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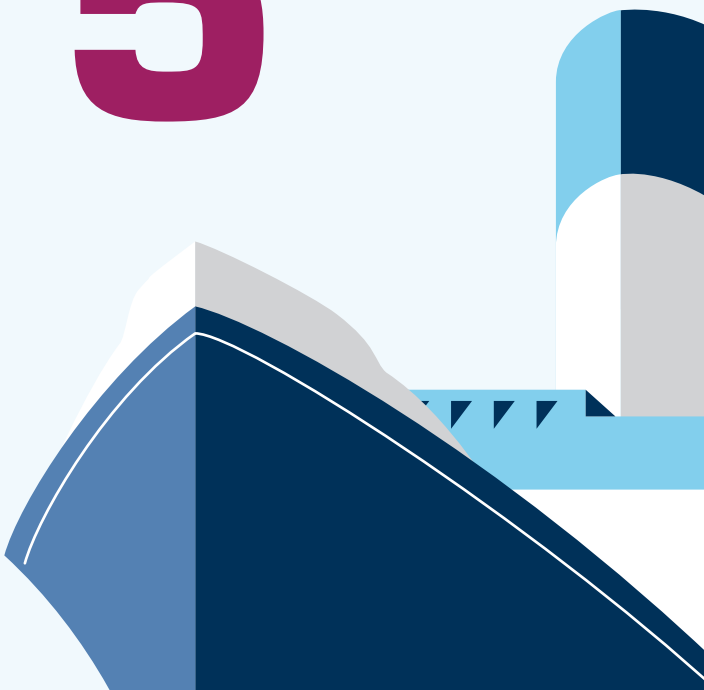


LEGAL ISSUES AND REGULATORY DEVELOPMENTS

Technology has become a crucial element of many systems on board ships and in ports and is continuing to transform and revolutionize the way in which shipping operations are conducted. Many current technological advances, including, for example, autonomous ships, drones and various distributed ledger technologies such as blockchain, hold considerable promise for the increased efficiency of operations and reduced costs, among other possibilities. However, uncertainty remains in the maritime industry with regard to their potential safety and security, and there is concern about the cybersecurity incidents that may occur. To minimize such risks for systems on board ships and in ports, and to facilitate the transition to potential new technologies, Governments and the maritime industry are continuing to improve the safety and risk management culture and making efforts to ensure compliance with the complex and evolving legal framework. In addition, the various distributed ledger technologies currently emerging and proliferating, including blockchain-related initiatives, need to be interoperable, as competition between them in a bid to make a specific technology the chosen standard for the industry may be detrimental for shipping.

