INTERNATIONAL MARITIME ORGANIZATION

E

COUNCIL
116th session
Agenda item 4

C 116/4/1
6 May 2016
Original: ENGLISH

STRATEGY, PLANNING AND REFORM

Trends, Developments and Challenges facing the IMO in the 2018-2023 period

Note by the Secretary-General

SUMMARY

Executive summary:	This documents presents the Trends, Developments and Challenges facing the Organization and the maritime community in the 2018–2023 period
Strategic direction:	4
High-level action:	4.0.3
Output:	4.0.3.1
Action to be taken:	Paragraph 4
Related documents:	C 114/D and C 114/3/2

1 Council, at its 114th session, agreed that the Working Group on the Development of a new Strategic Framework second session (SF-WG 2) should meet the week prior to the 116th session of Council to discuss the trends, developments and challenges (TDCs) facing the Organization and the maritime community in the 2018-2023 period based on a draft TDCs document.

2 This draft TDCs document is attached in the annex for the Council's information.

3 The Council will receive the report of SF-WG 2 for its consideration in due course with any recommendations and modifications to the TDCs made by the Working Group.

Action requested by the Council

4 The Council is requested to note the information provided.

***

ANNEX

TRENDS, DEVELOPMENTS AND CHALLENGES

Contents

A. Trends

1. Introduction

1 In 1948 an international conference in Geneva adopted a convention formally establishing the International Maritime Organization[1].

2 IMO's mission statement is:

> "The mission of the International Maritime Organization (IMO) as a United Nations specialized agency is to promote safe, secure, environmentally sound, efficient and sustainable shipping through cooperation. This will be accomplished by adopting the highest practicable standards of maritime safety and security, efficiency of navigation and prevention and control of pollution from ships, as well as through consideration of the related legal matters and effective implementation of IMO's instruments with a view to their universal and uniform application."

3 Initial focus was on safety issues, including the revision of the International Convention for the Safety of Life at Sea (SOLAS), before attention was given to matters such as facilitation of international maritime traffic. The increasing knowledge about impacts on the environment led IMO to start addressing pollution, initially in the context of oil pollution, which led to the development of the International Convention for the Prevention of Pollution from Ships, as well as legal regimes addressing liability and compensation issues.

4 As the importance of the human element was recognized a number of measures were adopted, including the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and the International Safety Management Code (ISM).

5 IMO has also focused on ensuring security of international shipping, through the development of a comprehensive security regime, as a response to global events, as well as addressing the security of ships and crew related to piracy and armed robbery at sea.

6 To achieve the objectives of the Organization, emphasis has been given to supporting Member States in their efforts to implement the global regimes through technical cooperation.

7 To further support Member States, the IMO Member State Audit Scheme has been developed with the aim of providing an audited Member State with a comprehensive and objective assessment of how effectively it administers and implements those mandatory IMO instruments which are covered by the Scheme.

8 Bearing in mind the mission statement, the following paragraphs set out some of the global trends that will influence the work of the Organization. The trends are expected to influence developments that will be impacting the maritime community and as a consequence, in some instances the Organization will take actions to address these developments.

2. 2030 Agenda for Sustainable Development

9 In September 2015 the United Nations' 193 Member States unanimously adopted the 2030 Agenda for Sustainable Development, consisting of 17 Sustainable Development Goals (SDGs) and 169 targets addressing the needs of people in both developed and

[1] The original name was the Inter-Governmental Maritime Consultative Organization, or IMCO, but the name was changed in 1982 to IMO.

developing countries, emphasizing that no one should be left behind[2]. The Agenda emphasizes the need for the three dimensions of sustainable development: social, economic and environmental, to go hand-in-hand as each depend on the others and are linked to peace, justice and effective institutions. Goals and targets to realize the Agenda will be defined in relation to people, planet, prosperity, peace and partnership.

10 As a specialized agency of the United Nations, IMO has an important role to play in assisting to achieve the 2030 Agenda for Sustainable Development[3]. The United Nations system is currently formulating a mechanism to support the achievement of the 2030 Agenda based on the combined expertise and strengths of each entity within the system, where each entity plays its role with mutual recognition of respective contributions. The increased collaboration is intended to eliminate duplication and fragmentation within the United Nations system.

11 IMO, as part of the United Nations system, has a strong tradition of assisting in achieving the overall goals of the United Nations, and has – within its mandate – provided input to and supported the Millennium Development Goals and played a significant role in combatting piracy.

12 The world today relies on international shipping and benefits from its smooth operation, by which food, raw materials, energy and consumer goods are moved across the globe at low cost, in a reliable and effective way. Therefore, international shipping is central to the functioning of global trade by connecting countries, manufacturers and consumers. International shipping provides access to markets and as such provides a way for Member States to enhance trade with other Member States.

13 Sustainable transportation is a cross-cutting issue, and as such an important enabler for all the issues covered in the SDGs. Though the 2030 Agenda is to be viewed as interconnected in nature, there are some of the goals that are more closely related to IMO than others. Those goals with a particular connection to maritime transportation are:

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture; and
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all.
Only through the continued efficient functioning of the maritime sector can trade flow freely, and food and energy be delivered cost-effectively across the globe; maritime transportation plays a central role, in particular for Small Island Developing States, in ensuring that food and energy is transported and delivered efficiently.

Goal 5: Achieve gender equality and empower all women and girls
Shipping has traditionally been a male-dominated industry. However, through its global programme on the Integration of Women in the Maritime Sector, IMO is making a concerted effort to empower women to be more broadly represented within the maritime community.

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
This is central to the effective functioning of the whole transportation sector and therefore a major driver for the delivery of other goals; focus on regional and transborder infrastructure to support economic development and human well-being, is central to ensure the best use of financial resources and seek synergies.

2 UN, 2016.
3 IMO, 2013.

Goal 13: Take urgent action to combat climate change and its impacts.
Following from the Paris Agreement, through which 195 Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have pledged to curb emissions, strengthen resilience and agreed to take common climate action, there is an expectation that maritime transportation considers which further measures to take from an industry that is truly global, and therefore not covered by national measures.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
Oceans, seas and coastal areas form an integrated and essential component of the Earth's ecosystem and are critical to sustainable development. They cover more than two-thirds of the earth's surface and contain 97% of the planet's water. As users of the oceans and seas, the maritime community has a central role to play in ensuring among other things good governance and adequate measures to reduce the negative anthropogenic impacts on the marine environment, which need to be implemented in an integrated, cross-sectoral manner involving all stakeholders.

14 The Agenda presents both opportunities and challenges and to achieve the SDGs, actions are not just necessary from Member States, but also from the private sector. Through its work, IMO will make a contribution to the 2030 Agenda by engaging with partners on a number of issues, providing an opportunity for heightening the profile of international shipping, but at the same time contribute to achieve these global goals.

15 Looking at challenges and providing responses in silos is being challenged with the 2030 Agenda. To achieve the 2030 Agenda, emphasis will be on thinking across sectors, and consider implications for all the three dimensions of sustainability. This also entails new understanding that the three dimensions are not opposites, but rather complementary. The 2030 Agenda places people as central to sustainable development, and solutions should be developed bearing in mind the impact on people.

16 For the maritime community, there will be a need to engage with stakeholders not necessarily engaged in international shipping, but those stakeholders that are relevant to ensuring the efficient and smooth functioning of the maritime sector, as a whole.

3. World trade and change in the shipping sector

17 The world economy has more than quintupled in the last 30 years (figure 1) and is projected to grow further in the following years, probably doubling in size by 2040[4]. One of the main drivers behind this trend is the continued increase in population. By 2030, the global population is expected to reach 8.5 billion (figure 2), continuing the existing economic growth trend and resulting in a rise in the demand for seaborne trade. This trend is primarily driven by growth and expansion in developing countries, leading to changes in trading patterns.

[4] According to the OECD, the world total GDP is projected to increase from 68,077,321 million US dollars in 2015 to 145,962,170 million US dollars in 2040 (OECD, 2016).

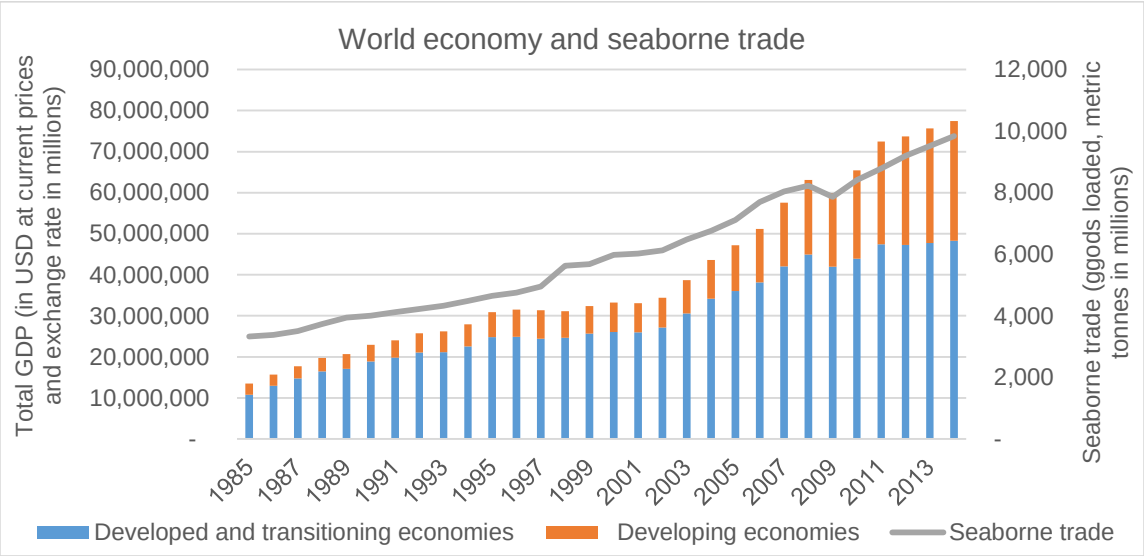


Figure 1 – World Economy and Seaborne Trade, 1985-2014
(UNCTAD, 2015a; UNCTAD, 2015b)

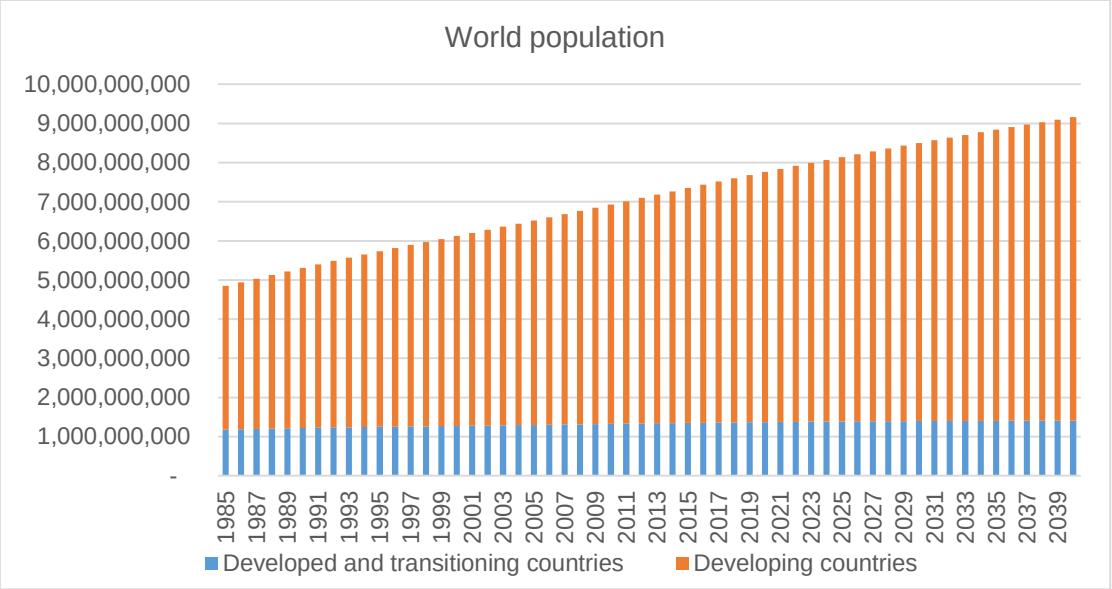


Figure 2 – World Population, 1980-2040
(UNCTAD, 2015c)

18 The change in trading patterns is underlined by the significant increase in the amount of goods that are unloaded in developing countries (figure 3). This growth indicates that developing countries are increasingly importing more goods, resulting in a growing demand for maritime transport and changing trade flows (figure 4). Developed and developing countries are therefore both benefitting from maritime trade, which is critical to the achievement of the SDGs.[5] Shipping also plays a key role in transporting food to all corners of the globe and therefore is a central component in ensuring food security across the world.

5 International Chamber of Shipping, 2015.

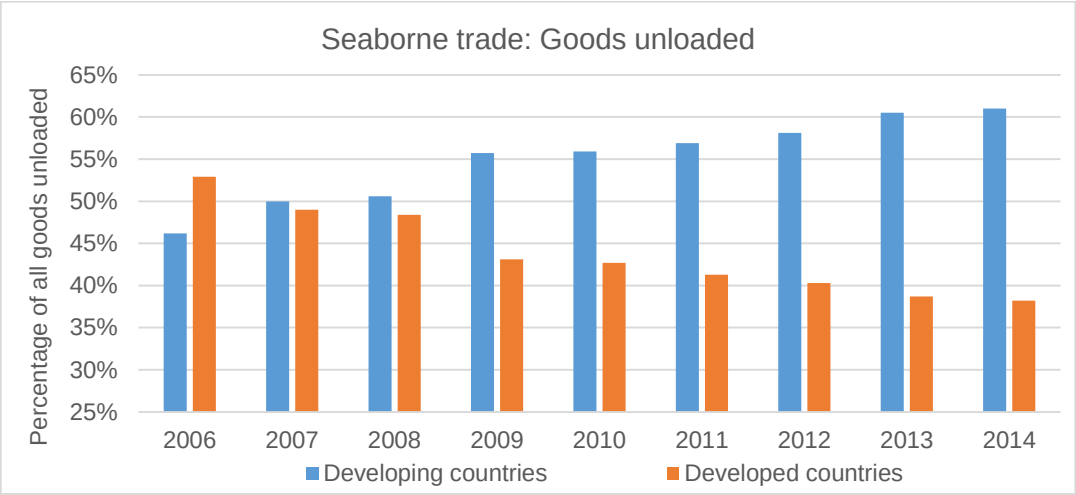


Figure 3 – Goods Unloaded in Developed and Developing Countries, 2006-2014
(UNCTAD, 2015d)

Top ten export routes in terms of annual percentage growth, 2015-2020				Top ten export routes in terms of annual percentage growth, 2021-2030			
	Country	**Exporting to**	**Annual % growth**		**Country**	**Exporting to**	**Annual % growth**
1	Viet Nam	India	20	1	Viet Nam	China	15
2	Ireland	Viet Nam	19	2	Bangladesh	China	14
3	Bangladesh	UAE	18	3	India	China	14
4	Viet Nam	Bangladesh	16	4	Viet Nam	Malaysia	14
5	Bangladesh	India	16	5	China	Viet Nam	14
6	UAE	Turkey	16	6	China	Malaysia	14
7	Viet Nam	UAE	16	7	Viet Nam	India	14
8	China	Viet Nam	16	8	China	India	14
9	Bangladesh	Ireland	16	9	India	Viet Nam	14
10	Viet Nam	China	16	10	Bangladesh	India	14

Figure 4 – Top Ten Export Routes, 2015-2020 and 2021-2030
(HSBC, 2012)

19 However, while expansion will take place in some regions, other States will not be affected by this growth, or could be adversely affected by the changing trading patterns. This is particularly the case for those without a stake in the increase in trade and/or those wholly dependent on maritime transportation, such as the Least Developed Countries (LDCs) and Small Island Developing States (SIDS), as incentives to transport goods to these countries might be weakened. In addition, besides having the potential to lift people out of poverty and hunger, it has to be kept in mind that growth is also associated with issues such as pollution, congestion and displacement.

20 The growing volume of trade also places pressure on necessary infrastructure, such as ports and land transport links as well as a quick clearance of ships by the relevant authorities. Increased shipping volumes can also lead to congestion in specific geographical areas, bringing about the need for better and smoother navigational flows. Furthermore, if the growing volume of goods cannot be moved by the existing fleet, new ships will have to be built to respond to the demand.

21 Shipping has adapted over the years to cater for the growth in trade, and developed new systems and technologies to provide the necessary services to the world at large. An example of this is containerization, which completely changed the way goods could be

shipped (figure 5). For most goods, shipping operates according to the just-in-time principle meaning that the need for storage is reduced, but it also means that the logistics chain is highly complex, and any disruption to trade routes can have serious ramifications for the individual shipping company, if not the whole transport chain.

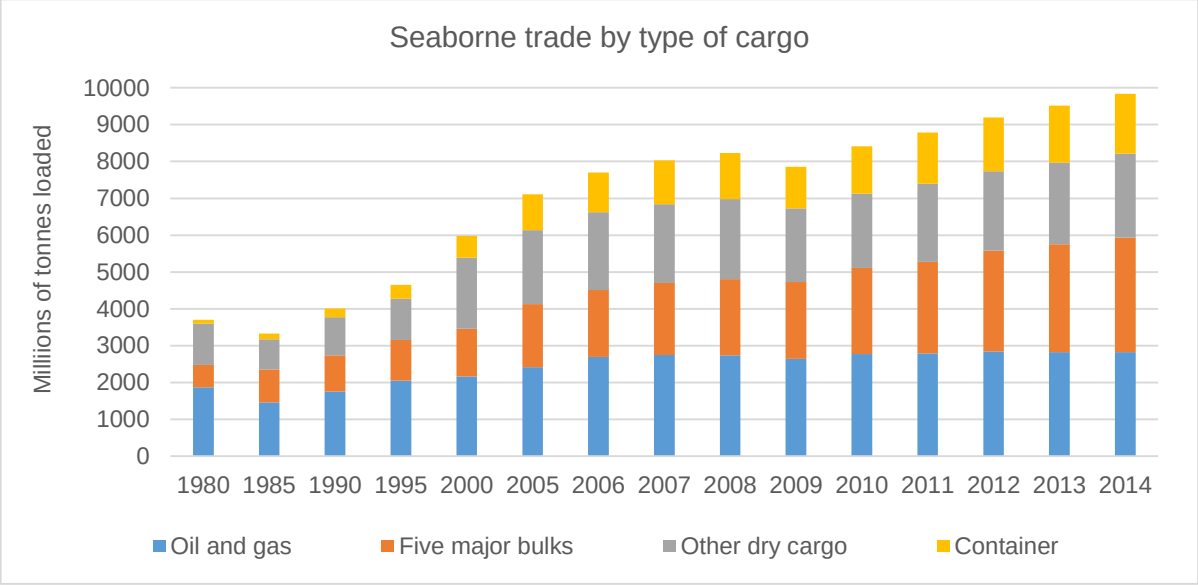


Figure 5 – Seaborne Trade by Type of Cargo
(UNCTAD, 2016d)

22 In a more interconnected world, crises or disasters in one region can have impacts far beyond that region. Major natural disasters, terrorist attacks, piracy, etc. might impact the functioning of vital infrastructure, with the potential of disrupting trade patterns and lengthening shipping routes. A recent development that has highlighted this has been the diversion of many commercial vessels from their planned routes as they assisted in the rescue of maritime migrants in the Mediterranean.

