shipowners hold on for a bit before choosing an abatement option, making big investments or tryouts. It was like a race among shipowners to find out the option that suits them the most without expecting in most of the cases any

rewards or incentives from governments or related organizations. The early compliers were more penalized than the ones that waited to the last minute because those ones had more information about tryouts that other companies performed and didn't waste the same time and money trying to find out which option to use (Halff et al., 2019).

Another fact that questions the sulphur cap, is that it only focuses on SOx emissions and forgets about NOx and GHG (Halff et al., 2019). Future regulations on these emissions are about to come in the near future and are highlighted in the IMO's agenda (IMO, 2019a), (Halff et al., 2019) and (Zis & Cullinane, 2020). IMO could have proposed a general regulation enclosing all of them because nowadays shipping companies have made big investments, but in a few years their options chosen might won't be acceptable to comply with the new regulations to come and they will need to search other abatement options again.

### **1.2.2. Control and enforcement**

The new sulphur limit applies to all sizes of ships, whether they are on international voyages, between two or more countries or just performing domestic voyages. There are many ships, especially the smaller ones, which before 2020 were already using fuel oils that meet with the new limit. In these cases, they weren't affected by the new changes (*IMO. b*, 2020).

After doing an extensive literature review, controls and sanctions on this regulation have been identified as one of the most controversial points of IMO 2020. According to (IMO, 2019b) and (*IMO. b*, 2020), monitoring, compliance, and enforcement of the new limit falls to Governments and national authorities of Member States that are Parties to MARPOL Annex VI. Flag States<sup>17</sup> and port States<sup>18</sup> have rights and responsibilities to enforce compliance. Regarding this issue, (Halff et al., 2019) stated that IMO has limited ability to enforce this regulation and that the problem of controlling the compliance is still unresolved. These authors and (Zis & Cullinane, 2020) pointed out the lack of a global uniform penalty scheme for non-compliance cases. This is happening because every country and port state controls are applying their own policies. If this is not solved soon, in the future there might be preferences in calling countries with lower penalties or with lower probabilities of inspection.

According to (Zis & Cullinane, 2020), the most common practices for controlling compliance are inspections while vessels are at ports. In these cases, the BDNs or bunker delivery notes and the ship logbooks that shows the time of fuel switching are checked. There exist other techniques such as air surveillance to control smoke plumes from vessels with drones or helicopters and also there exist some fixed stations that monitor incoming vessels.

(IMO, 2019b) states that vessels must be issued with an International Air Pollution Prevention (IAPP) Certificate by their Flag State. This certificate includes a section stating that the ship uses fuel oil with a sulphur content that does not exceed the applicable limit value as documented by the bunker delivery notes or uses an approved equivalent arrangement.

There are two special concepts to have in mind when talking about this new regulation.

Firstly, it is the "carriage ban", that is an additional measure adopted by IMO to support the implementation and compliance of the new limit. This MARPOL amendment was adopted in

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<sup>17</sup> Flag State: Is the State of registry of a ship.

<sup>18</sup> Port State: Any State with an international port.

2018 and entered into force on 1<sup>st</sup> March of 2020. The main purpose of it is to prohibit the carriage of non-compliant fuel oil for combustion purposes for propulsion or operations on board a ship. That kind of fuel, only can be carried on board a vessel if it is fitted with a scrubber system (*IMO. b*, 2020). This measure has been seen as a clear step forward of IMO to strengthen the sulphur cap as stated by (Zis & Cullinane, 2020).

Secondly, it is a FONAR, which is a fuel oil non-availability report. This document is not a waiver but can be used when a vessel face in a situation where it cannot make bunkering due to a lack of product or because the available one does not meet vessel's requirements. When this situation happens, the involved vessel must inform the soonest the next port of call and flag state via submitting the FONAR. According to regulation 18.2 of MARPOL Annex VI, it is the responsibility of the Party of the destination port, through its competent authority, to scrutinize the information provided and act, as appropriate. This solution was implemented by IMO due to the uncertainty regarding the future availability of compliant fuels and if using it, FONAR shall provide all the necessary evidence and justifications to make sure that vessel won't be penalized (*IMO. b*, 2020) and (DNVGL, 2019).

### 1.2.3. IMO 5 key changes

The benefits of this new regulation have been also discussed between authors, arguing about if they are worthwhile or not and if they can produce side effects. On this topic, IMO says that this limit brings five beneficial changes. These one are shown in Figure 1 and this section analyses the five potential benefits stated by IMO.

IMO is a specialized agency of the United Nations and for this reason, some of the benefits of implementing the sulphur cap are totally aligned with two of the seventeen Sustainable Development Goals of the 2030 Agenda for Sustainable Development adopted by the UN in 2015. Goal 3 "Good health and well-being" and Goal 14 "Life below water" are the ones that are more aligned with the expected benefits of the new limit (UN, 2020) and (*IMO. b*, 2020).

Figure 1: IMO 2020 Five key changes



Source: (*IMO. b*, 2020)

### **1. Cleaner air**

According to (IMO. b), 2020), SOx emissions from ships will drop drastically with an annual reduction of approximately 8.5 million metric tonnes of SOx. This will help to prevent the consequences of acid rain such as ocean acidification, problems on fertilization and effects on human health.

Air pollution will be reduced drastically, but in the case of scrubbers, some concerns say that the avoided air pollution might be converted into water pollution if the wastewater from these systems is not treated correctly or is illegally discharged (Ji, 2020). Some ports and states are starting to implement new policies regarding the use of scrubbers and some operators are being affected about it, as stated by one of the respondents of the survey.