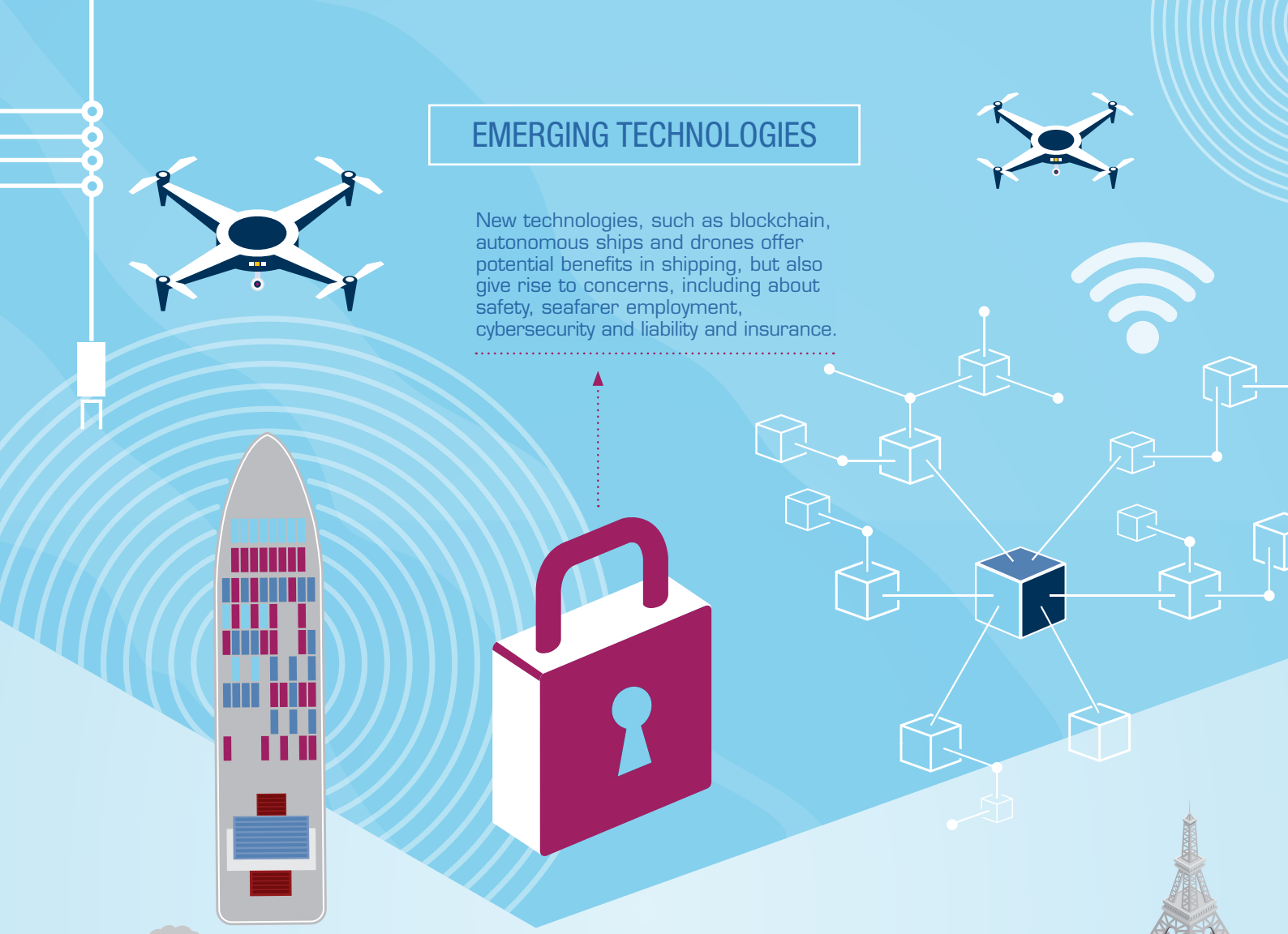
As the future of technological advances in shipping is being defined, and the maritime industry is leveraging technology to improve its services, the existing legal, policy and regulatory frameworks are being adapted and new frameworks written, as necessary, at both the national and international levels. The strategic plan for IMO adopted in December 2017 recognizes the need to integrate new and emerging technologies into the regulatory framework for shipping. This plan follows the adoption of a resolution that encourages maritime administrations to ensure that cyberrisks are appropriately addressed in existing safety management systems starting from 1 January 2021, as well as the adoption in July 2017 of the IMO guidelines on maritime cybersecurity risk management.

Important international regulatory developments during the period under review include the adoption by IMO in April 2018 of an initial strategy on the reduction of greenhouse gas emissions from ships, which aims at the reduction of total annual greenhouse gas emissions from ships by at least 50 per cent by 2050, compared with 2008. In addition, IMO adopted a decision with regard to regulatory scoping exercises to establish the extent to which the international regulatory framework should be modified to integrate the new technology involving maritime autonomous surface ships.

This chapter provides a summary of legal and regulatory developments related to these issues and highlights relevant policy considerations for the maritime sector.

EMERGING TECHNOLOGIES

New technologies, such as blockchain, autonomous ships and drones offer potential benefits in shipping, but also give rise to concerns, including about safety, seafarer employment, cybersecurity and liability and insurance.



REDUCING GREENHOUSE GAS EMISSIONS FROM SHIPPING

An initial strategy adopted at IMO in April 2018 aims to reduce total annual greenhouse gas emissions from ships by at least

by 2050.

SUSTAINABLE DEVELOPMENT GOALS

13 CLIMATE ACTION

14 LIFE BELOW WATER

This complements international efforts to address greenhouse gas emissions, including under the Paris Agreement and Sustainable Development Goal 13 on taking urgent action to combat climate change and its impacts.

PROTECTING THE MARINE ENVIRONMENT

In the light of Sustainable Development Goal 14, all countries are encouraged to consider becoming parties to relevant international conventions on marine pollution prevention and control as a matter of priority.