23 In view of the expected growth of seaborne trade, changing trading patterns and the resulting increase in traffic as well as taking into account the associated risks and threats related to these trends, IMO and the maritime community have to adopt a forward looking approach to prepare shipping for the future and strengthen the maritime community's position in global trade.

4. Energy efficiency and climate change

24 As part of the 2030 Agenda, climate change has been recognized as one of the greatest challenges of our time given that the consequences can undermine the ability of all countries to achieve sustainable development. Increases in global temperature, rising sea levels, ocean acidification and other impacts of climate change are seriously affecting coastal areas and low-lying coastal countries, including many Least Developed Countries and Small Island Developing States.

25 Anthropogenic, or man-made, CO_2 has been absorbed over time by the oceans. Research is now finding that the introduction of significant amounts of CO_2 into the seas can lead to alterations of the water chemistry (figure 6) and as a consequence, affect the life cycles of many marine organisms, particularly those at the lower end of the food chain, disrupting ecosystems which in turn can lead to for example food shortages.

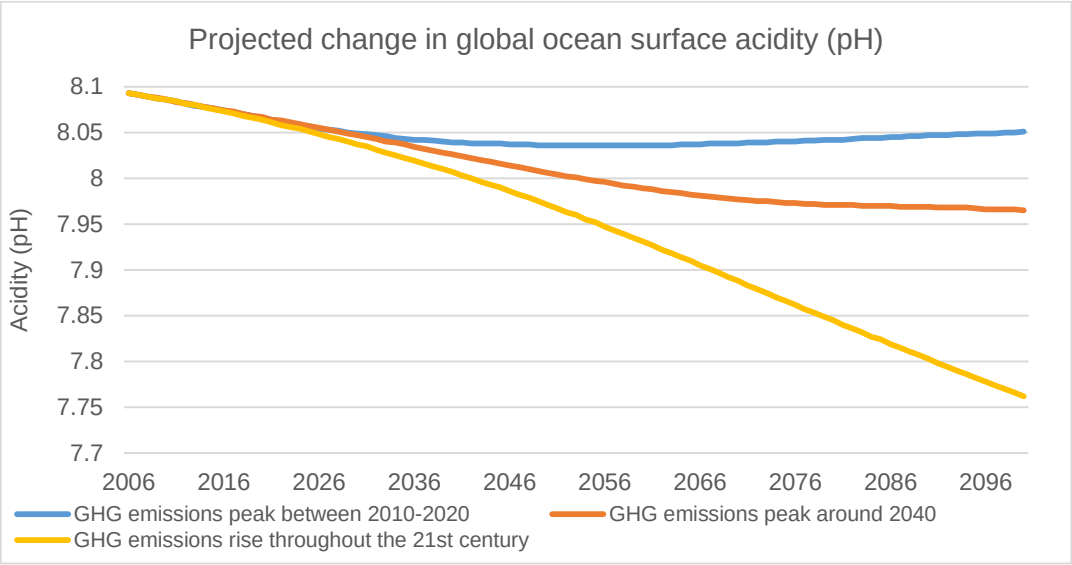


Figure 6 – Projected Change in Global Ocean Surface Acidity
(European Environment Agency, 2012)

26 Burning of fossil fuels and other human and natural activities has released enormous amounts of heat-trapping gases into the atmosphere, which has caused the Earth's surface temperature to rise. As oceans are absorbing the heat, this leads to sea level rises (figure 7) due to thermal expansion (as warmer oceans occupy more space), as well as the melting of glaciers and polar ice caps.

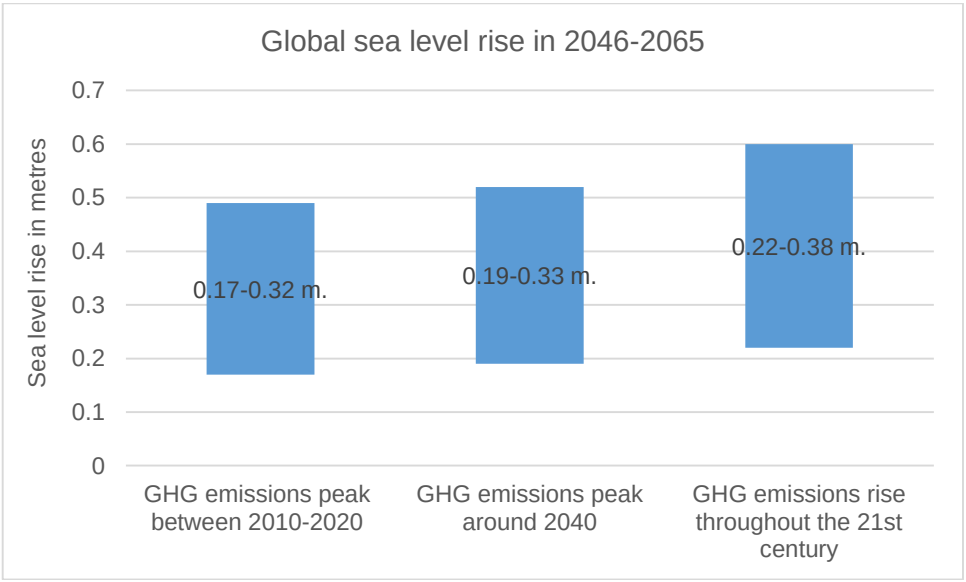


Figure 7 – Sea Level Rise
(IPCC, 2013)

27 Consequences related to climate change are closely linked to poverty alleviation and economic development, and therefore innovative solutions are needed to ensure that past mistakes are not repeated.

28 Although shipping is one of the most efficient models of transportation and has already reduced its CO_2 emissions (figure 8), the maritime industry still contributes to worldwide CO_2 emissions.

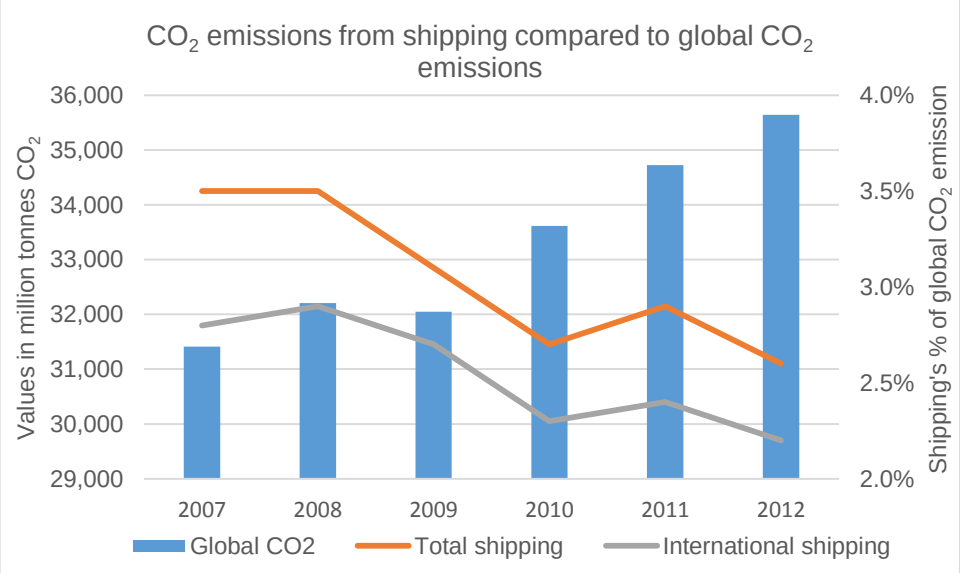


Figure 8 – CO_2 Emissions from Shipping and Global CO_2 Emissions (IMO, 2015)

29 Nevertheless, shipping will be expected to further reduce its environmental impact. While already having developed global regulations on energy efficiency for new ships, further discussions are already ongoing within the Organization on additional measures in order to ensure that international shipping takes upon it its responsibility in handling this global threat.

5. Technological advances

30 The advent of modern technology has significantly changed the world, especially demonstrated by how information and communication technology has impacted the way we live and interact with each other.

31 Technology development is accelerating and will continue to do so. Over the next decades, new technologies will significantly impact shipping, creating a more connected and efficient industry that is closely integrated with the global supply chain.

32 Within the international shipping industry, all parts of the sector have already seen changes in the way they are built and operated due to new technologies. Shipyards are using enhanced materials for the construction of ships and ship designs have become more complex. Equipment installed on board and ashore to navigate, operate and communicate has also changed, ensuring greater accuracy, but also adding burdens on the ship's crew and managers.

33 As technological advances present both opportunities as well as threats to the maritime community, the introduction of a new technology needs to be considered carefully, as does the regulatory approach to these emerging technologies. There is a need to ensure an appropriate balance between regulatory predictability for those being regulated and ensuring that regulations do not interfere with innovation and advances of new ideas.

34 While technological development will continue, the responses of the Organization will need to be fit-for-purpose in the long term and place particular emphasis on the human element, as seafarers roles continue to evolve and change. The successful adoption of new technologies will depend on an effective regulatory framework, technical standardization on a global scale and cooperation between all maritime stakeholders.

B. Developments and Challenges

1. Strengthened system of global maritime governance

35 IMO's main objective is to strengthen the system of global maritime legislation and create a level playing field for all nations involved in international shipping. It is important to underline IMO as the only forum in which to develop global regulation that can be uniformly applied. As the process to develop instruments is consensus driven, occasionally, the deliberations can be extensive or even protracted. In some cases, this has led to unilateral or regional regulations being developed which may contradict, or go beyond, those established at IMO. The development of regional/unilateral regulations can have an impact on the safety, security and environmental soundness of shipping as well as economic impacts for stakeholders in an industry which is global by nature as it works to ensure compliance with conflicting or overlapping regulations.

36 In order to continue to ensure a level playing field, the establishment of a stable and forward-looking global regulatory framework within the remit of IMO, that is able to address both expected and unexpected developments within its core activities of safety, security and environmental protection, has to be strengthened.

1.1. Development and review of IMO regulations

37 International shipping activities are governed by a large number of rules and regulations (figure 9), which at times may overlap, be burdensome or outdated. Overregulation can result in severe commercial, economic and administrative burdens upon national administrations and the industry, threatening the sustainability of maritime transport. In addition, regulations which are hastily adopted can jeopardize the stability of the global regulatory framework, because not all consequences and impacts on the maritime industry might have been considered. However, it is important that Member States and other stakeholders have confidence in the process to ensure early adoption, ratification and entry into force. In this respect, the cooperation between Member States, official maritime industry associations and other stakeholders needs to be strengthen to ensure inclusion of different views when regulations are discussed or reviewed.

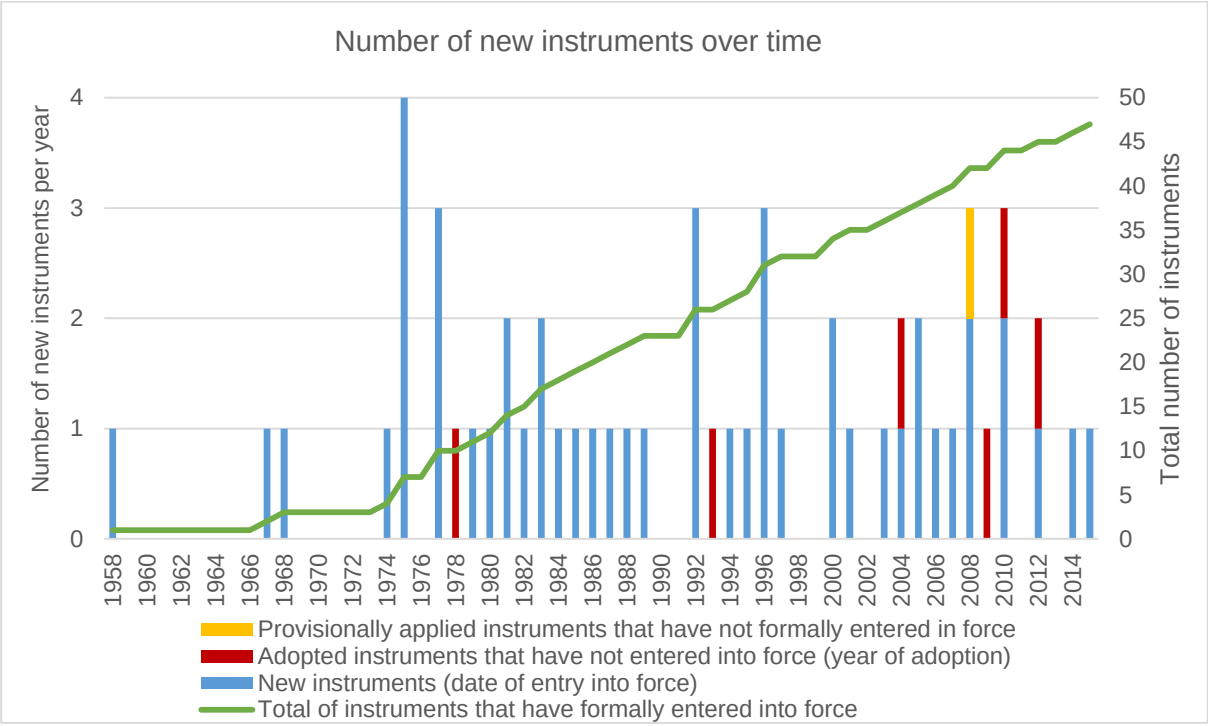


Figure 9 – Instruments over Time
(IMO, 2016a)

38 Regulations have in the past had a tendency to be developed as a response to a specific incident. In order to ensure a stable and predictable regulatory framework, increased emphasis on assessing the effectiveness on existing regulations could be a precursor for decisions on additional regulatory measures. New regulation should be developed only when the review and assessment of existing regulation establishes that it is necessary, because existing regulations do not sufficiently address the particular issue.

39 The development of individual regulations should not take place in isolation. The development of new regulation should be accompanied by the proof of an effective regulatory impact assessment (provision of technical and economic data) and a feasibility assessment (technical and commercial) to ensure that implementation of any new regulations do not conflict with instruments already in place, nor does it cause undue costs or administrative burdens for industry or for Member States. In order to achieve this, an analytical approach to assess safety, security and environmental issues should be applied before creating new regulation to ensure transparency and predictability of international regulations.

40 Traditionally, IMOs regulations have been prescriptive in nature. Prescriptive regulations tend to be a representation of past experience and, as such, become less and less relevant over time. This can, for example, hold back technically innovative ship designers from being able to properly address future design challenges. As a result, safety regulations need to be frequently updated to keep pace with lessons learned and with the latest technologies (figure 10).

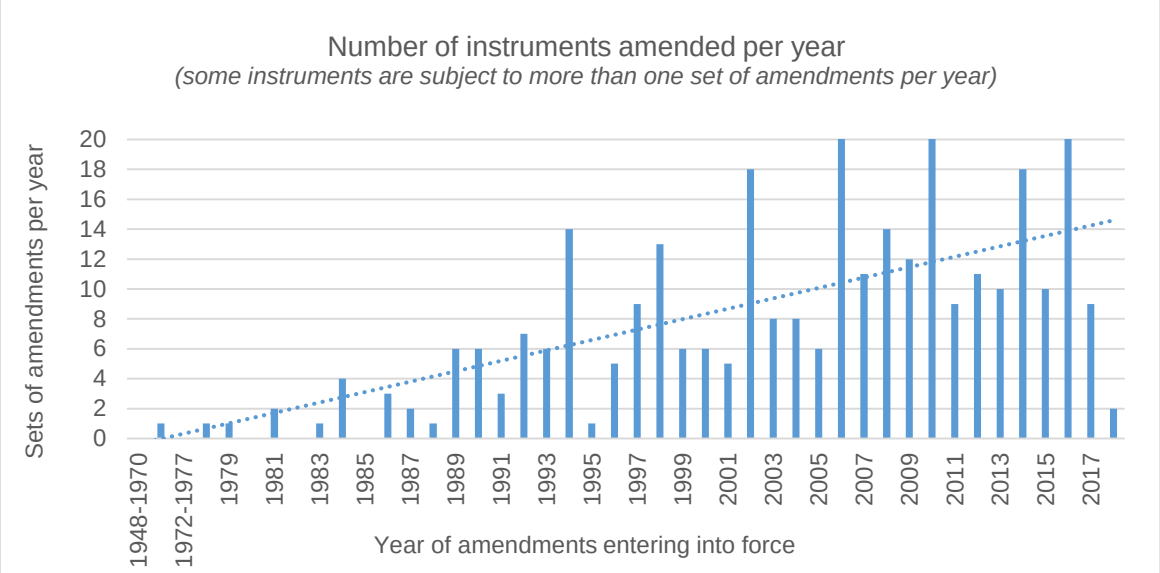


Figure 10 – Number of Instruments Amended per Year
(IMO, 2016b)

41 The ever increasing pace of technological developments and the overall improvement of technical capability are driving innovation in the shipping industry. Additionally, expectations of the public with regard to human safety and environmental protection are increasing. Given the fast pace of technological developments, adaption of new technologies or amendments of IMO regulations to enable new technologies without consideration of all safety aspects could easily undermine the regulatory framework and potentially have negative consequences. Therefore, in recent years, a clear tendency to move from prescriptive regulations to the adoption of a holistic risk-based or goal-based approach to maritime safety, is emerging. These approaches are balancing the elements affecting safety cost-effectively and throughout the lifecycle of the vessel. The goal is to assess safety as a key aspect of shipping with serious economic implications, rather than as an add-on in the design process seeking compliance with prescriptive regulations.

42 The creation of goal-based standards was introduced at IMO to enable the Organization to play a larger role in determining the standards of new ships built, which has been traditionally the responsibility of classification societies. Additionally, goal-based standards can also contribute to a more proactive approach of identifying possible adverse effects on the safety of ships at an early stage and to avoid excessive regulations.

43 The development of ship construction standards permits innovative designs but, at the same time, ensures that ships are constructed in such a manner that, if properly maintained, they could remain safe for their entire life-cycle. The standards also have to ensure that all parts of a ship could be easily accessed to facilitate proper inspection and ease of maintenance.

44 The implementation of the goal-based philosophy enables a new way of viewing the regulatory development process. Traditionally, issues related to fire protection, marine engineering, naval architecture and other maritime disciplines would, in most circumstances, be considered in isolation from each other and, after deliberations, prescriptive regulations would be prepared on a piecemeal basis to address each specific area of safety. However, the new regulatory approach is holistic in nature and focuses on achieving goals.