There are some side effects identified by research authors about this regulation. On this topic, (Ji, 2020) stated that the reduction of SO<sub>2</sub> contributes to global warming if CO<sub>2</sub> is not concurrently reduced. This author explains that atmospheric SO<sub>2</sub> also works as a cooling mechanism through conversion into sulphuric acid aerosols, which block incoming solar radiation and reflect the sun's heat. The sulphur emitted to the atmosphere helps to cool the planet by scattering solar radiation and thereby reducing the amount of surface heating. Consequently, the new reduction might affect this interplay of SO<sub>2</sub> and CO<sub>2</sub> in global warming.

### **2. Positive impacts on human health**

According to (IMO. b), 2020), the positive impacts on human health will be felt globally, but coastal areas will be the most benefitted ones. (Ji, 2020) and (Sofiev et al., 2018) agree with this point and also highlight the fact that shipping pollution globally accounts for about 400.000 premature deaths from cardiovascular disease and lung cancer, and that there are 14 million cases of childhood asthma every year. The new limit will reduce estimated ship-related premature mortality and morbidity.

### **3. Higher quality fuels**

The use of cleaner marine fuels is a clear step forward to reduce ecological damage, benefit coastal areas and reduce the effects on human lives (Ji, 2020) and (Wan et al., 2016).

Cleaner fuels aren't the end of the problem of air pollution from shipping. Vessels will continue producing harmful pollutants and greenhouse gases to the air (Sofiev et al., 2018). For this reason, further policies such as the "*IMO GHG Strategy*" will be essential for continuing making this sector more eco-friendly and keep reducing the side effects on populations (IMO. c), 2020), (Deling et al., 2020), (Zis & Cullinane, 2020), (Halff et al., 2019) and (Sofiev et al., 2018).

### **4. Ship operators, owners and refineries have adapted**

These new fuels of higher quality and the new technologies available have not fallen from heaven by magic. The main actors involved in the shipping industry have been forced to bear high costs in their work of finding abatement options to cope with IMO 2020 (Ji, 2020). Regarding refineries' response, they took the responsibility and also bore the costs of adapting their supply chain to be able to ensure fuel availability of the existing fuels and the new ones. These companies also faced difficult moments because they should be ready to satisfy the new shipping demand to come and they were really unsure of the shipping industry's response, due to the fact that companies were doubtful and waited until the last moment in some cases (Halff et al., 2019).

IMO and other stakeholders provided some guidance documents to enhance preparedness, but at the end, the ones that were in the front line were these actors and the customers. The extra costs that the shipping companies faced, have been transformed in new surcharges in freight rates, as stated by one of the respondents of the survey.

### 5. Changes for enforcement authorities

As stated, before in section 4.1.2. Control and enforcement, the fact that Flag and port State are the ones that have the responsibility of ensuring vessel compliance has been identified as one of the most controversial points of IMO 2020. For this reason, further work on it is needed.

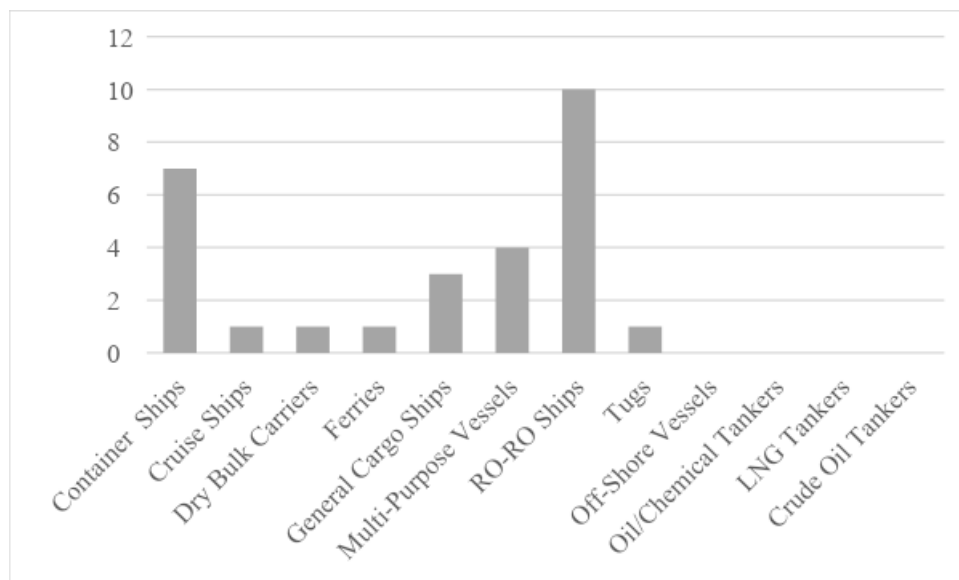
### 1.3. Analysis about how shipowners operating in Spanish ports have adapted their fleets to comply with new limits.

This section analyses all responses received by studying each question of the survey. Results obtained cannot be generalized for all shipping companies that operate in Spain because this exploratory research, but they provide real and fresh information about the main topic of this study.

#### 1. Type of vessels of your company

A total of 20 companies participated in the survey and some of them have more than one type of vessel in their fleets. For this reason, the graphic shows a higher number than 20 if all numbers of each type of vessel are summed. A clear participation of liner companies can be easily seen in *Figure 2*, being RO-RO ships, container ships, and multi-purpose vessels the ones that have more weight within the sample.