A. TECHNOLOGICAL DEVELOPMENTS AND EMERGING ISSUES IN THE MARITIME INDUSTRY

1. Cybersecurity

The *Review of Maritime Transport 2017* highlighted examples of cyberattacks and vulnerabilities in navigation and other systems on board ships and in ports, including interference with automatic identification systems and electronic chart display and information systems, the jamming of global positioning systems and the manipulation of cargo and other ship and port systems, including through the introduction of malware, ransomware and viruses (UNCTAD, 2017a). In particular, 2017 was marked by some major global cyberattacks, including the use of ransomware, which demonstrated that such attacks, although not widely targeted at shipping as yet, may have substantial impacts (*The Guardian*, 2017; ZD Net, 2018). Such incidents and other attacks, including some mass global positioning system-spoofing attacks on ships in the Black Sea, emphasize the importance of cybersecurity and cyberrisk management. Further, there have been reports of links between cyberattacks and physical piracy, whereby pirates have reportedly identified ships with valuable cargo and minimal on-board security by infiltrating the systems of shipping companies.

Cybersecurity guidelines for the maritime industry

To date, internationally binding cybersecurity regulations for the maritime industry have not been adopted. However, the IMO guidelines on maritime cybersecurity risk management provide high-level recommendations with regard to safeguarding international shipping from current and emerging cybersecurity threats and helping to reduce related vulnerabilities (IMO, 2017a). The guidelines contain five functional elements for effective risk management in the maritime sector, namely to identify, protect, detect, respond and recover (IMO, 2017b). To be effective, these elements need to be incorporated into all aspects of shipping company operations and personnel management, in the same way that the industry has embraced a safety culture, with the adoption of the International Safety Management Code and the implementation of safety management systems. The main purpose of the Code is to provide an international standard for the safe management and operation of ships and for pollution prevention; it establishes safety management objectives and requires the "company", defined as the shipowner or any person, such as the manager or bareboat charterer, who has assumed responsibility for operating a ship, to establish a safety management system and to establish and implement a policy for achieving these objectives (IMO, 2018a). The Maritime Safety Committee of IMO, in its resolution 428(98) on cyberrisk management in safety management systems, encourages administrations to ensure that cyberrisks are appropriately addressed in existing systems as defined in the Code no later than the first annual verification of the company's document of compliance after 1 January 2021. This is the first compulsory deadline established in the maritime industry for cyberrisks and is an important step in protecting the maritime transportation system and the entire maritime industry from increased cybersecurity threats. In addition, the strategic plan for IMO recognizes the need to integrate new and emerging technologies into the regulatory framework for shipping by balancing the benefits derived from such technologies "against safety and security concerns, the impact on the environment and on international trade facilitation, the potential costs to the industry and finally their impact on personnel, both on board and ashore" (IMO, 2017c).

At the same time, the shipping industry is taking a proactive approach to incorporating cyberrisk management into its safety culture, to prevent the occurrence of any serious incidents. Guidance has been and continues to be developed by classification societies and other industry associations. Shortly after the approval of resolution 428(98), industry bodies released the second version of their guidelines on cybersecurity on board ships, which builds on the first version released in 2016 and is more comprehensive. The second version is aligned with the recommendations in the IMO guidelines, provides practical guidance on maritime cyberrisk management and includes information on insurance-related issues. The industry guidelines suggest that cyberrisk management should do the following (BIMCO et al., 2017):

> "Identify the roles and responsibilities of users, key personnel and management both ashore and on board; identify the systems, assets, data and capabilities, which if disrupted, could pose risks to the ship's operations and safety; implement technical measures to protect against a cyberincident and ensure continuity of operations. This may include configuration of networks, access control to networks and systems, communication and boundary defence and the use of protection and detection software; implement activities and plans (procedural protection measures) to provide resilience against cyberincidents. This may include training and awareness, software maintenance, remote and local access, access privileges, use of removable media and equipment disposal; [and] implement activities to prepare for and respond to cyberincidents."

A significant new feature of the second version of the industry guidelines is the fact that they address insurance-related issues with regard to losses from a cybersecurity-related incident. The question of whether such losses should be covered by insurance has to date been unclear. In addressing this issue, the guidelines provide that "companies should be able to demonstrate

that they are acting with reasonable care in their approach to managing cyberrisk and protecting the ship from any damage that may arise from a cyber incident" (BIMCO et al., 2017). There is currently no regulation in place on cybersecurity in international shipping, yet maritime companies need to be proactive in addressing cyberrisk, as suggested by IMO and various industry bodies, and can no longer claim ignorance with regard to cyberrisk management.