45 With goal- and risk-based approaches, shipowners would be able to implement innovative ship and transport solutions. However, goal- and risk-based regulation as well as formal assessments for the introduction of new instruments require substantial amounts of data. This increase in data-based approaches also requires establishing of the necessary tools, i.e. data collection, verification, analysis standards and techniques within IMO's regulatory process for a consistent and transparent application. However, given that the submission of data to IMO is very inconsistent, the Organization would have to build and develop these resources to fully carry out risk-based assessment of any proposed regulation and develop further goal-based standards.

46 To assert its position as the main forum for the development of global and uniform standards, the main challenge for IMO is to ensure that its regulations keep pace with the developments within the maritime industry. This requires uniform and effective mechanisms for regular reviews of existing regulations and for the development of new regulations. This should take place in cooperation with all stakeholders, including the maritime industry. Additional challenges, related to the increasing pace of technological developments are the need to develop goal- or risk-based approaches for regulations. The expansion of these approaches within IMO regulations can only be ensured if data-based analytical mechanisms are established, for example by better utilizing port State control (PSC) and casualty data. Given the inconsistent submission of data to IMO, processes and capabilities have to be developed within the Organization to strengthen data analysis capabilities.

1.2. Assessing the effectiveness of IMO regulations

47 Monitoring of the effectiveness of IMO regulations to asses that the measures introduced are implemented correctly and have achieved their aims, is currently not carried out systematically. Placing a greater emphasis on reviewing the effectiveness of IMO regulations could ensure that these instruments remain current, efficient and proportionate, while also achieving the outcomes envisaged by the maritime community during their negotiations. The review could establish if the measures are effective in achieving the required outcomes and if not, why (for example, it could be related to drafting, implementation or simply not having the desired effect).

48 A systematic process could reduce the need for Member States or observers to bring shortcomings to the attention of the Organization on an ad-hoc basis, and increase the maritime community's confidence in measures adopted.

49 Assessing the effectiveness of regulations, considerations would have to be given to not only the specific purpose of the regulations, but also consequential impacts on other areas, for example the safety impacts of an environmental measure, or the human element implications of the introduction of new technology and equipment. This matter should not only be considered following the introduction of the new measure, but also throughout the initial drafting. In the same vein, consideration should also be given to the financial impact on ship-owners and operators. Throughout the process of developing regulations the three dimensions of sustainability need to be balanced.

50 The challenges for IMO are to establish uniform and systematic mechanisms to assess the effectiveness of existing IMO regulations and to constantly consider the impact of newly developed or amended regulations on other areas of the Organization's work and in particular the impact on the maritime industry (financial and with regard to the practicability of implementation).

1.3. Improving IMO's working practices

51 The five main IMO areas of work have their own distinct features, but are also partly overlapping or complimentary. The reduction of sub-committees has already enabled IMO to expedite matters and to deliver global solutions quicker.

52 However, some issues and regulations that IMO is dealing with cover more than one area of work and the Organization would be able to respond more comprehensively and effectively if all aspects of these issues were considered simultaneously. Some matters, such as the reduction of administrative burdens, require horizontal considerations to provide sustainable solutions.

53 While it has been a hallmark of IMO to deliver regulations of high regulatory and technical quality, one of the main challenges for IMO is that its overall working mechanisms need to be enhanced continually to ensure the decision making process continues to be agile and flexible to meet the future demands of Member States and the maritime industry in a timely manner.

1.4. Uniform Implementation

54 One of the purposes of the Organization is to ensure a level-playing field. To fully achieve this, uniform implementation of IMO conventions by all IMO Member States is needed. Conventions must be ratified in a timely manner to enter into force. This would facilitate a higher degree of predictability for the maritime industry. Considering the amount of time and resources spent negotiating new mandatory instruments, the duration of time between adoption of new instruments and their entry into force is critical. Failing to ensure the entry into force of international instruments can lead to the adoption of unilateral or regional measures, which is detrimental to IMO's global role and credibility (figure 11).

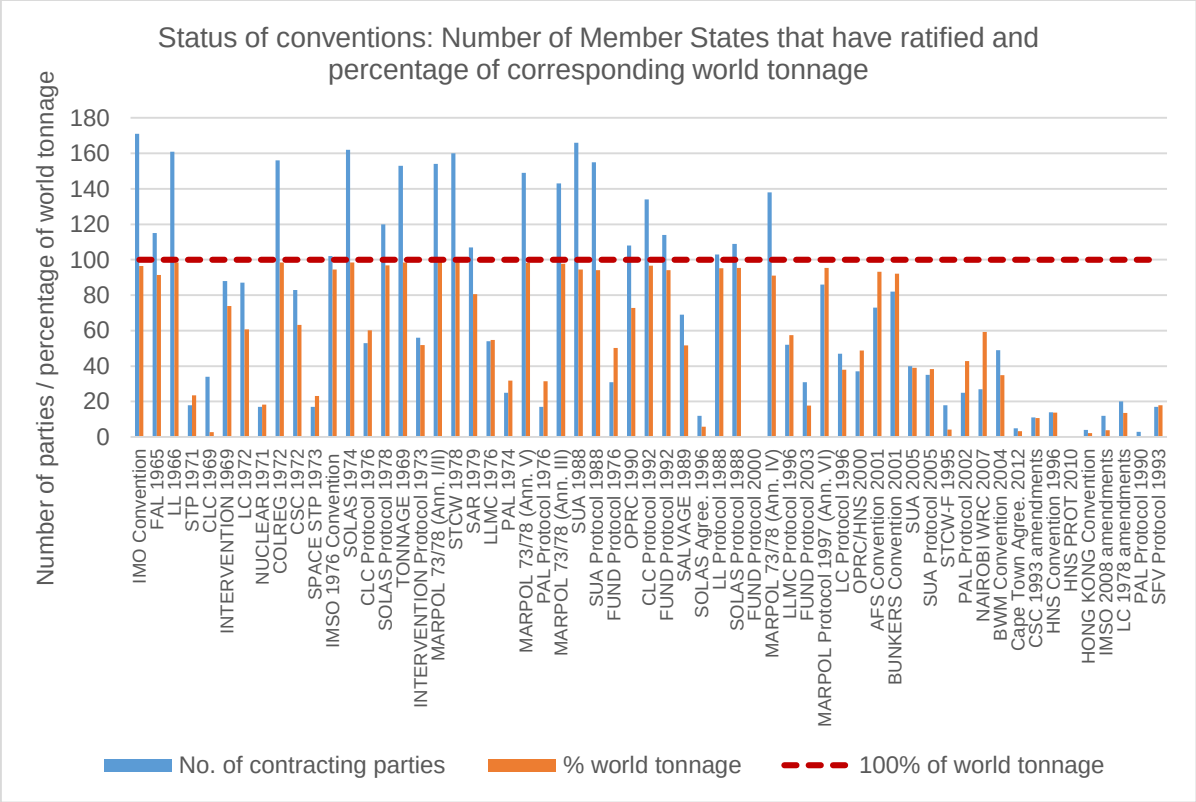


Figure 11 – Status of Conventions
(IMO, 2016a)

55 The increasing number of safety, security and environmental protection requirements in IMO's mandatory instruments places an added emphasis on the uniform implementation of IMO instruments within the maritime community. The effects of the financial crisis demand further scrutiny on new requirements to minimize additional administrative burdens. As IMO and the maritime industry will be judged by their overall performance, there is a need to not only raise standards, but also increase overall implementation and compliance.

56 IMO needs to ensure an enabling environment to adopt and implement IMO instruments worldwide. The role of technical cooperation in this regard is important. In order to ensure better implementation, benefits could be gained from capacity-building initiatives, as well as partnerships (public or private) in developing countries, where the competencies of a broader range of stakeholders are shared through cooperation.

57 An important element to enhance the uniform implementation of IMO regulations is the IMO Member State Audit Scheme (IMSAS). The Audit Scheme is a primary tool in assessing Member States' performance in meeting their obligations and responsibilities as flag, port and coastal States under the relevant IMO instruments. Analysis of the audit reports will provide a further component to assess the main needs of Member States and offer guidance for future technical cooperation activities.

58 Additionally, a better targeting of resources to where they are most needed would strengthen the current technical cooperation support system to provide a better mechanism for technical cooperation activities. These efforts will ultimately lead to better results with respect to the implementation of IMO regulations.

59 The challenge for IMO is to ensure that its instruments are implemented uniformly and without unnecessary delays. In order to achieve this, the Organization has to improve cooperation across all areas of its responsibility (safety, security, environmental protection) and with all stakeholders to assess the barriers to implementation and provide targeted technical cooperation activities. On an operational level, the main challenge will be the full implementation and utilization of the IMO Member State Audit Scheme (IMSAS) to systematically review audit findings to inform the regulatory process of the Organization and future consideration of new obligations and responsibilities for Member States under IMO instruments.

2. The maritime industry's reliance on effective facilitation of trade

60 The shipping industry moves around 80% of the world trade by volume[6], making it an integral part of the global economy and the international supply chain. With the expected expansion of the world fleet, the shipping industry has a keen interest in ensuring the effective facilitation of international trade to ensure that ships transit from port to port without unnecessary delays by simplifying and reducing paper work and formalities during the ships' stay and departure on international voyages.

61 Over time, IMO has established a very effective system of global maritime governance. It is a system of shared responsibilities under the IMO Convention, in which flag States, coastal States, port States and the industry including land-based sectors (e.g. ports, freight forwarders) all have a stake in developing and, subsequently, implementing the global measures adopted through IMO to facilitate international shipping.

6 UNCTAD, 2015d.

2.1. Reduction of administrative burdens

62 The increase in administrative burdens threatens these achievements and has resulted in the need to improve the facilitation of maritime activities. The increasing number of IMO conventions and their amendments have led to requirements to document many aspects of conducting shipping activities – all introduced to enhance safety, security and environmental protection. Paperwork and bureaucracy is an issue in most industries, but it is an especially significant problem for shipping because of its international nature with a lack of standardized forms, a traditional reliance on paper to document compliance and established procedures associated with the arrival, stay and departure of ships engaged on international voyages (figure 12).

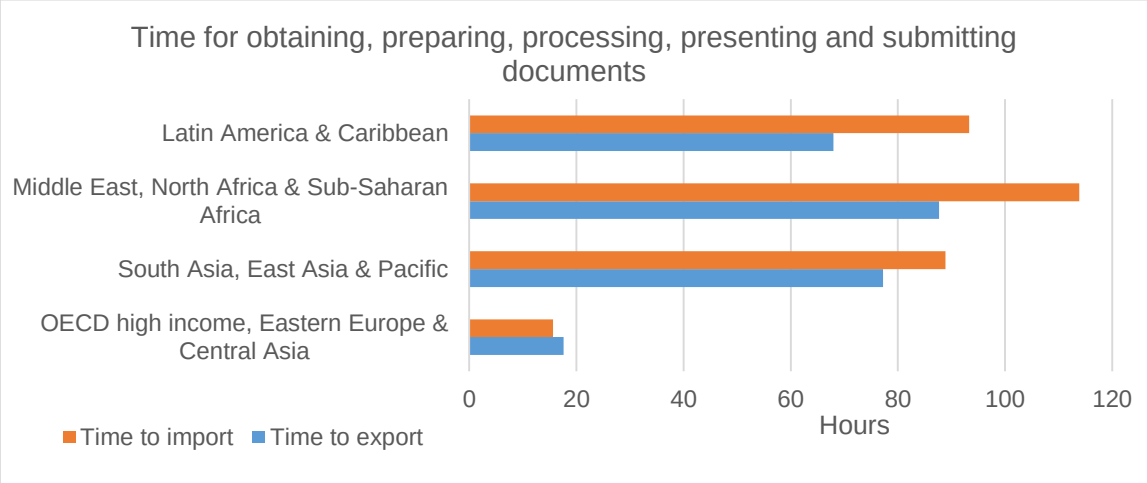


Figure 12 – Documentary Compliance
(World Bank, 2016)

63 The issue is not only related to the increase in the number of documents, but also the duplication of information to be provided, as well as the cumulative effect of the documentary requirements (figure 13). This is in particular a concern in relation to ships' crew with the responsibility of ensuring the safe navigation and operation of the ship, because time and attention is diverted to administrative tasks. Despite awareness about this, diverging practices in the clearance of ships and problems of duplication of information and multiple reporting have been pressing concerns for seafarers, ship owners and national administrations for years. The introduction of electronic information exchanges and electronic recording might present an opportunity to alleviate some of these burdens.

Perceived Level of Administrative Burdens (from survey among international seafarers)				
Type of task	**Tasks are repeated too often**		**Tasks require too much documentation**	
	Agree	Disagree	Agree	Disagree
Port and pre-arrival	71%	29%	79%	21%
PSC, FSC, class inspections	66%	34%	76%	24%
Vetting inspections	66%	35%	76%	24%
ISPS requirements	66%	34%	74%	27%
Internal QMS	63%	37%	76%	24%
Journals	59%	41%	65%	35%
Exercises and drills	51%	49%	64%	37%

Figure 13 – Perceived Level of Administrative Burdens
(COWI, 2013)

64 The challenges for the Organization are to balance the need to ensure the safety, security and environmental soundness of shipping and the shipping industries ability to manage their ships without being overburdened with paperwork.

2.2. Electronic transmission of information, including electronic certificates

65 The use of new technologies present both possibilities and challenges that need to be addressed. The use of new technologies, for example electronic certificates, have been identified as one of the major measures to alleviate administrative burdens (figure 14). To achieve this, electronic certificates need to be verifiable and be universally accepted. Without clear rules, ships may have to carry hard copies in addition to the electronic versions due to the uncertainty about the acceptance of electronic certificates.

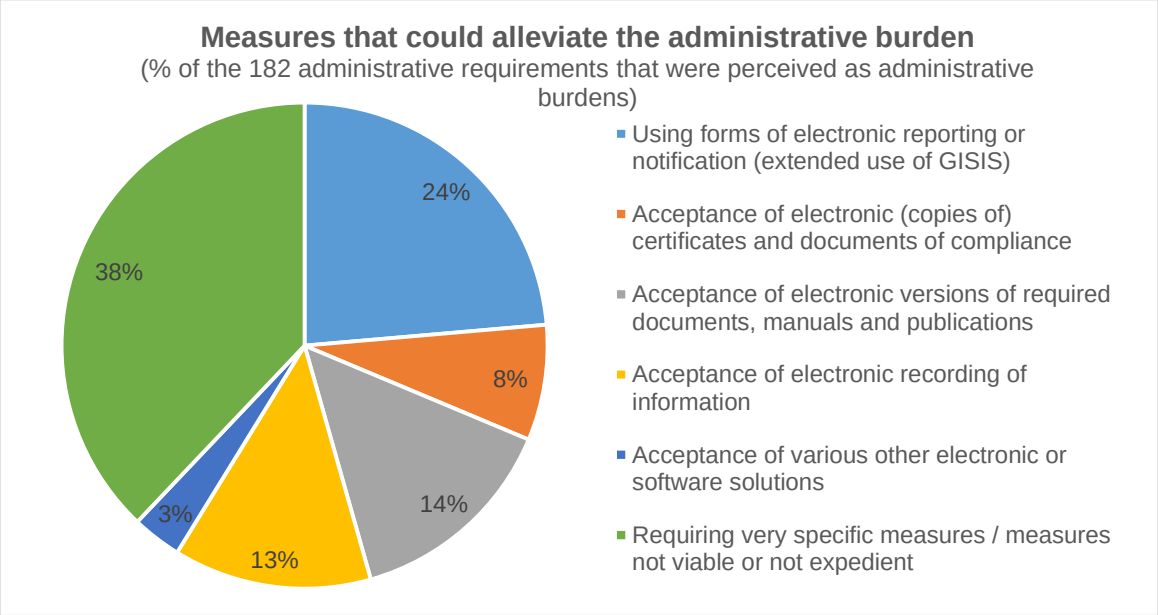


Figure 14 – Measures to Alleviate Administrative Burdens
(IMO, 2014a)

66 To take full advantage of these technological developments, such as the electronic transmission of information, required by IMO instruments, a closer cooperation of flag, port States and the industry is necessary.

67 The challenges for the maritime community are to work on increasing the uniformity of certificates and move towards the universal acceptance of electronic certificates. IMO should encourage cooperation between the relevant stakeholders and enable the work on solutions for electronic certificates as well as the transfer of suitable technologies to developing countries.

2.3. Single Window Approach

68 The single window approach provides a further possibility to utilize technological developments to reduce administrative burdens by facilitating the reporting requirements of a ship's crew. A single window is a facility that allows parties involved in trade and transport to provide standardized information and documents through a single entry point to fulfil all import, export and transit-related regulatory requirements. In 2014, 73 countries operated a single window of varying complexity[7].

7 World Bank, 2013.

69 At present, most existing single window systems are customs single windows and deal with the import or export clearance of cargo. While improving the performance of customs remains a high priority for many countries, it is only one of the many agencies involved in border processing, and is frequently the most modernized (figure 15). Customs agencies are often responsible for no more than one-third of regulatory delays.

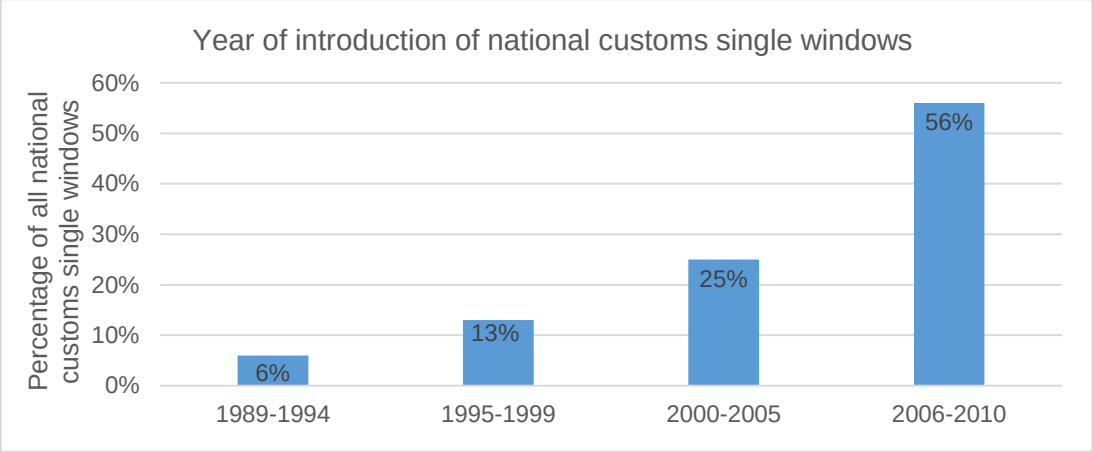


Figure 15 – Introduction of National Customs Single Windows
(World Customs Organization, 2011)

70 The focus of reform efforts therefore needs to shift beyond customs to tackle the systems and procedures employed by other border management agencies and myriad other organizations involved in regulating trade flows. Achieving meaningful trade facilitation gains requires a comprehensive approach based on effective information-sharing, streamlining of procedures and collaboration among all border management agencies.