**Figure 2:** Q1. Type of vessels of your company



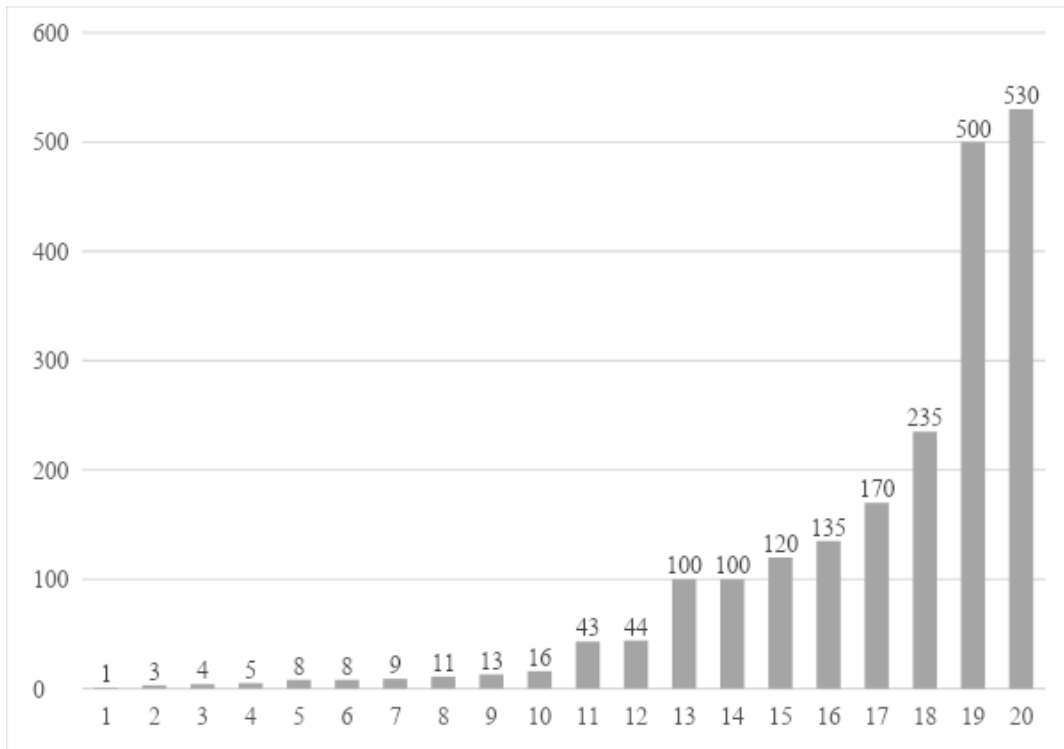
Source: Own source.

#### 2. How many vessels does your company have in its fleet?

*Figure 3* shows all answers received and data is ordered from the smallest to the largest number of ships in the fleets of the respondents. Companies with less than 20 vessels in their

fleet represent 50% of the sample and the rest are companies with a higher number of vessels under their control.

**Figure 3:** Q2. How many vessels does your company have in its fleet?



Source: Own source.

**3. What's the average size of the vessels of your company fleet? From XXXt to XXXt (DWT). In the case of container ships: From XXX to XXX (TEU's).**

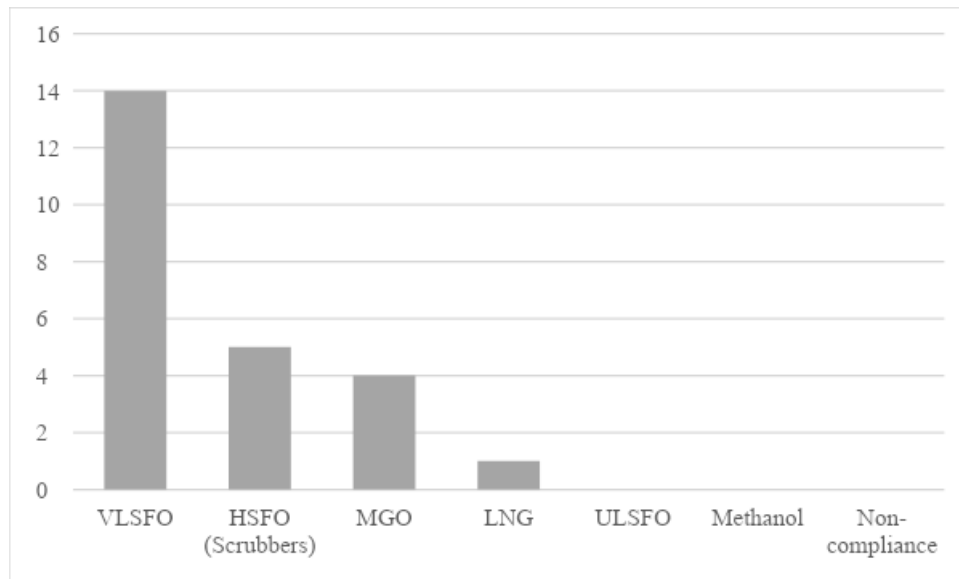
The results received on this question hasn't been considered valid because some of the answers of the respondents only showed a number and not the unit of measurement of it. Also other units of measurement of vessel size were received which created more confusion. The aim of this question was to see the average size of the vessels of the companies, but due to the various units of measurement received, the data couldn't be analyzed and it has been preferred to eliminate the question so as to avoid an erroneous analysis.

**4. Which option did your company choose to comply with the sulphur cap?**

Figure 4 shows what type of abatement options chose the companies to comply with the sulphur cap. The results show a clear tendency for VLSFO within the respondents of the sample. 14 companies have vessels in their fleets operating nowadays with VLSFO, 5 of them opted to install scrubbers in some of their ships, 4 have vessels burning MGO and one of them also opted for LNG.

A breakdown by type of vessel and abatement option couldn't be performed because some of the participants have different types of vessels in their fleets and also have opted for two or three different abatement options. In these cases, is impossible to determine which abatement option belongs to each type of vessel marked by the respondents.