In addition, the guidelines state that in many markets offering marine property insurance, policies may cover loss or damage to a ship and its equipment caused by a shipping incident such as grounding, collision, fire or flooding, even when the underlying cause of the incident is a cybersecurity-related incident. At present, there are exclusion clauses for cyberattacks in some markets and, if the marine policy contains a relevant exclusion clause, the loss or damage is not covered. In such circumstances, the guidelines recommend that companies verify with insurers and/or brokers in advance with regard to whether the policy covers claims for incidents related to cybersecurity and/or cyberattacks (BIMCO et al., 2017).

More generally, limited data on the frequency of attacks, severity of losses and probability of physical damage remain a challenge to underwriters (All About Shipping, 2018).

Finally, with regard to liability for a cybersecurity-related incident, the guidelines state the following (BIMCO et al., 2017):

> "It is recommended to contact the [protection and indemnity insurance] club for detailed information about cover provided to shipowners and charterers in respect of liability to third parties (and related expenses) arising from the operation of ships. An incident caused, for example by malfunction of a ship's navigation or mechanical systems because of a criminal act or accidental cyberattack, does not in itself give rise to any exclusion of normal [protection and indemnity insurance] cover. It should be noted that many losses which could arise from a cyberincident are not in the nature of third-party liabilities arising from the operation of the ship. For example, financial loss caused by ransomware or costs of rebuilding scrambled data would not be identified in the coverage. Normal cover, in respect of liabilities, is subject to a war risk exclusion and cyberincidents in the context of a war or terror risk, will not normally be covered."

The International Organization for Standardization standard 27001:2013 on information technology – security techniques – information security management systems – requirements, specifies requirements for establishing, implementing, maintaining and continually improving an information security management system within the context of an organization. The standard also includes requirements on the assessment and treatment of information security risks tailored to the needs of the organization. The requirements set out in the standard are generic and intended to be applicable to all organizations, regardless of type, size or nature.

In addition, some countries have also prepared guidelines on cybersecurity. For example, the National Institute of Standards and Technology in the United States published the *Framework for Improving Critical Infrastructure Cybersecurity* in 2018 and the Institution of Engineering and Technology in the United Kingdom published the *Code of Practice: Cybersecurity for Ports and Port Systems* in 2016 and the *Code of Practice: Cybersecurity for Ships* in 2017. Such codes can help companies develop cybersecurity assessments, plans and mitigation measures and manage security breaches, and should be used along with ship security standards and other relevant IMO regulations.

The maritime industry continues to work on improving the understanding of cybersecurity issues and on increasing risk management. Shipping companies are integrating innovative security technologies with existing systems and software, to prevent internal and external cyberattacks with minimal human intervention, including by providing real-time alerts and blocking malicious files to prevent unauthorized access to critical systems and data (Marine Log, 2018).

In addition to verifying that technology, policies and procedures are in place, and that employees at all levels are aware of cyberrisks and how to react in the event of an attack, companies should consider in particular how data is stored and secured, given growing concerns with regard to data usage and security, for example on social media websites, which illustrate the complexity of potential security risks.

Data storage and security is particularly relevant, given the entry into force on 25 May 2018, of European Union Regulation 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, which regulates how companies safeguard the processing and movement of the personal data of citizens of the European Union. Some of the key privacy and data protection provisions of the Regulation include requirements related to the consent of subjects for data processing; anonymization of collected data to protect privacy; provision of data breach notifications; safe handling of the transfer of data across borders; and the appointment by certain companies of a data protection officer to oversee compliance with the Regulation. Notably, it is not only companies in the European Union but any company that processes personal data related to offering goods or services or that monitors the behaviour of European Union residents, regardless of its location, that is subject to the Regulation. In the event of non-compliance, the Regulation provides for the administration of fines by supervisory authorities in member States.

2. Internet of things

The Internet of things refers to the network of connected devices with unique identifiers in the form of an Internet protocol address, which have embedded technologies or are equipped with technologies that enable them to sense, gather data and communicate about the environment in which they reside and/or themselves (see www.i-scoop.eu/internet-of-things/).

The shipping sector is increasingly harnessing data generated from satellite information and sensors linking equipment, systems and machinery to support informed decision-making related to route optimization, asset tracking and maintenance. Examples of applications in this domain include software that uses satellite-generated data to determine the most efficient route and estimate in real time the arrival time of vessels; and emerging intelligent containers that use sensors and telematics to track temperature, vibration, humidity and air quality during ocean transport, such as technology used by Maersk and the Mediterranean Shipping Company for reefer monitoring.