71 An approach to border processing and clearance is the establishment of National Single Window systems, which allow traders to submit all import, export, and transit information required by regulatory agencies via a single electronic gateway, instead of submitting and processing the same information numerous times to different government entities, including some that are automated and others that still rely heavily on paper.

72 As 80% of the world trade is carried by sea, the issue of clearance of ships can be considered a major factor in facilitating international trade. However, a maritime single window system for shipping as a means of transport is less extensively covered. Thus, there is a need to provide more specific guidance on maritime single window systems that is focused on the clearance of ships, passengers and crew members. The aim is to enable the submission of all the information required by public authorities in connection with the arrival, stay and departure of ships, persons and cargo without duplication.

73 In recent years, some progress has been made to develop a single window system for maritime transport, mainly through the developments of guidelines for setting up a single window system. However, further work is needed to support the implementation of single window systems.

74 The challenges for the maritime industry are to seek international consensus in simplifying reporting and recording requirements and to look for global solutions that may facilitate these exchanges such as the maritime single window. One of IMO's challenges is to enable the process of developing a maritime single window and explore possible synergies with existing national single window systems. Additionally, given the complexity of this approach, IMO will have to provide technical cooperation support to develop and implement single windows in developing countries.

2.4. Security

75 The FAL Convention encourages Member States to improve port and border procedures. However, the stringent security measures, established in the ISPS Code, surrounding shipping place additional strain on the flow of cargo through the maritime supply chain. In order to further facilitate trade, there will be a need to balance security and facilitation policies to improve the operational efficiency and effectiveness of procedures in the maritime supply chain. This can be achieved by increasing the flexibility of regulation to better reflect the variability of existing security threats in different countries and regions. In this respect, the knowledge and experience gained by contracting parties regarding maritime transport security should be considered. To reduce administrative burdens related to overlapping or unnecessary regulation, synergies between maritime transport safety, counter-terrorism and counter-piracy measures need to be improved.

76 With regard to piracy, while there is year on year decline in the number of vessels hijacked and crew members captured, for the first time in five years there was a reported increase in the number of actual and attempted piracy attacks during 2015 (though only by one incident; 246 compared to 245 in 2014) (figure 16). Attacks in South East Asia continue to increase, with this region now accounting for around 60% of global incidents. An issue with South East Asia is that traffic is very dense and different national territorial waters are adjacent to each other, making distinguishing responsibilities problematic.

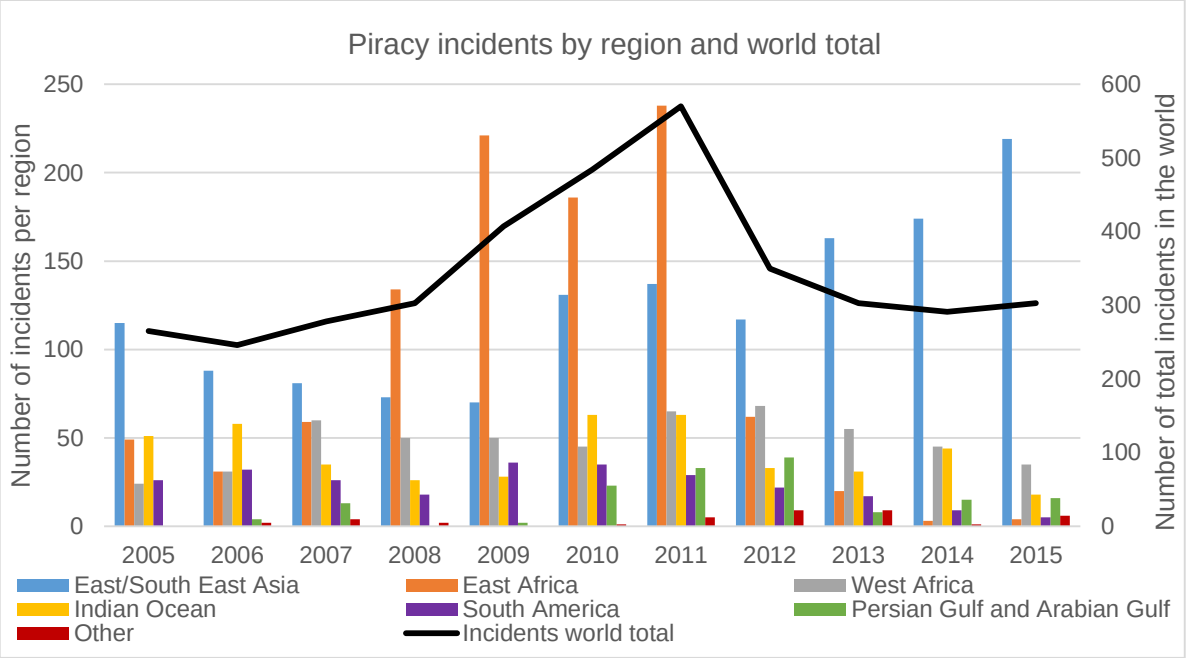


Figure 16 – Piracy Incidents, 2005-2015
(IMO, 2016c)

77 Of additional concern is the risk of cyberattacks by pirates. Pirates might exploit weaknesses in the shipping company's cybersecurity to track the movement of vessels or target orders for specific cargoes. For example, pirates could use their access to refineries to detect which vessel is carrying the fuel they are interested in and use the Automatic Identification System (AIS) information to locate and hijack the vessel. For example, there has already been one reported incident of Somali pirates that have hacked a shipping company's system to identify vessels passing through the Gulf of Aden with valuable cargoes and minimal on board security, which lead to the hijacking of a vessel.

78 The challenges for the maritime industry are to balance security and facilitation policies to improve the operational efficiency and effectiveness of procedures in the maritime supply chain. Additionally, new and emerging security issues, for example the increase of piracy in South East Asia and the threat of cyberattacks by pirates or terrorists, have to be monitored and measures to address these emerging issues need to be developed. The challenge for IMO is to support and enable the maritime community's efforts and provide a forward-looking perspective especially in the context of threats related to the usage of new technologies.

2.5. Infrastructure facilities

79 Sustainable economic growth, employment, prosperity and stability can all be enhanced through developing maritime trade by sea which will only continue to increase in volume and importance (figure 17). The economic, environmental and social developments facing ports include growing and concentrated traffic volumes brought about by ever-increasing ship size, the cost of adaptation of port and port hinterland infrastructure measures, volatility in energy prices, the new energy landscape and the transition to alternative fuels and potential changes in shipping routes from new or enlarged international passage ways.

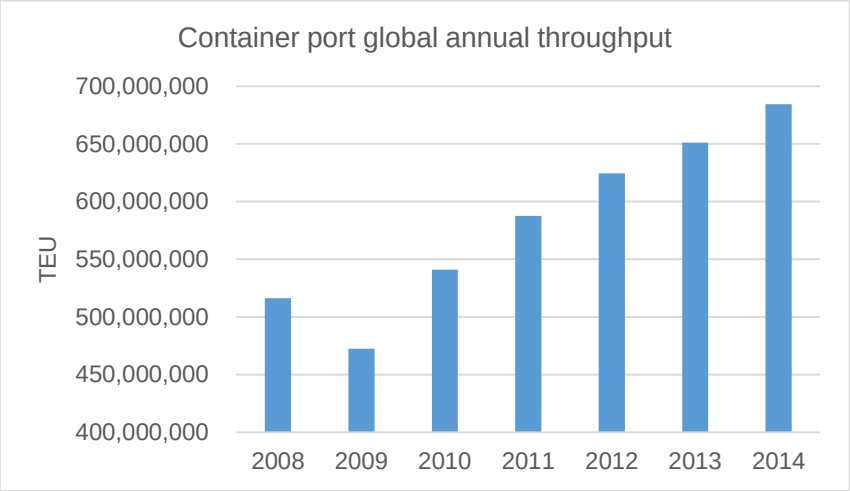


Figure 17 – Container Port Global Annual Throughput
(UNCTAD, 2015e)

80 Ports are an essential vital link in the maritime transport chain (figure 18) and any measures to improve their efficiency increasingly come under IMO's purview. Improving port infrastructure and efficiency is vital in this respect, and the port industry faces many challenges today that mirror those faced by the shipping community.

Top 20 container terminals and their throughput, 2012-2014 (TEUs and % change)						
	Port Name	**2012**	**2013**	**% change 2013-2012**	**2014**	**% change 2014-2013**
1	Shanghai	35,529,000	36,617,000	12.57	35,290,000	-3.62
2	Singapore	31,649,400	32,600,000	3	33,869,000	3.89
3	Shenzhen	22,940,130	23,279,000	1.48	24,040,000	3.27
4	Hong Kong	23,117,000	22,352,000	-3.31	22,200,000	-0.68
5	Ningbo	15,670,000	17,351,000	10.73	19,450,000	12.10
6	Busan	17,046,177	17,686,000	3.75	18,678,000	5.61
7	Guangzhou	14,743,600	15,309,000	3.83	16,610,000	8.50
8	Qingdao	14,503,000	15,520,000	7.01	16,580,000	6.83
9	Dubai	13,270,000	13,641,000	2.80	15,200,000	11.43
10	Tianjin	12,300,000	13,000,000	5.69	14,060,000	8.15
11	Rotterdam	11,865,916	11,621,000	-2.06	12,298,000	5.83
12	Port Klang	10,001,495	10,350,000	3.48	10,946,000	5.76
13	Kaohsiung	9,781,221	9,938,000	1.60	10,593,000	6.59
14	Dalian	8,064,000	10,015,000	24.19	10,130,000	1.15
15	Hamburg	8,863,896	9,258,000	4.45	9,729,000	5.09
16	Antwerp	8,635,169	8,578,000	-0.66	8,978,000	4.66
17	Xiamen	7,201,700	8,008,000	11.20	8,572,000	7.04
18	Tanjung Pelepas	7,700,000	7,628,000	-0.94	8,500,000	11.43
19	Los Angeles	8,077,714	7,869,000	-2.58	8,340,000	5.99
20	Jakarta	6,100,000	6,171,000	1.16	6,053,000	-1.91
	Total top 20	284,059,418	296,791,000	4.48	310,116,000	4.49

Figure 18 – Top 20 Container Terminals, 2012-2014
(UNCTAD, 2015d)

81 The operational complexities of dealing with larger ships; the need to manage congestion; the need to do more with less space, the continued pressure to enhance safety and security in and around port areas and to embrace greener technologies (for example port reception facilities) and working practices, are among the specific developments that the entire supply chain needs to address. So too are the need to reduce the administrative burden on ship masters, seafarers and shipping companies, and to reduce the time scales of the ships and cargo at ports. The port infrastructure, support facilities, and the human capital throughout the maritime industry need to be further developed to enable ports to offer a more efficient service.

82 The main challenge for the maritime community is to assess and acknowledge the relevance of ports and port facilities for international shipping. A significant challenge for the Organization is to identify means to deal with the economic, environmental and social challenges facing ports in recognition of their vital link in the maritime transport chain, keeping in mind the significance of ports beyond issues of facilitation, i.e. the environmental as well as the safety and security impact of ports. A first step to strengthen the cooperation with ports could entail a closer cooperation and strengthened information sharing with port State control (PSC) regimes.

3. Marine technology to foster a safety culture and the efficiency of shipping

83 In the 21st century, the pace of technological development has accelerated, impacting the shipping industry. Early identification of emerging technologies that impact the global shipping industry is vital to making the right decisions at the right time with regard to international regulations. Despite the many benefits of technology, emerging technologies could also present challenges and threats to the maritime community.

84 The challenges for the maritime community are to proactively adapt expediently to new technologies while assessing the potential impact of new technologies on safety, security, environmental protection as well as the human element. The main challenge for IMO is to remain aware of the technological developments and their impact on IMO's areas of work. Additionally, with regard to providing a level playing field and preventing a technology gap, a significant challenge for IMO will be to facilitate the transfer of knowledge, including training opportunities, to developing countries, especially SIDS and LDCs. Considering the pace of technological developments, a major challenge for IMO will be to develop less prescriptive and more flexible instruments using for example goal-based standards or risk-based approaches.

3.1. Safe ship operation and navigation

85 In the current connected world, news of maritime disasters is communicated faster. Although safety of shipping has increased significantly over time, which can be observed by the decrease of total losses of vessels by 45% over the past decade (figure 19). Nevertheless, the public's response to fatal accidents at sea has placed the industry under increased scrutiny, demanding action from regulators to introduce new requirements to improve safety. Avoiding accidents and ensuring the safety of on-board personnel and passengers presents one of the most complex challenges faced by the shipping industry as, unlike mechanical or technical systems, safety systems must account for the seemingly infinite variables of human behaviour.

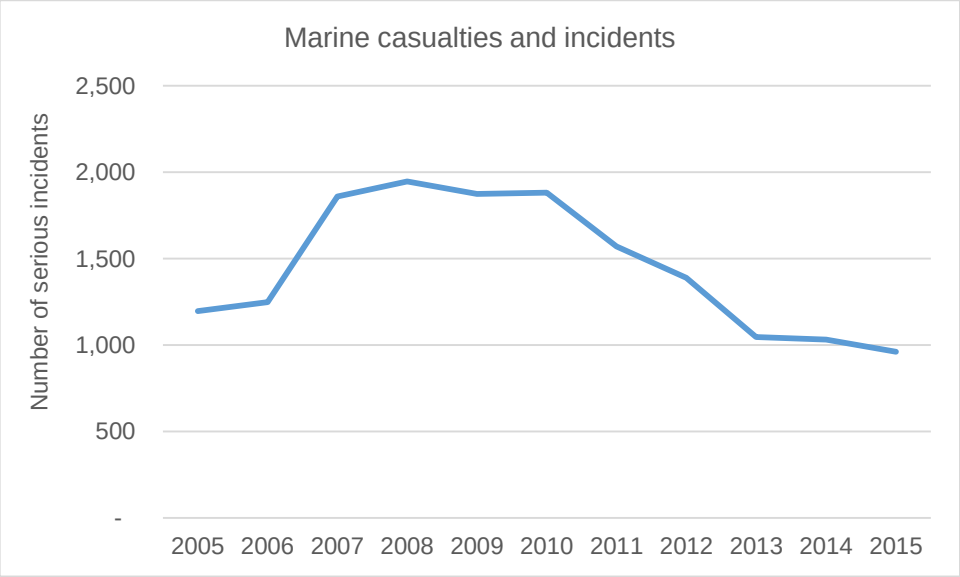


Figure 19 – Marine Casualties and Incidents
(IMO, 2016d)

86 Nevertheless, operational safety also relies on a broad range of technologies. Satellite and communication technology, surveillance and navigation technology have significantly changed the way ships are navigated and the planning of routes (figure 20). Those technologies also enable improvements with regard to distress and safety systems as well as Search and Rescue (SAR) activities. Increasing need for data transfer between vessels and onshore bases to ensure optimal operational efficiency, safety, and security are driving these developments, as is the need for shipping to deliver goods to consumers on time.

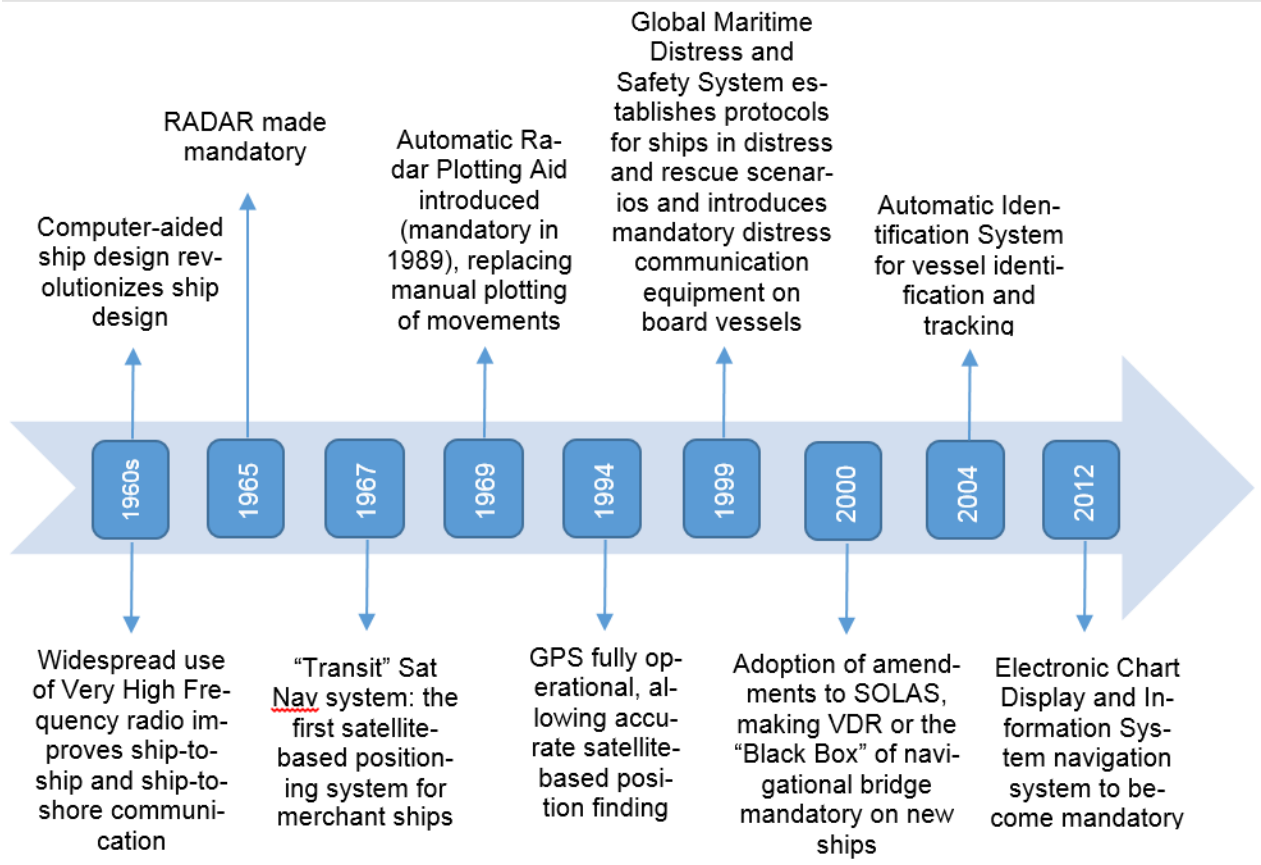


Figure 20 – Timeline of Developments in Navigation Technology
(Allianz Global Corporate & Specialty, 2012)

87 Advanced radio communication technology enables the transmission of information in a digital and language independent format, and can be used for on board, ship-ship and ship-shore communications. Increased reliance on these systems also means that vulnerability of ship operations increases. Additionally, issues such as interoperability between different hosts/systems, and the capacity of the systems and services become more important.