**Figure 4:** Q4. Which option did your company choose to comply with the sulphur cap?



Source: Own source.

These results also show that the transition from fossil fuels to cleaner ones hadn't been done yet and that it will take some years to be completed. Regarding new abatement options, any respondent marked them with this question. In the last open question, one of the participants stated that they use lithium batteries while vessels are in port and another one explained that they are waiting some new deliveries within the next years using innovative hybrid solutions.

**5. Only in the case of having marked "HSFO (Scrubbers)" in the previous question (Q.4).**

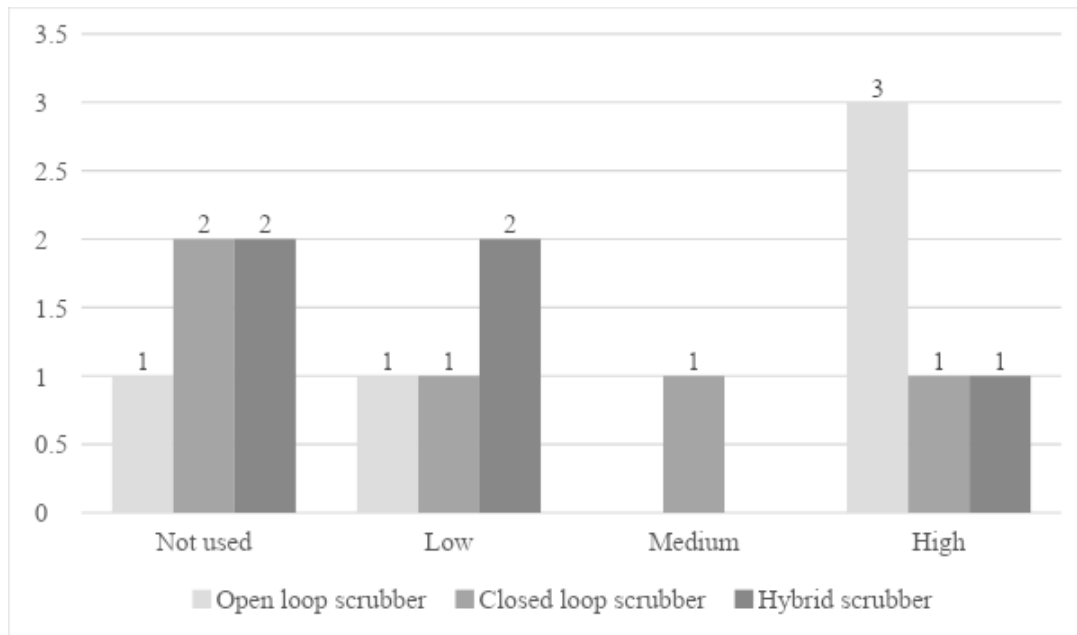
**Please indicate the presence of each type of scrubber in your fleet**

This question was designed to see the presence of each type of scrubbers in respondent's fleets. 5 companies use scrubbers, and all operate using different types of scrubbers, but one of them only uses the closed ones.

Results obtained in this question show that there is a clear tendency to operate with different types to be able to meet the necessities of each vessel of a fleet. Open loop scrubbers are the ones with a higher presence in the fleets of the respondents. Three of the five companies that opted for scrubbers stated that there is a high presence of open loop ones in their fleets. Closed sloop ones are in second position and the ones that have less presence are the hybrid ones.

**Figure 5:** Q5. Only in the case of having marked "HSFO (Scrubbers)" in the previous question (Q.4). Please indicate the presence of each type of scrubber in your fleet





Source: Own source.

**6. Evaluate from 1 to 5 the importance that your company gave to the following factors in the selection of the option to cope with IMO 2020. 1 is the lowest punctuation and 5 the maximum.**

The 10 factors analysed in this question have been split into two graphics to have a better image of the results.

**Investment costs:** 9 of the 20 companies gave the maximum punctuation to this factor and 5 gave it 4 points. This represents that 70% of the sample gave high importance to the investment costs when choosing how to cope IMO 2020. (See Figure 6).

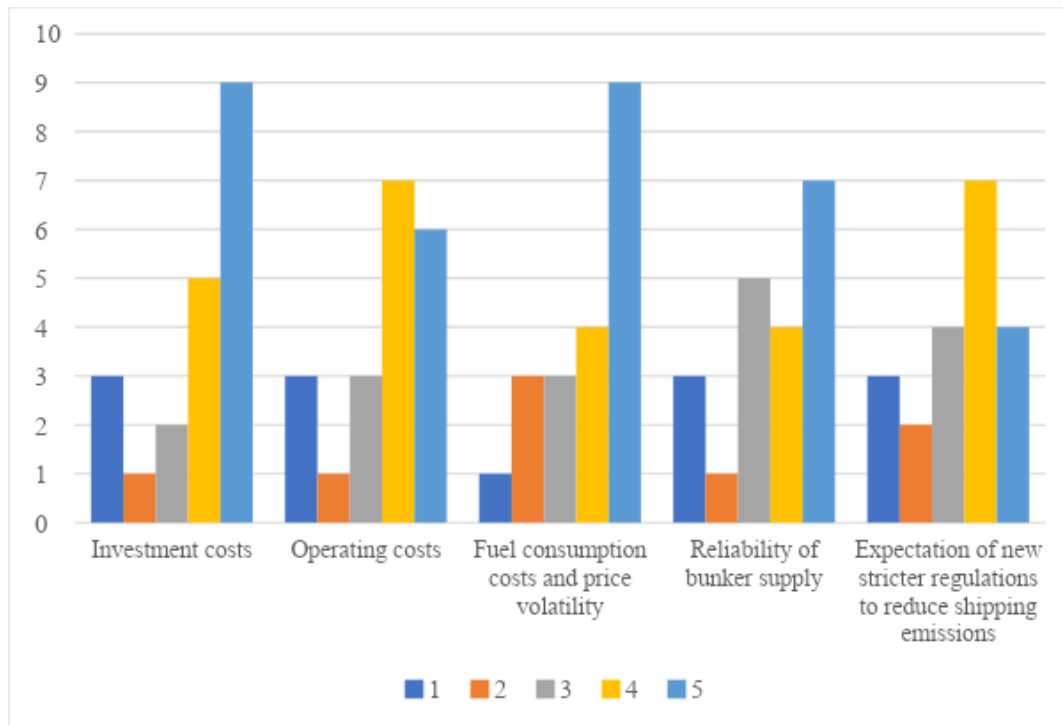
**Operating costs:** This factor also looks as one of the most important for the companies. 7 respondents gave it 4 points and 6 more gave it the maximum punctuation. This represents that 65% of the sample took seriously this factor into consideration. (See Figure 6).