The Internet of things is also increasingly used in the industry to improve ship-to-shore connectivity and with regard to intelligent traffic management. A closer interface between ships and ports involves, for example, the use of big data analytics to reduce transit times and time lost when entering ports and other high traffic areas, thereby contributing to alleviating port congestion. For example, the digitalization collaboration initiative between the port of Rotterdam and IBM is helping to prepare this port to host connected ships in future and involves installing sensors across 42 km of land and sea to collect information about traffic management at the port with a view to improving safety and efficiency. A similar initiative between the Maritime and Port Authority of Singapore, academic institutions in Singapore, namely the Institute of High Performance Computing and Singapore Management University, and Fujitsu aims to embed the Internet of things and artificial intelligence technologies to enable long-term traffic forecasts, hotspot calculation and intelligent coordination models.

The Internet of things is also being used to develop systems that support navigation in challenging conditions, such as adverse weather conditions or in congested waterways. For example, in March 2018, Rolls-Royce launched an intelligent awareness system that fuses multiple sensors with intelligent software to create a three-dimensional model of nearby vessels and hazards, to increase safety (Rolls-Royce, 2018). Other applications of the Internet of things currently being tested include the departure of ships without human intervention, the remote controlling of the sailing of ships and the automatic docking of vessels to enable safe berthing (Wärtsilä, 2018).

When shipment events can be recorded in real time, this provides opportunities to optimize operations through blockchain, for example, to track spare capacity, improve connections between different legs of a journey in the global transport network and facilitate capacity-sharing to cope with overcapacity.

3. Use of blockchain

Blockchain is a distributed ledger technology that enables peer-to-peer transactions that are securely recorded, as in a ledger, in multiple locations at once and across multiple organizations and individuals, without the need for a central administration or intermediaries. One of the potential problems identified with regard to digital innovation in the maritime industry is insufficient electronic data interchange standardization and the need for a common data format to exchange information (*Combined Transport Magazine*, 2016). Electronic data interchange involves the electronic transfer from one computer to another of commercial or administrative transactions using an agreed standard to structure the transaction or message data (Economic Commission for Europe, 1996). This lack, along with a general lack of clarity with regard to the potential uses of blockchain, are among the factors that may explain the continued reliance in the shipping industry on paper-based documentation for deliveries of cargo containers.

Overall, blockchain holds potential to improve the security of the Internet of things environment. It addresses several aspects of information security, including confidentiality, integrity, availability and non-repudiation. For example, blockchain can protect the security of documents by blocking identity theft, through the use of public key cryptography; preventing data tampering, compared with document signing and other forms of electronic data interchange, through the creation of a public key and a private key; and stopping denial of service attacks, through the removal of the single target that a hacker may attack to compromise an entire system (Venture Beat, 2017). Allowing data to be managed through blockchain could therefore involve adding an extra layer of security and a gradual decrease in the use of centralized storage and processing for data.

In the maritime industry, blockchain has the potential to be used, among others, to track cargo and provide end-to end supply chain visibility; record information about vessels, including on global risks and exposure; integrate smart contracts and marine insurance policies; and digitalize and automate paper filing and documents. Such applications can help save time and reduce costs related to the clearance and movement of cargo. Several initiatives that focus on the container shipping segment have emerged, although blockchain is not yet fully implemented across the sector. Different varieties of maritime single windows are being developed to handle a quotation encompassing an entire ocean transport transaction, including booking, documentation generation and customs clearance. Maritime single windows imply potential efficiency gains and reduced

costs for shipping companies due to standardization, which allows fragmented back-end systems to be superseded, and digitalization, which enables the elimination of intermediaries and inefficiencies related to the processing of documentation. For example, Maersk and IBM intend to establish a joint venture, which remains subject to the receipt of regulatory approvals. The aim of the venture is to develop an open trade-digitalization platform, designed for use by the entire industry, to help companies move and track goods digitally across international borders. The platform will use blockchain and other cloud-based, open-source technologies, including artificial intelligence, the Internet of things and analytics, delivered through IBM, and initially commercialize the following two core capabilities aimed at digitalizing the global supply chain (Maersk, 2018):

> "A shipping information pipeline will provide end-to-end supply chain visibility to enable all actors involved in managing a supply chain to securely and seamlessly exchange information about shipment events in real time; paperless trade will digitize and automate paperwork filings by enabling end users to securely submit, validate and approve documents across organizational boundaries, ultimately helping to reduce the time and cost for clearance and cargo movement. Blockchain-based smart contracts ensure all required approvals are in place, helping speed up approvals and reducing mistakes."