88 Interaction between the technological systems and the human element are becoming more complex and require a better understanding at the design, manufacturing and operational phases of the product and system development.

89 Today, increasingly ergonomic and integrated bridge control systems are available. The development of global standards and principles, i.e. IMO's e-navigation strategy, covering ergonomics and improved integration of bridge controls is already underway, helping to ensure better coordination between design and operations. Also, a more standardized bridge will reduce the time needed for personnel to familiarize themselves with bridge controls and eventually lead to the development of best practices that can be applied throughout the

industry. At the same time, technologies developed by other industries (e.g. aviation) are being applied to shipping to help reduce port congestion and collision risk. Today, some of the world's busiest ports utilize satellite technologies to track and monitor vessel traffic (Vessel Traffic Service, VTS).

90 The main challenges for the maritime community are to increase and improve the utilization of these new navigation and communication technologies through their implementation and providing training to seafarers. A challenge for IMO is to enable cooperation between Member States, ship owners and the manufacturers of navigation and communication technologies to provide solutions that address issues of system compatibility, standardization and the capacity of services to reliably transmit and store information. Another challenge for IMO will be to update relevant safety procedures, in order to keep them up to date with current technological developments. This includes the update of the Global Maritime Distress and Safety System (GMDSS) as well as the harmonization of international Search and Rescue (SAR) efforts. Additionally, IMO will have to support the education and training of seafarers to increase their awareness of safety and security issues of electronic navigation as well as to understand the dangers of overreliance on electronic navigation systems.

3.2. Utilization of big data

91 The use of advanced information and communication technologies provides access to an unprecedented amount of data associated with shipping. This data is produced by different sources and in different formats, such as hydrographic data, maritime traffic data, maritime accident data and data on cargo flows across the world. However, to make full use of this amount of data, new strategies and methods of data analysis need to be developed, as among other issues, current data collection is inconsistent, patchy and sometimes unreliable.

92 The availability of data enables new avenues for increasing the safety of ship operation by facilitating the reduction of risks caused by human error, as well as increasing the efficiency of shipping. The use and analysis of the data available can enable real-time performance monitoring to improve safety through alert systems and increase operational efficiency through energy management, voyage planning and positioning.

93 For the review and development of IMO instruments, the availability of data creates the possibility to apply a more data-driven approach to the decision-making process. Data analytics can help to better understand the shipping industry and detect underlying developments in more detail and ultimately, basing regulations on objective criteria.

94 However, in order to utilize the data that will become available as technology evolves, mechanisms to ensure data integrity and data quality need to be developed. Additionally, as data networks and data management become increasingly vital to shipping, the systems will need to be able to shield themselves from external interferences, such as viruses, manipulations and cyberattacks.

95 The main challenge for the maritime industry is to utilize the data that is already available in an efficient way as well as to explore additional opportunities to utilize it. However, there is also the need for strategies and methods to ensure data quality and integrity and to acknowledge the impact of the reliance on data with regard to the human element as well as external interferences. The challenges for IMO are to also utilize data and develop data collection, monitoring and analysis mechanisms for amending and developing regulations based on objective criteria to ensure safer, more efficient and environmental sound shipping.

3.3. Automation and remote operations

96 Advanced technologies also enable the automation of ships, which may lead to semi-autonomous ships (e.g. engine room crewless ships) or fully autonomous ships (remote controlled). Although, semi- or fully automated vessels are likely to first operate within territorial waters, it should be foreseen that they will eventually branch out to international waters.

97 Further technological evolution will also have an impact on the workflows and processes. For example, physical on-board surveys could be replaced by remote monitoring, regulatory compliance and enforcement could be achieved remotely without visiting the ship and real-time decision-making in ship management and autonomous operation will become feasible.

98 Advances in digital information exchange technology has permitted ship systems and shore based monitoring and communications to be linked in ways previously thought impossible. This relationship between ship and shore can open up the management of ship operations to others beyond the ship master who operates under the oversight and regulatory authority of the flag State. The potential for a division of authority might also divide responsibility and liability between multiple actors.

99 The main challenge for the maritime industry will be to assess the level of automation that still enables a safe and secure operation of a vessel, while also acknowledging the risks that might be associated with autonomous ships with regard to cybersecurity issues as well as the potential division of authority that a more autonomous shipping entails. The main challenges for IMO are to acknowledge and monitor the impact of increased automation as well as the effects of remote operations on ships, crews and shore-side personnel in terms of safety, security and training of seafarers. The Organization has also to take these developments into consideration when amending or developing instruments to protect the maritime transport system from negligence, attacks or possible malfunction arising from increased automation.

3.4. Cybersecurity

100 Evolving technologies like sensors, robotics, information and communication technologies that drive advances in smart controls, optimization, decision support tools, automation, as well as system management, demand updates of international standards in order to mitigate any unforeseen safety, and especially cybersecurity implications, to the maritime transport system. As dependency on electronic information grows, the issue of cybersecurity becomes increasingly relevant (figure 21).

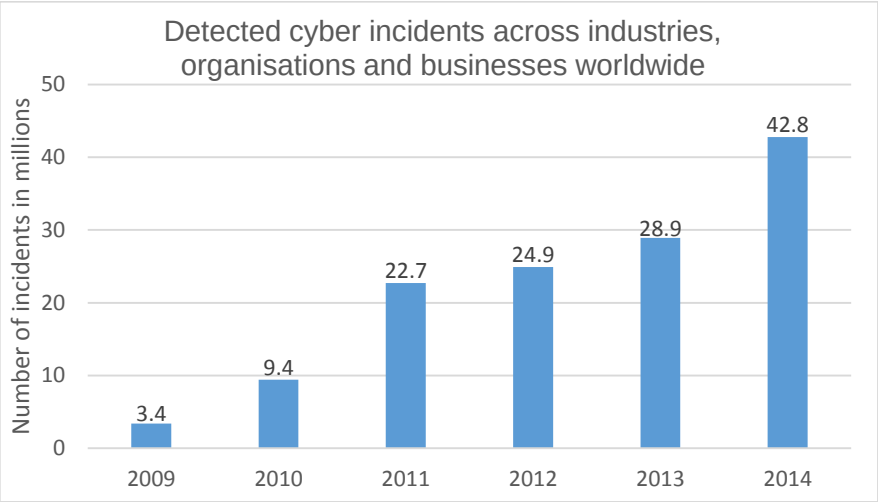


Figure 21 – Cyber Incidents, 2009-2014
(PwC, 2015)

101 Ship and port facility operators are increasingly dependent on computers and technologies for, for example, propulsion, engineering, cargo handling, safety and environmental control. In this respect security is a concern if faced, for example, with malicious acts to control, disable or exploit system, and safety issues such as malware, incorrect operation of systems and other technical errors. Navigation, for example, can be affected by accidental or intentional interferences with the GNSS signals, causing misleading situational awareness, the sabotaging of vessel traffic service, or the endangering of integrated bridge and autopilot systems.

102 Cyberattacks on the maritime industry are often under-reported as companies prefer to deal with security breaches internally. If reports of cyberattacks emerge, they are usually very vague, providing little insights into the progress the maritime industry has made in strengthening cybersecurity. Examples of cybersecurity issues reported to date include a hacker causing an oil platform located off the coast of Africa to tilt to one side forcing a temporary shutdown. In another instance, hackers infiltrated cybersystems of a port to locate specific containers loaded with illegal drugs and remove them undetected[8].

103 While the risk of loss or damage caused to, or by a ship as a direct result of a cybercrime is currently low for bulk or general cargo vessels, more specialized or technically-advanced vessels engaged in oil and gas exploration and exploitation are more predisposed through their use of remote systems. Therefore, apart from virus detection software, additional steps need to be taken by the maritime community to assist ship owners and operators to implement cyber risk management practices and ensure the security of the services delivered.

104 The main challenge for the maritime industry is to acknowledge the risks of cyberattacks that might to some extent already take place undetected and to work on more robust cybertechnology, utilizing the experiences of other industries (in particular aviation). The main challenge for IMO is to take the necessary steps to develop and assist with the implementation of cyber risk management practices.

8 Allianz Global Corporate & Specialty, 2016

3.5. Hydrographic surveys and nautical charts

105 Shipping activity is increasing through trading on new routes with larger vessels, along with increased access to polar routes and larger vessels transiting the world's major canals. This, along with the limitations of information provided in nautical charts due to the gaps in hydrographic surveying, creates environmental and safety concerns and reduces the efficiency of maritime navigation. According to the International Hydrographic Organisation (IHO), around 70% of the world's coastal waters remain inadequately surveyed or unsurveyed, with specific areas, for example the polar regions, having over 95% of its coastal waters inadequately surveyed or unsurveyed (figure 22).

Examples of unsurveyed areas in the 0-200m depth zones	
Area	**Unsurveyed area**
South West Pacific	> 95%
Polar regions	> 95%
Caribbean	> 80%
West Africa	> 80%
Australia	45%
United Kingdom	29%

Figure 22 – Examples of Unsurveyed Areas
(IHO, 2016)

106 Additionally, technological developments are outpacing charts and surveys. Electronic navigational chart (ENC) detailing may not be as accurate as the Global Navigation Satellite Systems (GNSS) position of the ship displayed on its Electronic Chart Display and Information System (ECDIS). Reliance on modern navigation equipment may lead to seafarers overlooking the fact that caution is needed when planning routes and navigating ships to ensure that there is a sufficient safety margin between charted hazards and the ship's intended route.

107 This results in a widening gap between the overall quality of hydrographic surveys and nautical charts, which are collected using systems that do not meet modern standards and the requirements and navigation capabilities of deep draught shipping. Out-of-date maps can lead to accidents, longer voyages than necessary and may prevent the optimal loading of ships. These issues create environmental and safety concerns and reduce the efficiency of maritime navigation.

108 The main challenge for the maritime industry is to acknowledge and be aware of the deficiencies of hydrographic surveys and nautical charts as well as ensure that their personnel on board and ashore are aware of these deficiencies. The challenges for coastal States are to improve the hydrographic surveys and nautical charts within their territorial waters and to improve cooperation between states for surveying international waters, in particular the arctic region. The main challenges for the Organization is to recognize and promote hydrography as an important tool for efficient maritime navigation and to assist in global capacity-building initiatives to expand hydrographic surveying.

3.6. Ship design and ship building

109 Ship design is fundamental to optimize performance and contribute to a safer, greener and more efficient shipping industry. The pressure to reduce costs and improve energy efficiency of shipping leads ship owners to increase the freight-carrying capacity of vessels. The freight capacity of container ships has increased by more than 110%, from 9,000 in 2005 to more than 19,200 twenty-foot equivalent unit (TEU) in 2015. This development is expected to continue (figure 23).

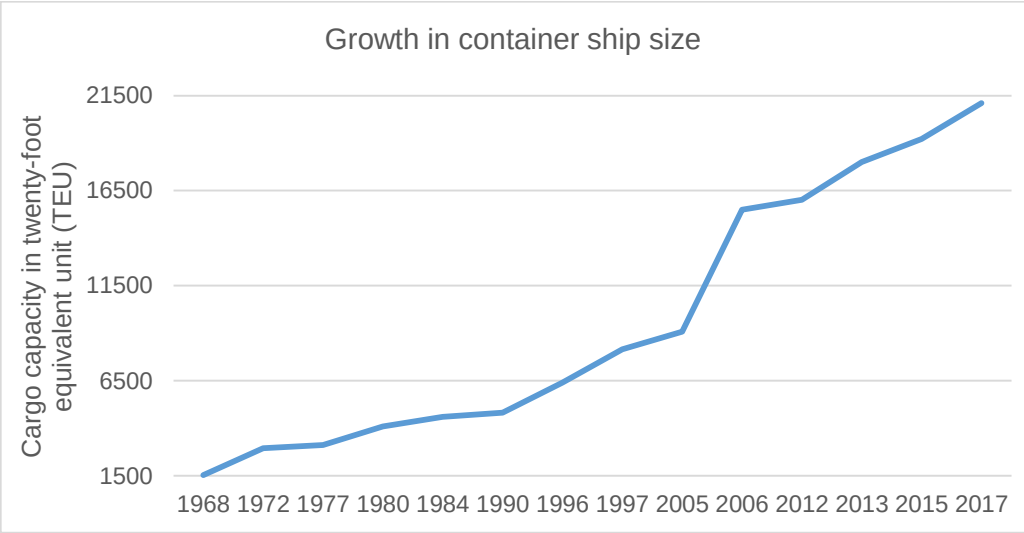


Figure 23 – Development in Container Ship Size
(Allianz Global Corporate & Specialty, 2015; Maersk, 2016; OECD & IFT, 2015)

110 The use of advanced materials for ship construction will be a factor in improving ship performance. With regard to composite materials, there is a push from certain sectors of the maritime industry to construct commercial vessels in whole or in part with these materials.

111 The use of new materials (such as composites, e.g. fibre reinforced plastics (FPR) or nanomaterials) have impacts beyond ship performance. Factors related to safety, such as fire risks, life safety appliances and health and environmental concerns regarding construction and disposal must also be considered.

112 The main challenge for IMO is to ensure its regulatory framework remains current and is adapted to address the changes in ship design and ship building, including the evaluation of the effects of changes in ships design on other aspects of shipping, for example environmental matters.

3.7. Propulsion systems and alternative fuels

113 Ship propulsion and power generation are a major area of technological development (such as alternative fuels, propulsion energy-saving devices, renewable sources of energy and emission abatement technology), bringing with it the potential for reducing pollution (exhaust gas emissions) and a reduction of costs (rising fuel costs, fleet overcapacity) that will impact the shipping industry in the future.

114 Incremental improvements and the inclusion of technology already proven in the shipping context will be further explored. Shipping segments are already operating ships that use distillates like Marine Gas Oil and low-sulphur heavy fuel oil. Additionally, the adoption of Liquefied Natural Gas (LNG) as a marine fuel has begun although the number of LNG-fuelled ships in the global fleet is still limited. Information from DNV GL (March 2016) shows an operational fleet of 77 LNG-fuelled vessels, with another 85 confirmed for delivery by the end of 2022 (figure 24). This implies a doubling of the fleet over the period 2013-2018. Forecasts, assessing developments of the number of LNG fuelled vessels, even predict a possible increase of over 1000% by 2025 when assuming an increase in oil prices, the increase of environmental protection measures and an increase in bunker facilities (high case scenario in figure 25)[9].

[9] In the base case scenario, it is assumed that the number of ECAs stays the same, and the 0.5% global sulphur limit in bunker fuel enters into force in 2020. The high case scenario is based on the assumptions that there might be new ECAs in 2018; the 0.5 % global sulphur limit in bunker fuel enters into force in 2020; and a reduction in LNG bunker prices (Lloyd's Register, 2012).

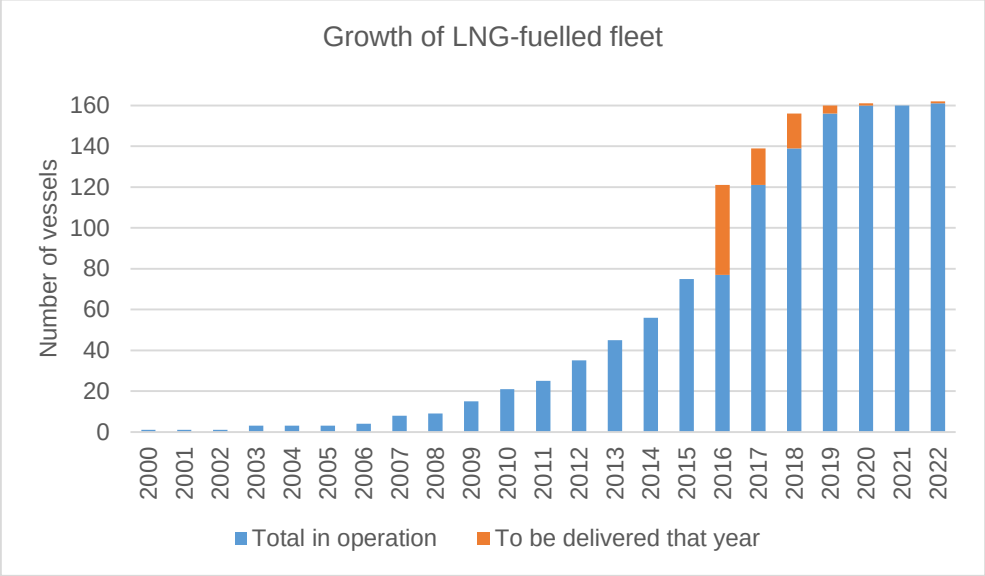


Figure 24 – World LNG-Fuelled Fleet
(DNV GL, 2016)

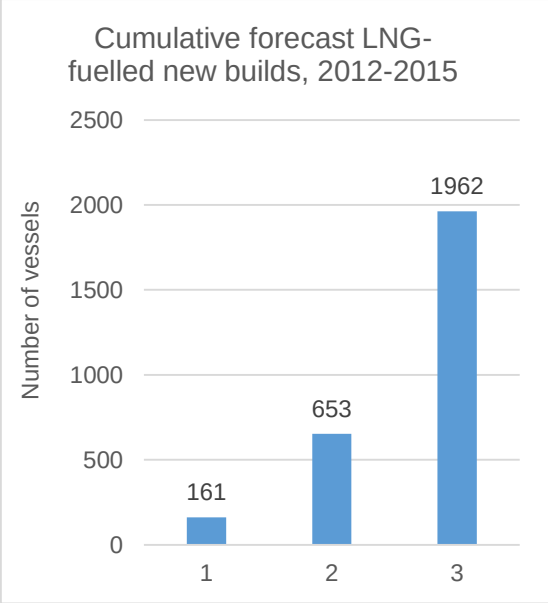


Figure 25 – Forecast: LNG-Fuelled new builds, 2012-2025
(Lloyd's Register, 2012; DNV GL, 2016)

115 Over the next years, it is likely that the energy mix will be characterized by a high degree of diversification. The viability of many new technologies depends heavily on the various fuel prices and their relative differences. However, the bunkering infrastructure will also need to be in place and fuel availability will need to be reliable. Safe transport, storage and use of such fuels must also be addressed.

116 To contribute further to the energy efficiency of the shipping industry, research into and development of novel solutions is currently taking place. Besides, the adoption of further alternative fuels, i.e. methanol or biodiesel and recent developments in the use of electricity from conventional or renewable power production (e.g. wind, solar), provide an alternative pathway for shipping. Fully electric and hybrid propulsion systems, like hydrogen fuel cells or battery powered propulsion systems can use electricity to power ships at berth and to charge batteries to facilitate energy storage and power management systems (figure 26).