**Fuel consumption costs and price volatility:** 45% of the respondents gave 5 points to this factor, which highlights its importance now of taking the decisions. (See Figure 6).

**Reliability of bunker supply:** Punctuation given by respondents to this factor looks quite irregular, but it seems that it also had a high level of importance for shipowners. (See Figure 6).

**Expectation of new stricter regulations to reduce shipping emissions:** Punctuation given to this factor looks a little bit surprising because stricter regulations to cut air emissions from shipping will come in the next future and this factor wasn't one of the most important for the companies. (See Figure 6).

**Figure 6:** Q6. 6. Evaluate from 1 to 5 the importance that your company gave to the following factors in the selection of the option to cope with IMO 2020. (1 is the lowest punctuation and 5 the maximum)



Source: Own source.

**Vessel age:** Punctuation given by respondents to this factor is also quite irregular and some of the respondents gave it more points and the others less. This irregularity has appeared because not all companies have vessels with the same age compared with the others and each respondent answered considering the characteristics of its particular fleet. (See Figure 7).

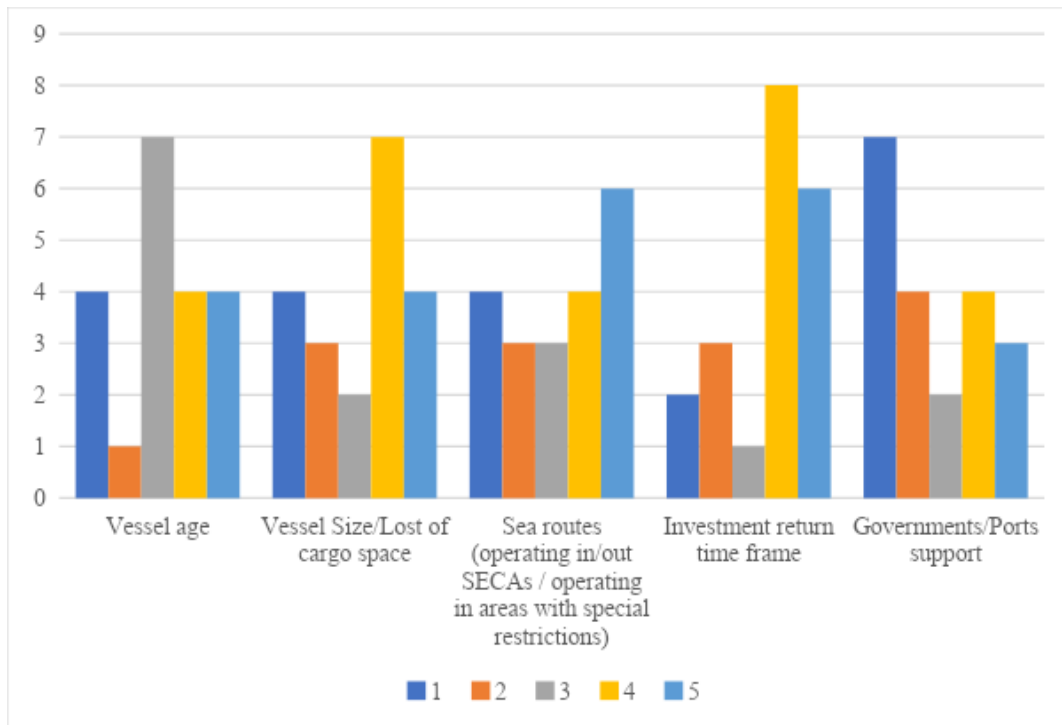
**Vessel Size/Lost of cargo space:** The same that happened with “Vessel age” factor, happened in this case. Punctuation is quite irregular but it is because it depends on every particular case. (See Figure 7).

**Sea routes:** This factor is different for every company due to the fact that each one has its own traffic lines. For this reason, the values are so different and there is not a clear tendency. (See Figure 7).

**Investment return time frame:** It looks as one of the most important points for the companies. 8 respondents gave it 4 points and 6 more gave it the maximum punctuation. This represents that 70% of the sample took seriously this factor into consideration. (See Figure 7).

**Governments/Ports support:** This point received the lowest punctuation. This could be because as identified in the literature review, there has been a lack of financial support and for this reason companies didn’t give importance to this factor because they already knew that there wasn’t much support from governments and ports. 35% of the respondents gave 1 point and 20% gave 2 points. This represents that 55% of the participants punctuated low this factor. (See Figure 7).