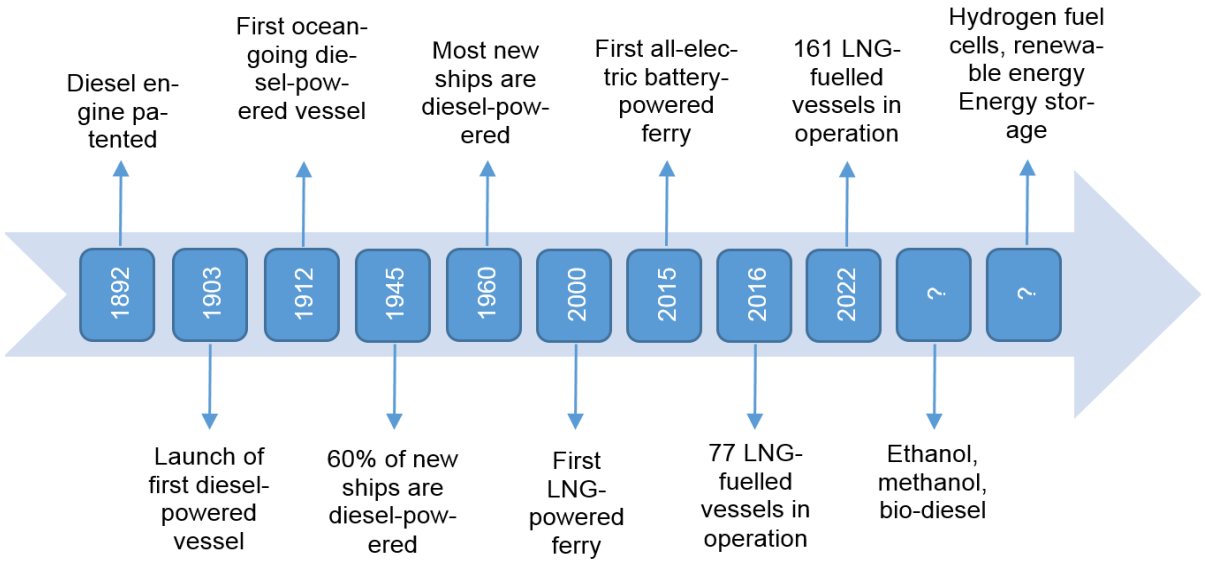


Figure 26 – Timeline of Developments in Fuel Types
(DNV GL, 2014; DNV GL, 2015a; Independent Barents Observer, 2016)

117 Energy storage is critical both for the use of electricity for ship propulsion and to optimize the use of energy on hybrid ships. Battery powered propulsion systems are already being engineered with engine manufacturers focused on hybrid battery solutions. Additionally, energy storage provides benefits in relation to availability of power, by providing emergency power and redundancy availability as well as enabling easier utilization of renewable energy sources. Although, these techniques have been proven in other sectors (in 2012, electric vehicles represented 0.02% of the world's passenger cars and by 2020 electric cars are expected to already represent 2% of all passenger cars[10]; the sales of hybrid cars have grown by 437% in the past decade[11]), they have not yet been implemented in the commercial shipping industry.

118 Although research has indicated that those technologies can be applied successfully to the maritime environment, further research is necessary before they can be used to complement existing power systems on ships. The development of electric or hybrid propulsion systems need to take into account cost, safety and reliability to ensure that a battery driven vessel is as cost-effective, safe and reliable as a traditional vessel. However, the pace of technology is advancing rapidly and solutions to these issues are likely to be developed for larger vessels.

119 The main challenge for the maritime community is the diverse range of alternative technologies that are currently available that entail the uncertainty of choosing a technology that will prevail. Additional challenges include the availability of alternative fuels and bunker facilities. For IMO the main challenge is to address the uncertainties with regard to new technologies and provide regulations that incorporate the utilization of these technologies in a timely manner. Besides, the Organization might need to establish mechanisms to support and enable the development of novel solutions to promote fuel efficiency through partnerships and cooperation with all relevant stakeholders.

10 International Energy Agency, 2013
11 ICCT, 2015

4. Energy efficiency and environmental stewardship

120 The growing awareness and environmental consciousness of the general public, as well as the ease of access to media reports on the state of the oceans are external drivers that have a direct effect on the pressure on governments and international organizations such as IMO to address environmental issues, and to work jointly on the protection of the marine environment (figure 27). This however must be balanced with the cost to the maritime industry, both in economic and safety terms. In this respect, the maritime community should seek inspiration from other industries, such as the automotive industry, and consider how to develop innovative solutions for the maritime community.

121 Finding solutions requires multidisciplinary engagement and collaboration among several distinct but related technical fields, including marine engineering, biology, chemistry and naval architecture. Treatment and management strategies of air and water pollution may have potential adverse environmental and safety consequences, including mechanical and electrical failure of equipment, impact on ship propulsion or human health risks of using chemicals and other mechanical treatments. Therefore, it is necessary to ensure that pollution control technologies both protect the environment and do not interfere with the safety and proper operation of vessels.

122 The key issues having a significant impact on the shipping industry are Greenhouse gases (in particular CO_2), SO_X, NO_X, particulate matter and ballast water management. Further emerging issues that could likely result in regulatory initiatives are black carbon and hull biofouling.

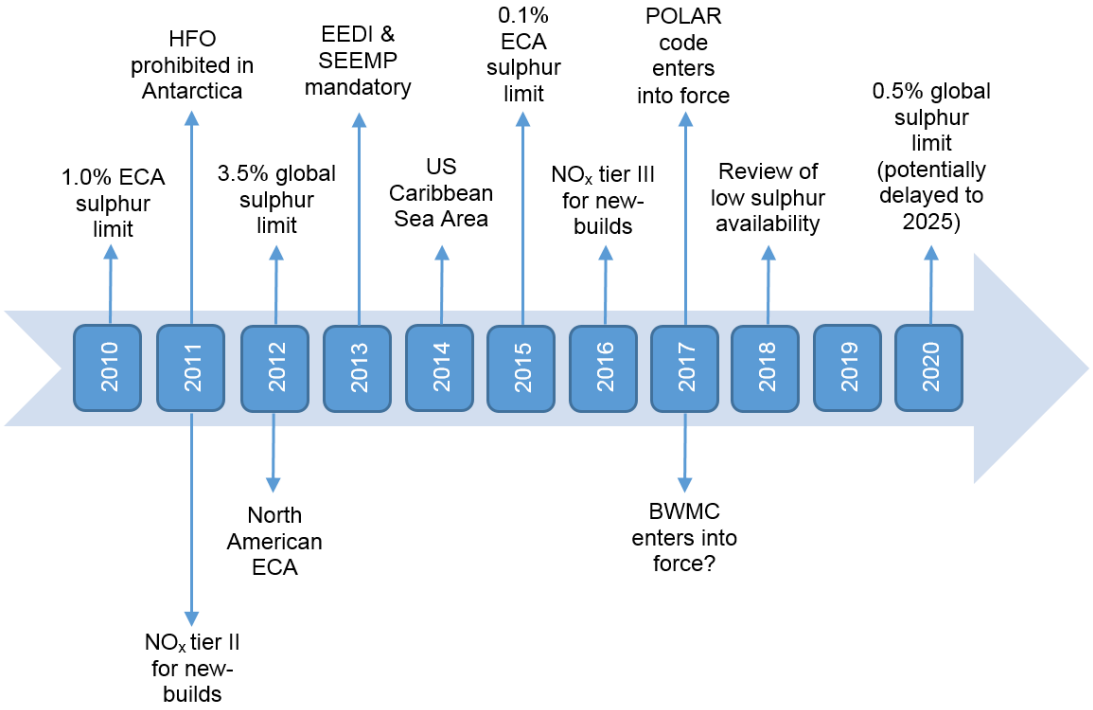


Figure 27 – Timeline of Recent and Upcoming Environmental Regulations for the Maritime Industry (DNV GL, 2015b; IMO, 2012; IMO, 2016e)

123 A major challenge for the Organization is to communicate its achievements as well as raise awareness of IMO's mandate and progress with regard to environmental matters. IMO will also have to balance the enhanced environmental standards with, in particular ship safety and seafarer training. Further, IMO should seek to improve coordination between its regulatory bodies as well as with other relevant stakeholders and seek closer collaboration with the maritime industry to be aware of possible concerns when developing or reviewing regulation.

4.1. Marine pollution

124 Marine pollution can be caused through a number of operations on ships, for example operational discharges from ships including garbage disposal. The control and management of operational discharges is already addressed by IMO with regard to environmental hazards associated with ships' cargo and fuel.

125 Garbage from ships, and in particular plastics, has negative effects on the marine environment and ocean dependent activities, and can lead to environmental degradation and loss, economic impacts on marine activities (fishing, tourism, etc.) and the marine ecosystems as well as pose a health risk for humans through the contamination of food sources, amongst others. The effectiveness of ships to comply with discharge requirements depends largely upon the availability of adequate port reception facilities, especially within special areas. Hence, Governments are obliged to ensure the provision of adequate reception facilities at ports and terminals for the reception of garbage without causing undue delay to ships, and according to the needs of the ships using them. As the public focus on specific materials like plastics increases, there might be the need to concentrate the attention on the adequacy of port reception facilities and to balance this with the promotion of the shipping community's achievements with regard to operational discharges from ships.

126 Additionally, when considering and developing new environmental regulations the consequences for the maritime industry have to be taken into account. As some environmental regulations on marine pollution entail significant cost implications for the maritime industry, provisions have to be made to lower barriers for implementation. For example, the expected entry into force of the IMO Ballast Water Management Convention will have a significant regulatory impact in the coming years. A fixed timeline mandates that most ships travelling international waters will be obliged to have ballast water treatment systems installed by the end of this decade. Once the Convention enters into force, a strong surge in systems demand is expected, as several thousand ships will need to have those systems installed in a short time span (figure 28).

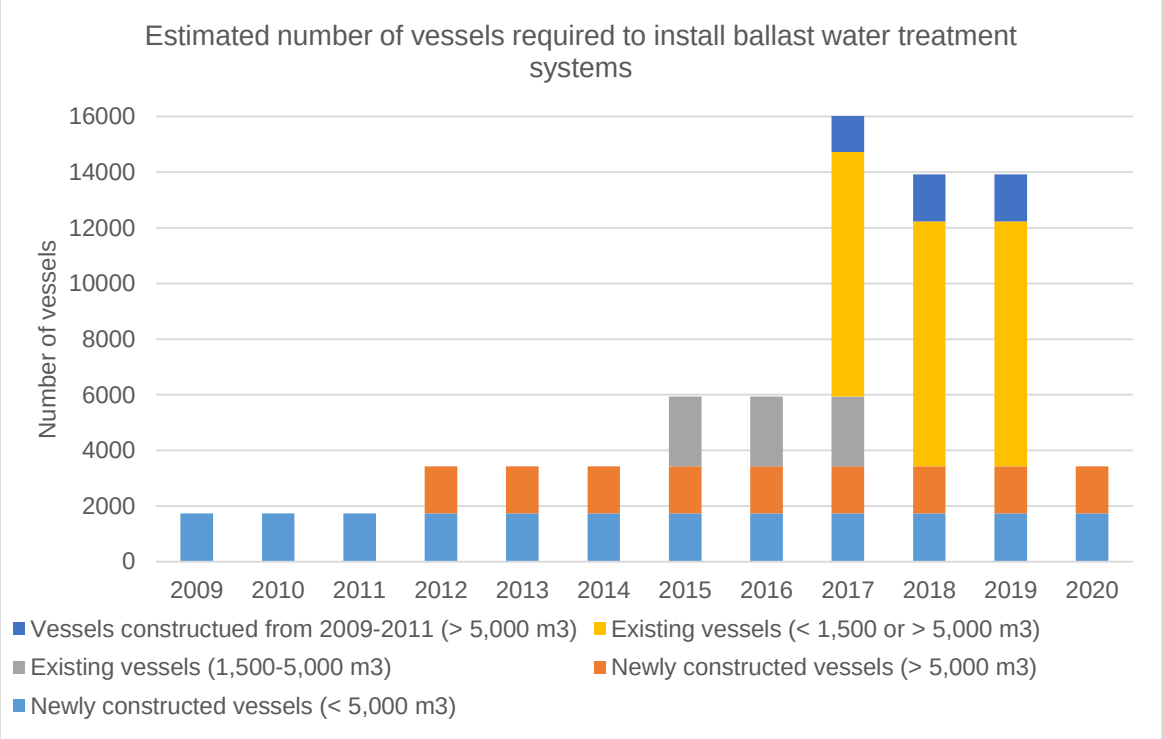


Figure 28 – Installation of Ballast Water Treatment Systems
(IMO, 2010)

127 The main challenge for the marine industry is to prepare for the implementation of necessary systems to adhere to IMO regulations. Additionally, with respect to the discharge of garbage from ships, it will be challenge to raise the awareness of crews with regard to this, as well as to adhere to the regulations set out in MARPOL Annex V. The main challenges for IMO are to enhance cooperation to build global capabilities and enable a more timely and efficient implementation of regulations in particular by lowering barriers for implementation. Additionally, with regards to garbage disposal, IMO has to promote the importance of port reception facilities as well as encourage Member States, in particular with the support of technical cooperation activities, to provide adequate port reception facilities. Besides, IMO has to pay attention to the needs and capabilities of developing countries, especially SIDS and LDCs, to manage waste disposals from ships and to protect their marine ecosystems which may be under increased pressure from the growth in maritime traffic.

4.2. Air pollution and energy efficiency

128 Although, the contribution of shipping to the global CO_2 emissions has decreased in the last years (figure 29), the predicted increase in the volume of shipping is likely to lead to an increase in greenhouse gas emissions from ships. Besides, with the recent Paris Agreement on climate change, the international shipping community will be expected to contribute further to the global efforts to address emissions.

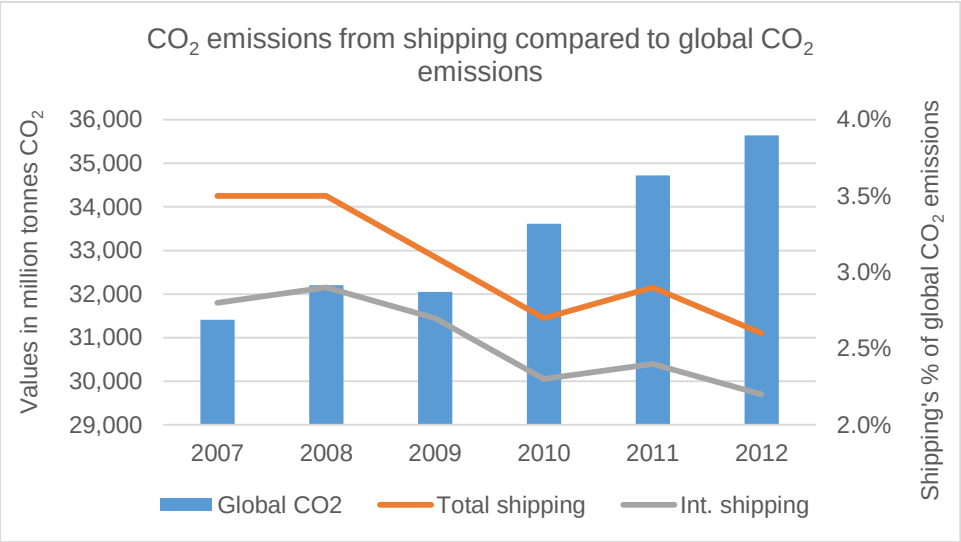


Figure 29 – CO_2 Emissions from Shipping compared to Global CO_2 Emissions (IMO, 2015)

129 The shipping industry is both a contributor to the global CO_2 emissions and but also a relatively low-carbon mode of transporting freight, as shipping has the lowest carbon footprint per unit of cargo transported. Nevertheless, ships carry more than half of international goods by tonne-mile[12] and could substantially reduce emissions if the shipping industry can achieve an increased level of efficiency (figure 30).

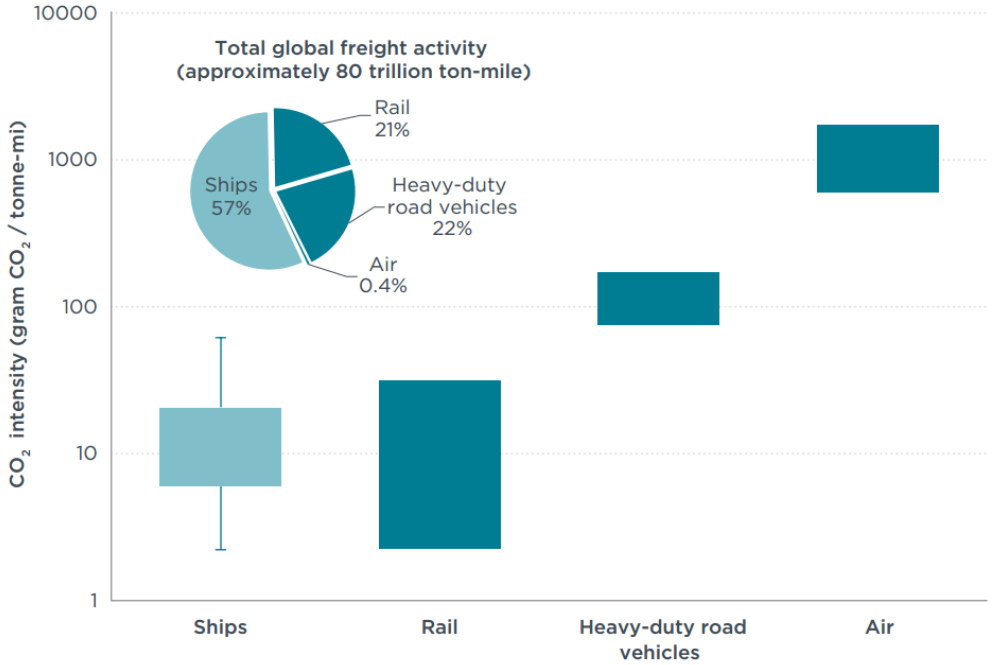


Figure 30 – CO_2 Intensity and Global Transport Activity of Different Freight Modes (ICCT, 2013)

12 UNCTAD, 2015.

130 In order to enable an increased energy efficiency, in 2011 IMO adopted the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) and in 2013 the EEDI and SEEMP entered into force. By setting increasingly stringent energy efficiency requirements for new ships, the EEDI is intended to stimulate the development of more energy efficient ship designs, leading to a reduction of operational CO_2 emissions on a ship by ship basis. The SEEMP, is designed to stimulate the increased utilization of energy efficient operational practices for shipping vessels (figure 31).

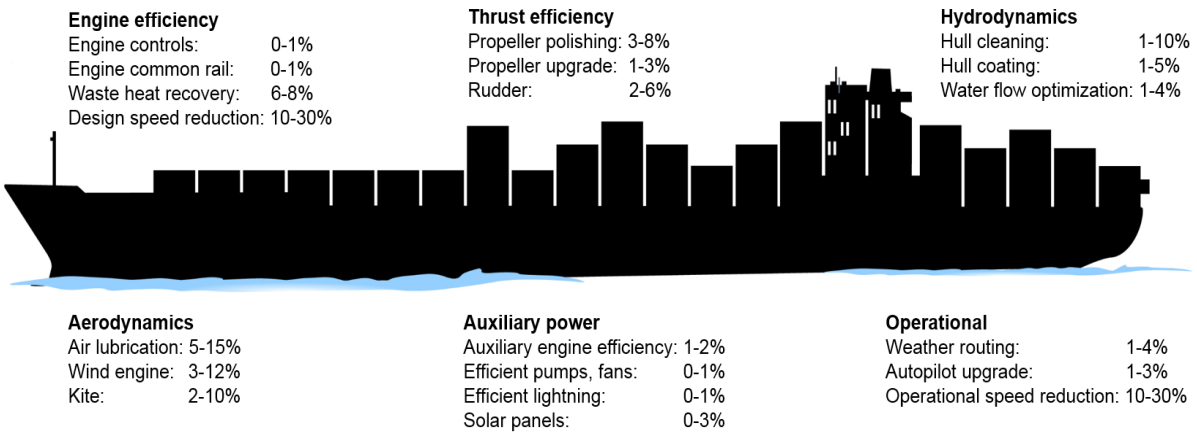


Figure 31 – Potential Fuel Use and CO_2 Reductions from Various Efficiency Approaches
(ICCT, 2013)

131 However, with the expected growth of world trade over the next 20 to 30 years, these instruments might contribute to the lowering of the emission growth rate, but not to an absolute decrease in emissions (figure 32). Therefore, further measures might be needed for the shipping industry to contribute to the overall reduction of GHG emissions.

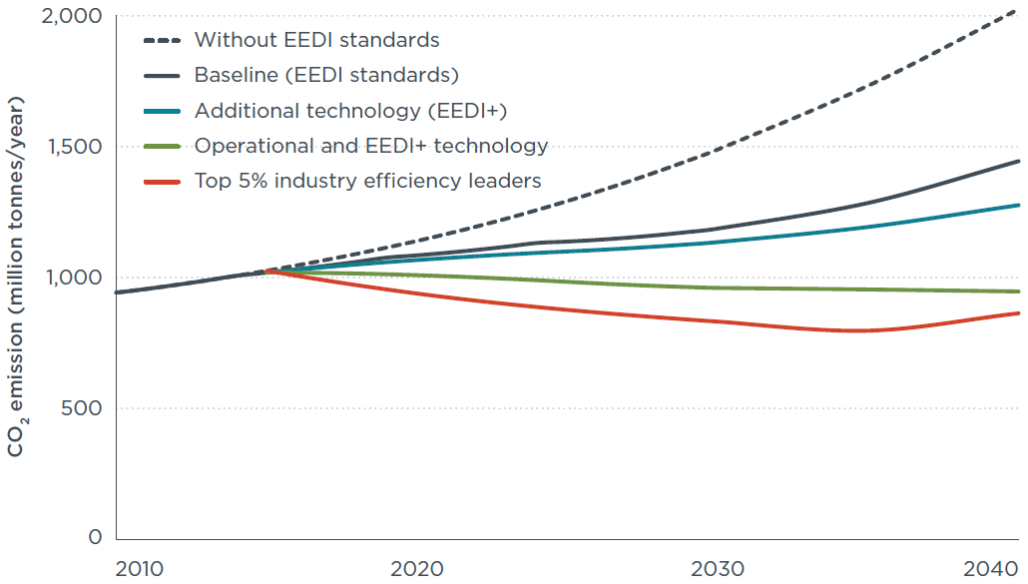


Figure 32 – Potential Reductions in CO_2 Emissions from Various Efficiency Standards, Use of Best Available Technologies and Best Practices
(ICCT, 2013)

132 SO_X, NO_X, and particulate matter emissions have potential impacts on the ecosystem and negative health effects on exposed populations. These impacts have led to regulations setting maximum global emission levels as well as more stringent levels applying to designated

Emission Control Areas (ECAs) (figure 33). The instruments allow emissions to be reduced by either using compliant fuel oil, an alternative fuel, for example gas, or an approved equivalent method like an exhaust gas cleaning ("scrubbers").

Current Emissions Control Areas (ECAs)	Entry into force
Baltic Sea (SO_x)	19 May 2005
North Sea (SO_x)	22 November 2006
North America (SO_x, NO_x and PM)	1 August 2011
US Caribbean Sea (SO_x, NO_x and PM)	1 January 2013

Figure 33 – Current Emissions Control Areas (ECAs)
(IMO, 2012)

133 In 2015, stricter rules for ECAs came into effect limiting the sulphur content in fuel oil used by ships to no more than 0.10%. In 2020, or 2025 pending an IMO decision by 2018, the 0.50% sulphur global cap for fuel oil used by ships will enter into force (figure 34). The limitation of sulphur content will have a major impact on the shipping industry, by driving technological developments, developments with regard to operational issues of switching fuel types when entering ECAs, the investment into alternative fuels and the availability of low-sulphur fuel oil for vessels.

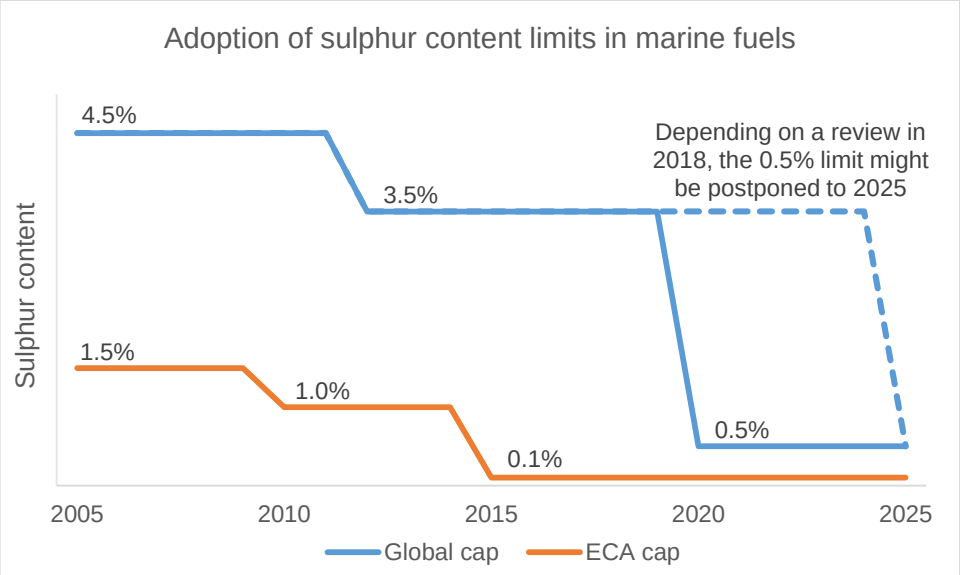


Figure 34 – Adoption of Sulphur Content Limits in Marine Fuels
(IMO, 2016f)

134 The main challenge for the maritime industry is to develop ways to fully utilize energy efficiency measures to substantially reduce emissions from shipping. The maritime industry will also have to provide adequate training to seafarers in order to utilize the operational practices to increase efficiency. The main challenges for IMO are to evaluate further measures that might help to address an additional reduction in CO_2 emissions from ships and develop systems to monitor the effectiveness of any new systems and regulations, for example by enhanced data collection and analysis capabilities. Additionally, IMO has to support the need and capabilities of developing countries to enable technology and knowledge transfer as well as adequate training for seafarers.

4.3. Emerging environmental developments

135 As environmental awareness and sensitivity of stakeholders increase, there will be pressure to address further potential environmental risks. Consequently, there are other environmental issues emerging on the agenda that might become more prominent in the

coming years. Black carbon emissions from shipping may be a significant contributor to polar ice melting and, at present, extensive research into the contribution of black carbon to climate change is ongoing.

136 The increasing maritime trade and traffic volumes highlight the need to address issues such as marine bioinvasions (figure 35). Biofouling is recognized as a major transport pathway for alien species of the same order as ballast water (figure 36). However, it can not only endanger marine ecosystems but can also negatively impact ships' performance, increasing fuel consumption and emissions, further contributing to environmental degradation. To date, IMO has developed a set of voluntary guidelines to manage biofouling. As discussion on this matter continues, this could be transformed into further regulations in the next decades, taking into account potential economic implications for the shipping industry.

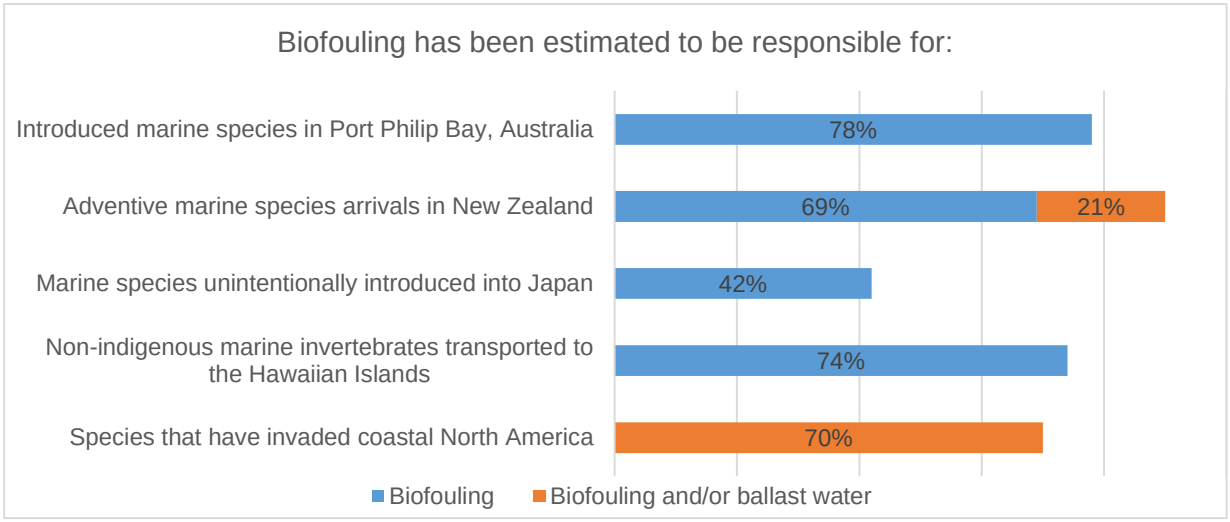


Figure 35 – The Impact of Biofouling
(Global Invasive Species Programme, 2008)

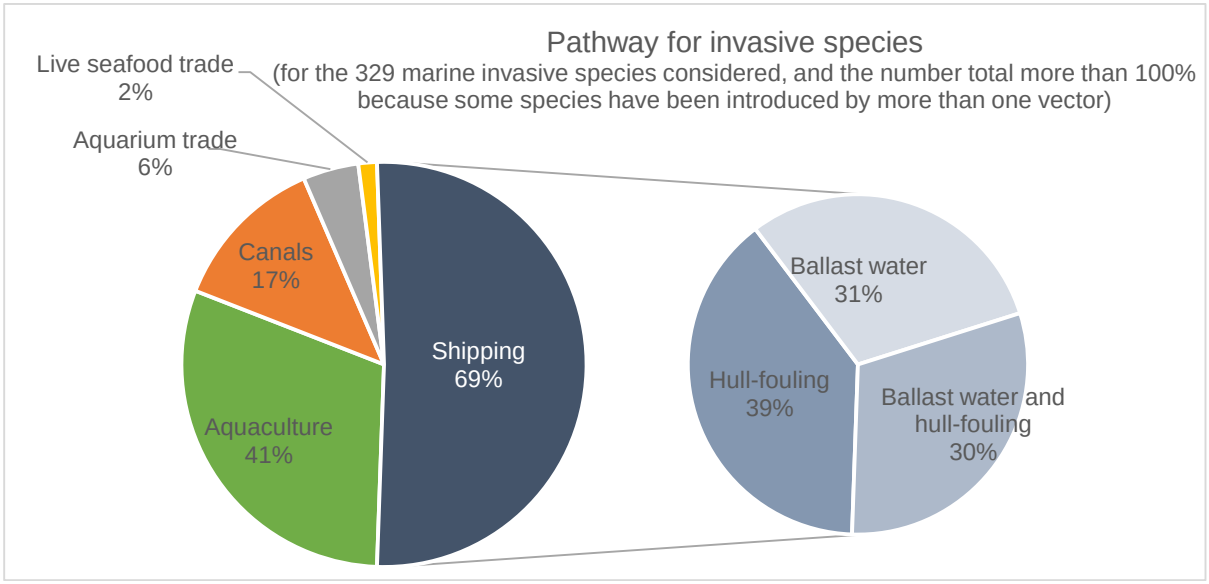


Figure 36 – Pathway for Invasive Species
(Global Invasive Species Programme, 2008)

137 The main challenge for the maritime industry is to acknowledge and be aware of the possible adverse impacts of emerging environmental issues. The main challenge for the Organization is to keep pace with emerging environmental developments and provide means to better assess the contribution and impact of shipping with regard to these developments, in order to consider the need for potential regulation or any other measures to mitigate the shipping industry's contribution.

5. Seafarer welfare as a precursor to safe, secure and efficient shipping

138 With the continuing growth of the economy, accompanied by the expansion of the global fleet and the acceleration in the development of new technologies, the demand for shipping services will continue to rise over time. This will require increased numbers of seafarers, specifically highly qualified sea-going staff, with a thorough knowledge of the industry, in particular, personnel that understands all of the supply chain elements the shipping industry is involved in.

5.1. Crewing and fatigue

139 With a need for an additional 42,000 officers by the end of 2019 to crew the expanded fleet, there is an expected shortfall of about 15,000 officers and engineers within the next three years[13]. Due to this shortage, there are expectations that officers working longer shift patterns will compensate the shortfall. The increased demand for a multi-tasking crew is accompanied by persistent pressure to further reduce crewing numbers.

140 Therefore, maintaining a professionally skilled and motivated labour force of seafarers across ranks and nationalities remains an issue of international importance. Maritime transport involves labour that resides at their place of work, where between 10 and 35 crew per ship operate the larger vessels 24 hours per day, for most of the year. Working conditions routinely involve motion, noise, vibration, and highly technical tasks that are associated with long working hours and varying shift patterns. All these elements, in conjunction with continued pressure to further cut costs by doing more with less crewing, contribute to workplace fatigue that increases the risk of human error during operations that can lead to severe accidents, the loss of lives and can have a negative impact on the environment (figure 37).

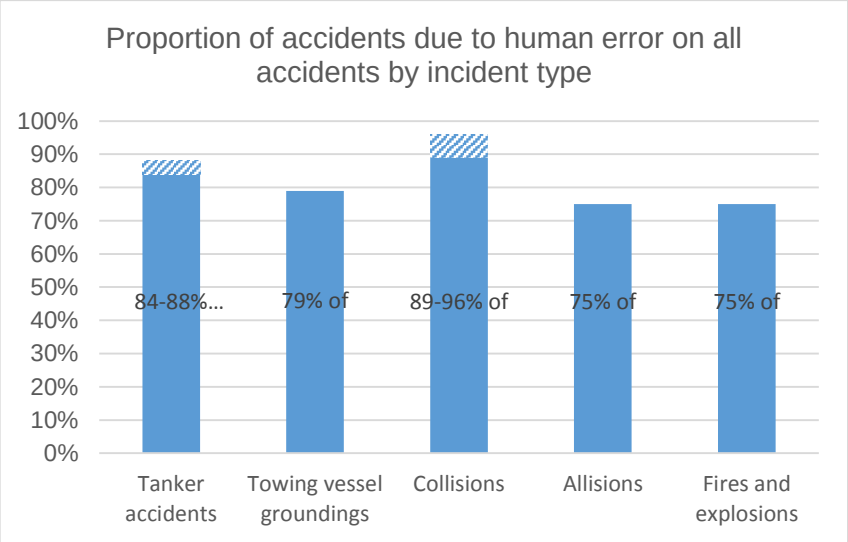


Figure 37 – Proportion of Accidents due to Human Error (Rothblum, 2000)

13 Drewry, 2015

141 The main challenge for the maritime industry is to implement the guidelines of IMO with regard to seafarer fatigue and continuously work on improving the working conditions of seafarers. The challenges for IMO are to monitor and assess the developments with regard to crewing levels, fatigue-related issues and human error related incidents to act accordingly. In addition, IMO might have to strengthen its cooperation with the shipping sector and other relevant United Nations Organizations, for example the International Labour Organization (ILO).

5.2. Seafarer demand and possible manpower gap

142 With the expected shortage of officers (figure 38), further efforts must be made to encourage new generations, including women, to consider a career within the maritime industry as a rewarding and fulfilling career choice. There are concerns within the maritime community about a lack of coherent initiatives to promote the attractiveness of a career at sea. These issues combined with working conditions and wages that are not competitive with those onshore, especially for highly qualified personnel, do not encourage potential seafarers to consider this career and render it difficult to retain seafarers for a life-long career at sea.

Supply/Demand Gap for Officers (negative values indicate demand exceeds supply)			
	2010	**2015**	**2020**
Cold Scenario (economic conditions worsen)	-2%	-2%	2%
Benchmark Scenario (2.3 % per annum increase in number of ships worldwide)	-2%	-5%	-1%
Hot Scenario (economic conditions improve)	-2%	-11%	-9%

Figure 38 – Supply/Demand Gap for Officers
(BIMCO et al., 2010)

143 Therefore, measures such as maritime awareness campaigns, international partnerships between maritime training institutions, implementation of various employee strategies, offering financial incentives to the maritime sector and increase the direct participation of the industry in skill development efforts, should be further explored and promoted.

144 One of the main challenges for the maritime industry is to develop coherent and global initiative to attract competent and qualified personnel. In this respect, IMO can provide a platform and support to commence these global initiatives to attract and retain qualified personnel through the widespread promotion of maritime careers.

5.3. Seafarer education and training

145 In addition to the potential shortfall of seafarers, the education and training of crew remains a matter that requires further consideration. While in theory new technologies should make shipping safer, the human element is proving to be a major concern. Increasingly sophisticated maritime technologies can only be properly operated and managed by crew with considerable skill, knowledge and expertise. Apart from a highly-advanced skill set, personnel now also need training in management, communication skills, IT, budget handling and many other fields.