**Figure 7:** Q6. Evaluate from 1 to 5 the importance that your company gave to the following factors in the selection of the option to cope with IMO 2020. (1 is the lowest punctuation and 5 the maximum)

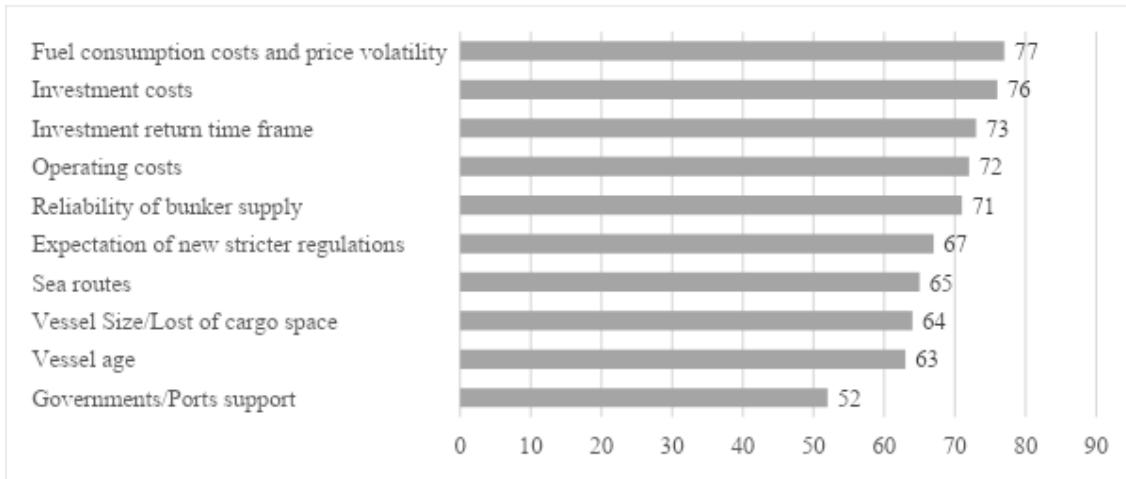


Source: Own source.

*Figure 8* has been created thanks to the data obtained in question six and shows the total punctuation that each factor received. The ones that received more points are the ones that had more importance for the companies in this survey when they made the decisions about how to cope with IMO 2020. These ones are “Fuel consumption costs and price volatility”, “Investment costs” and “Investment return time frame” as can be seen in the graphic. The one that received the lowest punctuation is “Government/Port support” as stated previously.

(Kim & Seo, 2019) results indicate that Korean shipping companies that participated in his study decided their response according to cost factors such as investment and operating costs. The results of this survey are aligned with (Kim & Seo, 2019) findings because same factors are in the top four of the total punctuation received.

**Figure 8:** Total punctuation received

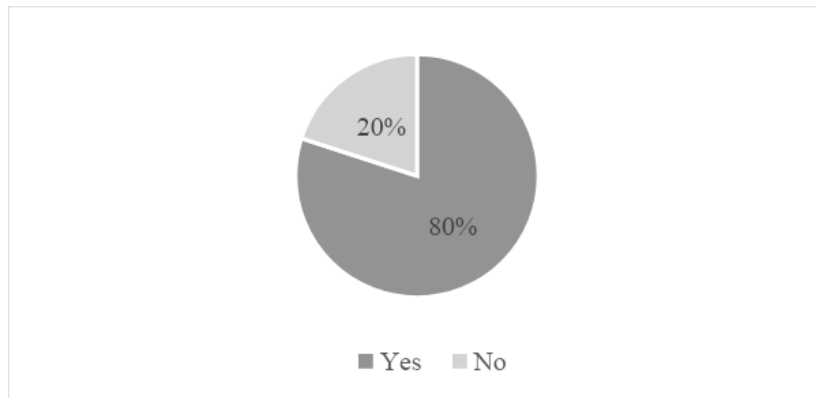


Source: Own source.

**7. Does your company (or you) think that Spain has a good bunkering supply chain in its main ports?**

Regarding the question about if Spain has a good bunkering supply chain in its main ports, 80% of the respondents agreed with this and 20% weren't agreeing.

**Figure 9:** Q7. Does your company (or you) think that Spain has a good bunkering supply chain in its main ports?

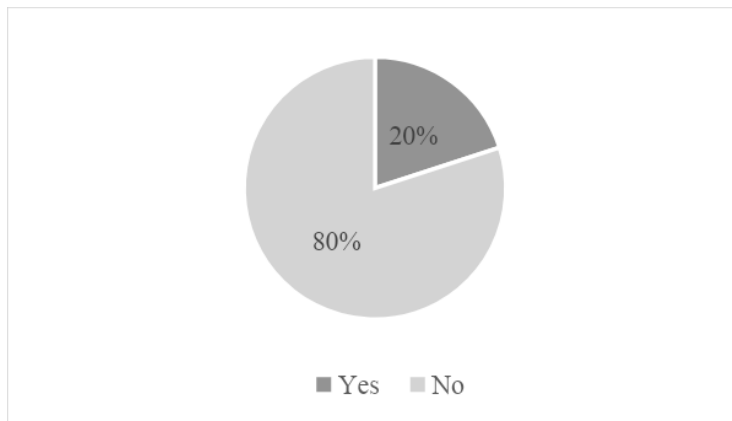


Source: Own source.

**8. Has Covid-19 affected your decisions made regarding SOx regulation? (e.g., delays in new deliveries, delays in retrofitting, bunker prices change, others).**

Regarding the question about if Covid-19 has affected companies' decisions regarding the sulphur cap, 80% of the participants stated that it hasn't affected them and 20% said that it has affected them. This question was created because some news from shipping newspapers pointed out that this pandemic was affecting the decisions with delays in new deliveries, in retrofitted vessels and creating changes in bunker prices among others. Analyzing the results obtained, it looks like that this is not the case for most of the sample of this study.

**Figure 10:** Q8. Has Covid-19 affected your decisions made regarding SOx regulation? (e.g., delays in new deliveries, delays in retrofiting, bunker prices change, others).

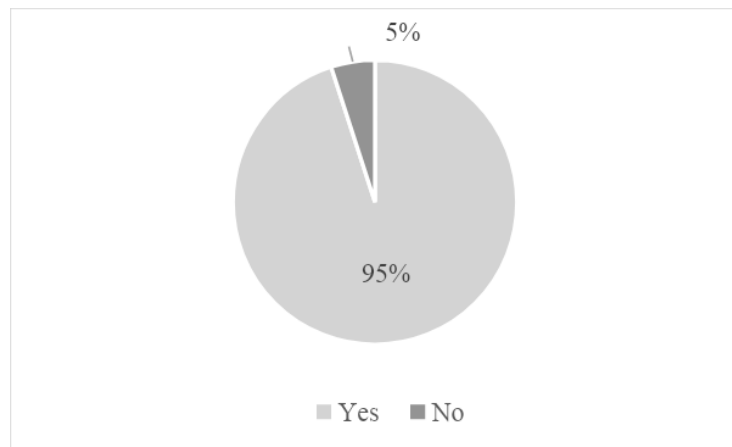


Source: Own source.

**9. After these 5 months since the entry into force of IMO 2020, is your company happy with the strategy adopted?**

This question was designed to see how companies are satisfied with their decision after these months since the regulations came into force. Analyzing the results obtained, 95% of the respondents are happy with their strategies adopted and just 5% look unhappy about their choice.

**Figure 11:** Q9. After these 5 months since the entry into force of IMO 2020, is your company happy with the strategy adopted?



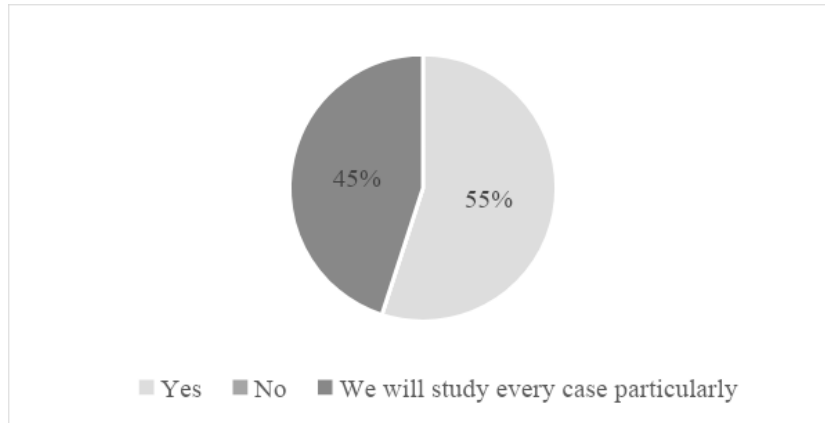
Source: Own source.

**10. Regarding your future new orders or acquisitions, will your company continue with the same strategy adopted?**

Shipowners performing new orders or acquisitions need to decide again, what abatement option to choose for their new vessels. In this question, 45% of the respondents answered that they will study every case particularly, which has a total sense because as stated during the paper, every vessel has its special necessities and for this reason it looks normal to analyze future strategies to adopt for all new orders or acquisitions. The rest 55% of the participants

stated that their companies will continue with the same strategy adopted to meet the sulphur cap.

**Figure 12:** Q10. Regarding your future new orders or acquisitions, will your company continue with the same strategy adopted?

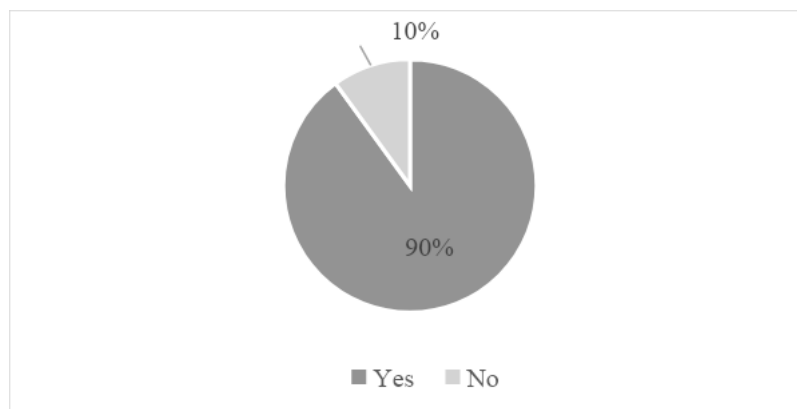


Source: Own source.

**11. Does your company (or you) believe that there has been a lack of financial support and incentives of the governments or related organizations for SOx regulatory compliance?**

Regarding the fact that there has been a lack of financial support and incentives for this regulation, the answer received in this survey is almost unanimous. 90% of the participants agreed with this point, which was also found as a critical point in the literature review performed. Only 10% of the respondents answered no to this question.

**Figure 13:** Q11. Does your company (or you) believe that there has been a lack of financial support and incentives of the governments or related organizations for SOx regulatory compliance?