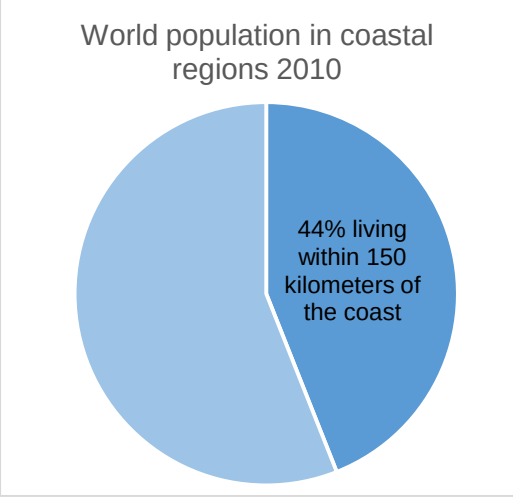
146 This will impact the provision of maritime education and training as more technologically advanced ships might require fewer but more highly qualified crew members. In the past, training courses have been provided based on generic models of navigation equipment. Now, there is a need to move towards more targeted and specific training to improve safety. Nevertheless, there is a fundamental need for standardization of equipment as well as the provision of unified training standards for electronic navigation equipment.

147 There is additional concern about the declining experience of onshore technical staff, as seafarers tend to shift from working at sea to a position onshore much earlier than they used to. This leads to a decrease in the level of experience among onshore personnel. With the rapid changes in technology, onshore staff cannot keep abreast of the technical equipment on board of ships. Therefore, mechanisms need to be in place to update onshore personnel with the technological developments on board. This will contribute to improving decision making onshore.

148 The main challenge for the maritime industry and seafarers is to emphasize life-long learning in order to keep pace with changing requirements, new technologies and expanding roles. The challenge for IMO is to create standardized training opportunities with regard to the use of new technologies for crew onshore and on board by, for example, strengthening its cooperation with relevant training institutions.

6. Role of the maritime community in ocean governance

149 The use of the world's oceans is intensifying as a result of the increase of maritime transport and the emergence of new maritime industries, such as deep sea mining and the growth of existing ones, such as off-shore energy-generation and marine aquaculture. As the world's economies develop, the world's population further migrates to coastal areas (figure 39) and the use of the oceans intensifies, new challenges emerge in respect to the resolution of competing interests, which need to be overcome to ensure the potential for continued economic growth. These competing interests can range from tensions with regard to environmental concerns and growth of demand for seaborne trade, oil, gas and rare earth elements, to pressure for the protection of ocean spaces for users other than the industry.



The World's Ten Largest Cities by population		
1	Tokyo, Japan	Coastal
2	Delhi, India	
3	Shanghai, China	Coastal
4	Mexico City, Mexico	
5	São Paulo, Brazil	Coastal
6	Mumbai, India	Coastal
7	Osaka, Japan	Coastal
8	Beijing, China	~160 km from the coast
9	New York City, USA	Coastal
10	Cairo, Egypt	~200 km from the coast

Figure 39 – World Population in Coastal Regions
(UN, 2014; UN Atlas of the Oceans, 2010)

6.1. Sustainable development of activities in the marine space

150 To ensure sustainable development of activities in the marine space, economic activity needs to be balanced with the capacity of the oceans to remain healthy and diverse in the long term. Uncoordinated, competing demands can lead to unregulated activities with regard to the usage of the maritime space and damages to the health of world oceans. In order to achieve a balance between competing interests, coordination is required. Any decisions on ocean use must be properly analysed and agreed upon by all stakeholders, taking into account all relevant global standards and ensuring the sustainability of all different uses. The aim should be the proper coordination of initiatives.

151 The maritime community is already involved in coordinating activities for ocean governance. An example is the designation of Particularly Sensitive Sea Areas (PSSAs), i.e. areas that need special protection through action by IMO due to their significance for recognized ecological, socio-economic or scientific reasons and their vulnerability to damage by international maritime activities (figures 40 and 41).

	Current PSSAs	Year
1	Great Barrier Reef	1990
2	Archipelago of Sabana-Camaguey	1997
3	Sea Area around Malpelo Island	2002
4	Marine Area around the Florida Keys	2002
5	Wadden Sea	2002
6	Paracas National Reserve	2003
7	Western European Waters	2004
8	Torres Strait as an extension to GBR PSSA	2003
9	Canary Islands	2004
10	Galapagos Archipelago	2004
11	Baltic Sea Area	2004
12	Papahānaumokuākea Marine National Monument (North-western Hawaiian Islands)	2007
13	Strait of Bonifacio	2011
14	Saba Bank (Caribbean Island of Saba)	2012

Figure 40 – Current PSSAs
(IMO, 2012)

	Potential PSSAs	Proposing state(s)	Stage
1	East Asian Sea region	Indonesia, Malaysia, Philippines and Viet Nam	Preparing to submit a PSSA submission for the East Asian Seas region at MEPC 69 *(MEPC 69/15, p.5)*
2	Tubbataha Reefs National Park	Philippines	Proposing the designation of the aforementioned area as a PSSA *(MEPC 69/10/1; MEPC 68/10, p. 2)*
3	Ha Long Bay (Quang Ninh) – Cat Ba (Hai Phong)	Viet Nam	A submission to the committee is currently being developed as part of the framework cooperation agreement between IMO and the Norwegian Agency for Development cooperation *(MEPC 69/INF.12)*
4	Jomard Entrance, Louisiade Archipelago	Papua New Guinea	A submission to the Committee is currently being developed for the designation of a PSSA *(MEPC 69/INF.14)*
5	Banc d'Arguin National Park World Heritage Site and an adjacent sea area	Mauritania	Following MEPC 68, a submission is currently being prepared to propose the designation of the Mauritanian upwelling zone as a PSSA, with the aim of this being considered by the Committee in 2016/2017. *(MEPC 69/INF.19)*

Figure 41 – Potential PSSAs
(IMO, 2014b; IMO, 2014c; IMO, 2016g; IMO, 2016h; IMO, 2016i; IMO, 2016j; IMO, 2016k)

152 Nevertheless, ocean governance will gain further importance due to the adoption of the SDGs. SDG 14 specifically addresses the conservation and sustainable use of oceans, seas and marine resources, as careful management of the oceans is considered a key feature of a sustainable future. The development of a sustainable maritime transportation system that minimizes the environmental impact of shipping is a first step to support sustainable development. Further coordination to align ocean-related activities of all stakeholders could be enhanced by participating in designated coordinated organs, such as United Nations Oceans.

153 Waste dumping and the marine pollution caused by operational or accidental factors associated with ships, platforms and other marine structures engaged in deep seabed mineral exploration and exploitation activities, or in the transport of such resources towards areas of national jurisdiction, are not regulated by international instruments. This leaves a gap in the regulation of such activities at an international level. There are ongoing discussions under the London Convention and Protocol on the prevention of marine pollution by dumping of wastes and other matter to include the waste from undersea mining activities in jurisdictional waters into the London Convention and Protocol on the prevention of marine pollution by dumping wastes and other matters. An agreement would result in an international regulatory framework for undersea mining, applicable to the disposal of tailings and waste and also controlling the volume of such materials that may be dumped at sea. This would have major consequences for the maritime industry.

154 The main challenge for IMO and the maritime community is to ensure utilization of the marine space that does not adversely affect international maritime transport and consider the maritime community's responsibilities to contribute to better coordination and cooperation between all relevant stakeholders. Additionally, the IMO has to define its role with regard to the SDGs, in particular SDG 14 as well its involvement in the relevant United Nations forums.

6.2. Participation in and coordination with United Nations initiatives

155 There are ongoing United Nations negotiations relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction (BBNJ). After initial deliberations, a consensus was reached to develop a legal framework under UNCLOS on the conservation and sustainable use of BBNJs and an increase in the designation of Marine Protected Areas (MPAs). The potential entry into force of the legal framework under UNCLOS might have consequences for the maritime community, as IMO is the only Organization that legislates activities on international waters.

156 The emergence of new issues concerning oceans governance leads to the need to develop mechanisms to address these developments. A pathway to foster cooperation and enable stakeholders to address emerging issues is marine spatial planning of clearly defined ocean areas. This strategic process brings together all stakeholders engaged in different uses of the ocean, to ensure the best use of marine resources whilst managing the risks and balancing the trade-offs from marine activities, like coastal port development, fisheries management including tackling illegal, unreported and unregulated (IUU) fishing, seabed mining, oil and gas exploration and the dumping of waste.

157 IMO's active participation in United Nations initiatives is of utmost importance to enable the maritime community to proactively participate in decisions and regulations on ocean governance matters and prevent unexpected adverse impacts and implications of these decisions on the maritime industry. Additionally, the need for increased cooperation between the actors invested in ocean matters necessitates the development of new mechanisms to enable a constructive form of cooperation that comprises all relevant stakeholders.

158 The main challenge for IMO and the maritime community will be to assess and define its role within the context of ocean governance and to monitor the developments in all relevant forums discussing this issues of ocean governance, in particular United Nations forums. Further, IMO has to pay particular attention to the needs and capabilities of developing countries, especially SIDS and LDCs, to protect their marine ecosystems which may be under increased pressure from the growth in maritime traffic and use of ocean space.

References

1 Allianz Global Corporate & Specialty. (2012). *Safety and Shipping 1912-2012: From Titanic to Costa Concordia*, (figure 20).
http://www.agcs.allianz.com/assets/PDFs/Reports/AGCS_safety_and_shipping_report.pdf

2 Allianz Global Corporate & Specialty. (2015). *50 Years of Container Ship Growth*, (figure 23).
https://www.allianz.com/v_1427968040000/media/press/document/other/50_years_of_container_ship_growth_en.pdf

3 BIMCO, International Shipping Federation, Institute for Employment Research & International Maritime Conventions Research Center. (2010). *Manpower 2010 Update: The Worldwide demand for and Supply of Seafarers – Highlights*, (figure 38).
http://www.maritimemanpower.com/wp-content/uploads/2014/11/Manpower-Study-highlights.pdf

4 COWI. (2013). *Survey on Administrative Burdens among International Seafarers*, (figure 13).
http://www.dma.dk/publications/documents/surveyamonginternationalseafarers.pdf

5 DNV GL. (2014). *Alternative Fuels for Shipping*, (figure 26).
http://www.billionmilessg.com/sites/billionmilessg.com/files/PositionPaper_AltFuels_280214_tcm4-592866_0.pdf

6 DNV GL. (2015a). *Alternative Fuels for Shipping – Pathways to 2050*, (figure 26).

7 DNV GL. (2015b). *Shipping 2020*, (figure 27).
http://www.dnv.nl/binaries/shipping%202020%20-%20final%20report_tcm141-530559.pdf

8 DNV GL (2016). *LNG Fuelled Vessels: Ship list – vessels in operation and on order*, (figures 24; 25).

9 Drewry. (2015). *Shortage of Ship Officer Crew Receding*, (footnote).
http://www.drewry.co.uk/news.php?id=375

10 European Environment Agency. (2012). *Ocean acidification*, (figure 6).
http://www.eea.europa.eu/data-and-maps/indicators/ocean-acidification/assessment-1

11 Global Invasive Species Programme, the. (2008) *Marine Biofouling & Invasive Species: Guidelines for Prevention and Management*, (figures 35; 36).
http://www.issg.org/pdf/publications/GISP/Guidelines_Toolkits_BestPractice/Jackson_2008.pdf

12 HSBC. (2012). *Long-term forecast for Global Overview: Trade routes*, (figure 4).
https://globalconnections.hsbc.com/us/en/tools-data/trade-forecast-tool

13 ICCT. (2013). *Long-term potential for increased shipping efficiency through the adoption of industry-leading practices,* (figures 30; 31; 32).
http://www.theicct.org/sites/default/files/publications/ICCT_ShipEfficiency_20130723.pdf

14 ICCT. (2015). *Technical brief no. 1*, (footnote).
http://www.theicct.org/sites/default/files/publications/ICCT_TechBriefNo1_Hybrids_July2015.pdf

15 IHO. (2016). *IHO/OHI Publication C-55 Status of Hydrographic Surveying and Charting Worldwide*, (figure 22). https://www.iho.int/iho_pubs/CB/C-55/index.html

16 IMO. (2010). *MEPC 61/2/17: Harmful aquatic organisms in ballast water*, (figure 28).

17 IMO. (2012). *MEPC.1/Circ.778/Rev.1: List of special areas under MARPOL and particularly sensitive sea areas*, (figures 27, 33, 40).

18 IMO. (2013). *World Maritime Day: A Concept of a Sustainable Maritime Transportation System*, (footnote). http://www.imo.org/en/About/Events/WorldMaritimeDay/WMD2013/Documents/CONCEPT%20OF%20%20SUSTAINABLE%20MARITIME%20TRANSPORT%20SYSTEM.pdf

19 IMO. (2014a*). Periodic review of administrative requirements in mandatory IMO instruments*, (figure 14). http://www.imo.org/en/OurWork/rab/Documents/Formal%20report%20of%20the%20Ad%20Hoc%20Steering%20Group%20for%20Reducing%20Administrative%20Requirements%20to%20Council.pdf

20 IMO. (2014b). *MEPC 66/INF. 20: Identification and Protection of Special Areas and PSSAs*, (figure 41).

21 IMO. (2014c). *MEPC 68/10: Identification and Protection of Special Areas and PSSAs*, (figure 41).

22 IMO. (2015). *Third IMO Greenhouse Gas Study 2014*, (figures 8; 29). http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Third%20Greenhouse%20Gas%20Study/GHG3%20Executive%20Summary%20and%20Report.pdf

23 IMO. (2016a). *Status of Conventions: Summary of Status of Conventions*, (figures 9; 11). http://www.imo.org/en/About/Conventions/StatusOfConventions/Pages/Default.aspx

24 IMO. (2016b). *List of Conventions, Other Multilateral Instruments and Amendments in Respect of which the Organization Performs Depositary and Other Functions*, (figure 10)

25 IMO. (2016c). *GISIS: Piracy and Armed Robbery – Regional Analysis of Reports on Acts of Piracy and Armed Robbery*, (figure 16).

26 IMO. (2016d). *GISIS: Marine Casualties and Incidents – Casualty Data from IHS*, (figure 19). https://gisis.imo.org/Secretariat/MCI/IHSData.aspx

27 IMO. (2016e). *List of Conventions, other multilateral instruments and amendments in respect of which the organization performs depositary and other functions*, (figure 27). http://www.imo.org/en/About/Conventions/StatusOfConventions/Documents/List%20of%20instruments%20%20as%20at%201%20January%202016.pdf

28 IMO. (2016f). *Sulphur oxides (SO_x) – Regulation 14*, (figure 34). http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx

29 IMO. (2016g). *MEPC 69/15: Technical cooperation activities for the protection of the marine environment*, (figure 41).

30 IMO. (2016h). *MEPC 69/INF.14: Identification and Protection of Special Areas and PSSAs*, (figure 41).

31 IMO. (2016i). *MEPC 69/INF.19: Identification and Protection of Special Areas and PSSAs*, (figure 41).

32 IMO. (2016j). *MEPC 69/INF. 12: Identification and Protection of Special Areas and PSSAs*, (figure 41).

33 IMO. (2016k). *MEPC 69/10/1: Identification and Protection of Special Areas and PSSAs*, (figure 41). http://www.imo.org/en/About/Conventions/StatusOfConventions/Documents/List%20of%20instruments%20%20as%20at%201%20January%202016.pdf

34 Independent Barents Observer, the. (2016). *Hurtigruten of the future will operate on battery power*, (figure 26). http://thebarentsobserver.com/industry/2016/01/hurtigruten-future-will-operate-battery-power

35 International Chamber of Shipping. (2015). *Shipping Industry Supports Global Climate Change Deal and is Committed to Ambitious CO_2 Reduction Led by IMO*, (footnote). http://www.ics-shipping.org/news/press-releases/view-article/2015/12/01/shipping-industry-supports-global-climate-change-deal-and-is-committed-to-ambitious-co2-reduction-led-by-imo

36 International Energy Agency. (2013). *Global EV Outlook: Understanding the Electric Vehicle Landscape to 2020*, (footnote). https://www.iea.org/publications/globalevoutlook_2013.pdf

37 IPCC. (2013). *Climate Change 2013: The Physical Science Basis,* (figure 7). http://www.ipcc.ch/report/ar5/wg1/

38 Lloyd's Register. (2012). *LNG-fuelled deep sea shipping*, (figure 25).

39 Maersk. (2016). *Explore our fleet*, (figure 23). http://www.maersk.com/en/hardware/fleet

40 OECD. (2016). *Domestic product: GDP long-term forecast*, (footnote). https://data.oecd.org/gdp/gdp-long-term-forecast.htm.

41 OECD & ITF. (2015). *The Impact of Mega-Ships*, (figure 23). http://www.internationaltransportforum.org/pub/pdf/15CSPA_Mega-Ships.pdf

42 PwC. (2015). *Managing cyber risks in an interconnected world*, (figure 21). http://www.pwccn.com/webmedia/doc/635527689739110925_rcs_info_security_2015.pdf

43 Rothblum, Anita M. (2000). *Human Error and Marine Safety*, (figure 37). http://bowles-langley.com/wp-content/files_mf/humanerrorandmarinesafety26.pdf

44 UN. (2014). *2014 Revision of the World Urbanization Prospects*, (figure 39). http://www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html

45 UN. (2016). *Sustainable Development – Knowledge Platform: Documents by Topic: Sustainable development goals*, (footnote).

46 https://sustainabledevelopment.un.org/index.php?menu=1528

47 UN Atlas of the Oceans. (2010). *Human settlements on the Coast*, (figure 39). http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xODc3JjY9ZW4mMzM9KiYzNz1rb3M~

48 UNCTAD. (2015a). *UNCTADSTAT: Gross domestic product: Total and per capita, current and constant (2005) prices, annual, 1970-2014*, (figure 1). http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96

49 UNCTAD. (2015b). *UNCTADSTAT: World seaborne trade by types of cargo and country groups, annual, 1970-2014*, (figure 1). http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=32363

50 UNCTAD. (2015c). *UNCTADSTAT: Total and urban population, annual, 1950-2050*, (figure 2). http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=97

51 UNCTAD. (2015d). *Review of Maritime Transport 2015*, (figures 3; 5; 18). http://unctad.org/en/PublicationsLibrary/rmt2015_en.pdf

52 UNCTAD. (2015e). *Container port throughput, annual, 2008-2014*, (figure 17). http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=13321

53 World Bank, the. (2013). *Doing Business 2014: Understanding Regulations for Small and Medium-Size Enterprises*, (footnote) http://www.doingbusiness.org/~/media/GIAWB/Doing%20Business/Documents/Annual-Reports/English/DB14-Full-Report.pdf

54 World Bank, the. (2016). *Doing Business: Trading Across Borders*, (figure 12) http://www.doingbusiness.org/data/exploretopics/trading-across-borders

55 World Customs Organization. (2011). *A Survey of Single Window Implementation*, (figure 15). http://www.wcoomd.org/en/topics/research/activities-and-programmes/~/media/2DF5A36D3ECA46CCB7B17BDF77ACC021.ashx

List of Figures