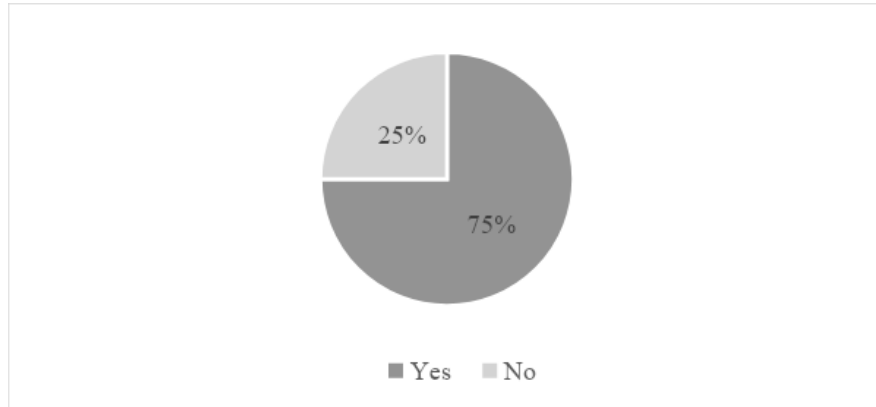
Source: Own source.

**12. Does your company (or you) believe that a global uniform penalty scheme is needed for non-compliance cases? To avoid any future preferences in calling countries with lower penalties or with lower probabilities of inspection.**

Three quarters of the respondents stated that a global uniform penalty scheme is needed for non-compliance cases. This result is aligned with the findings done in the literature review regarding this topic. Some of the authors pointed out this problem and 75% of the companies

that have participated in the survey agreed with it and only 25% think that this uniform penalty scheme is not needed.

**Figure 14:** Q12. Does your company (or you) believe that a global uniform penalty scheme is needed for non-compliance cases? So as to avoid any future preferences in calling countries with lower penalties or with lower probabilities of inspection.



Source: Own source.

**13. In this space you can give all the extra information that you want to add to this survey. You can talk about specific questions adding more information to your answers or explain to us whatever you want. We would really appreciate any extra information given.**

Eight of the respondents provided extra information to the survey in this open question. This represents 40% of the total participation. Some of the answers received explain in more detail the strategy adopted by companies, provide information about how IMO 2020 has affected them, or respondents just used it to express their feelings and thoughts about the sulphur cap. This extra data cannot be shown due to the confidentiality of the survey, but it is of high value and has helped to see and understand the real point of view of some shipping companies.

## Conclusions

After analyzing the IMO 2020 and the adaptation to it of some shipping companies, the following conclusions can be made.

- There is a lack of academic literature about how things are going on after these months since the implementation of the new sulphur limit and also about the Spanish scenario. For this reason, this study can be considered as a fresh source of information for shipowners to see what strategies have been adopted by other companies and to better understand the sulphur cap.
- Control and enforcement have been identified as one of the most critical points of the sulphur cap as stated by the authors and it has been confirmed analysing

the results of the survey. Three quarters of the respondents stated that a global uniform penalty scheme is needed for non-compliance cases.

- The lack of financial support has also been one of the most controversial aspects of IMO 2020. Results obtained in the survey showed that 90% of the participants agreed with this point, which is aligned with the findings done in the literature review.
- The sulphur reduction has clear positive impacts on human health and people living near the Spanish ports will be the most benefited in Spain.
- Quietly the same abatement options that were available when the reduction in SECAs came into force have been the same ones that shipowners had available to cope with IMO 2020. This shows that there haven't been many advances in new abatement options and that a preference from fossil fuels continues present in the shipping sector.
- The most relevant factors that affected the decision of one abatement option or another within the participants of the survey have been: "Fuel consumption costs and price volatility", "Investment costs" and "Investment return time frame". The results of this thesis are aligned with (Kim & Seo, 2019) findings because same factors are in the top four of the total punctuation received.
- (Zis & Cullinane, 2020) and (Halff et al., 2019) stated that MGO and LSFO are the products that will provide the immediate compliance for most shipping companies. The results of the survey regarding the selection of an abatement option are aligned with their findings because 14 of the companies that participated have vessels burning VLSFO and 3 are using MGO, representing this the 85% of the sample of this exploratory research.

## 1.4. Limitations of the analysis

Despite the contributions of real data and the analysis of the existing literature to summarize it to easily understand the main points of IMO 2020, the analysis performed has some limitations:

- The overview of the different options to cope the sulphur cap doesn't contain much information regarding fuel prices and its volatility during these months because there isn't academic research performed on it yet and because the analysis of this topic wasn't an objective of the thesis.



- Results obtained in the survey cannot be generalised for all shipping companies that operate in Spain because this exploratory research, but they provide real and fresh information about the main topic of this thesis.
- A breakdown by type of vessel and abatement option couldn't be performed because some of the participants have different types of vessels in their fleets and have opted for two or three different abatement options.

## 1.5. Suggestions for future research

After finishing the analysis, the following further work has been identified useful and interesting to continue analyzing the IMO 2020 and its impacts on the shipping sector.

- Future work on a breakdown focusing on a particular type of vessel and the abatement options selected for the shipowners could be interesting in the future, but many variables like ship size, age, or sea routes among others might difficult the analysis.
- An analysis about Spain as a bunker supplier could be performed studying the different ports and the availability of products to meet the sulphur cap in each one. This could be useful for the Spanish bunkering sector to reinforce their value and attract more customers.
- The effects of Covid-19 were not one of the goals of this research, but further work analysing how it has affected the shipowner's decisions regarding the sulphur cap could be interesting to learn from errors and to be protected if another pandemic occurs.
- Cleaner abatement options need to gain force to face the existing ones and to attract shipowners' attention. For this reason, more studies analysing the benefits of other options would be useful for the whole shipping sector and for the human health.
- Freight costs have increased due to the extra costs that shipowners endorsed. This factor can promote modal shifts in some trade lines. A further analysis trying to find real evidence of these possible modal shifts in transportation of goods could be interesting.
- More research should be done regarding how fuel prices and availability is going on since the sulphur cap entered into force.

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