Another example of the use of blockchain in shipping is the completion by Hyundai Merchant Marine and other members of a consortium, in September 2017, of a pilot voyage applying blockchain that used secure paperless processes for shipment booking and cargo delivery. Hyundai Merchant Marine also reviewed the feasibility of introducing the technology into shipping and logistics and tested and reviewed the combination of blockchain with the Internet of things through the real-time monitoring and management of the reefer containers on the vessel (Lloyd's List, 2017).

In addition, in August 2017, Japan formed a consortium of 14 members to develop a platform for sharing trade data using blockchain, and Singapore-based Pacific International Lines signed a memorandum of understanding with PSA International and IBM in Singapore to develop and test supply chain business network solutions based on blockchain (Lloyd's List, 2017). Other initiatives include the cargo-booking portals of INTTRA and GT Nexus; the e-commerce business platform of CMA CGM; and the single window at the port of Cotonou, facilitated by the World Bank, to ease the management of vessel traffic, cargo and intermodal operations.

Potential future applications of blockchain in shipping could include smart contracts, which are contracts in the form of a computer programme run within blockchains that automate the implementation of the terms and conditions of any agreement between parties. Several smart contract prototypes have been launched that involve digitalizing electronic bills of lading and other trade documents, such as CargoDocs under essDOCS and Cargo X. However, the development of financing, payment and insurance aspects related to shipping remain in experimental and pilot stages. Once the use of such contracts reaches maturity, possible scenarios include the negotiation of freight prices directly between asset owners and their counterparts; the automatic processing of payments upon specified conditions being satisfied; and the issuance of insurance policies and settling of marine insurance claims through blockchain.

Blockchain has been deployed for the first time in the marine insurance sector. In May 2018, some industry actors collaborated with Ernst and Young and the software security firm Guardtime to launch the world's first blockchain-based platform for marine hull insurance. The platform, which is ready for commercial use, is expected to help manage risk for more than 1,000 commercial vessels in its first year and is planned to be implemented for other types of insurance for the marine cargo, global logistics, aviation and energy sectors (Splash 247, 2018). The platform "connects clients, brokers, insurers and third parties to distributed common ledgers that capture data about identities, risk and exposures and integrates this information with insurance contracts" and has the ability to "create and maintain asset data from multiple parties; to link data to policy contracts; to receive and act upon information that results in a pricing or a business process change; to connect client assets, transactions and payments; and to capture and validate up-to-date first notification or loss data" (Guardtime, 2017).

In addition, in 2017, two logistics companies, along with a containership operating company, completed a pilot project on blockchain-based paperless bills of lading that involved the use of an application for the issuance, transfer and reception of original electronic documents, and the containers, shipped from China to Canada, were successfully delivered to the consignees (Marine Log, 2017). The potential use of blockchain in this context is worth noting, as commercially viable electronic alternatives to traditional paper-based bills of lading have only recently emerged. Earlier attempts in this regard include the Bill of Lading Electronic Registry Organization (UNCTAD, 2003; www.bolero.net) and, more recently and with some success, essDOCS (www.essdocs.com). The main challenge in efforts to develop electronic alternatives to traditional paper-based transport documents has been the effective replication of a document's functions in a secure electronic environment while ensuring that the use of electronic records or data messages has the same legal recognition as that of paper documents. With regard to bills of lading, as the exclusive right to the delivery of goods has traditionally been linked to the physical possession of original documents, this includes in

particular the replication in an electronic environment of the unique document of title function (UNCTAD, 2003).

Blockchain is also being used to improve tuna traceability to help end illegal and unsustainable fishing practices in the tuna industry in Asia and the Pacific. In January 2018, the World Wide Fund for Nature in Australia, Fiji and New Zealand, in partnership with a technology innovator, a technology implementer and a tuna fishing and processing company, launched a pilot project in the tuna industry in the Pacific that will use blockchain to track the journey of tuna "from bait to plate", strengthening transparency and traceability. The aim is to help end illegal, unreported and unregulated fishing and human rights abuses of seafarers and workers in the tuna industry and to address safety issues and broader impacts on the environment (The Conversation, 2018a).

Finally, blockchain is also proliferating in terminal and port development. For example, in April 2015, construction was completed of a fully automated and environmentally sustainable container terminal at the port of Rotterdam, and in September 2017, a field laboratory, Block Lab, was launched, which is aimed at developing applications and solutions based on blockchain.

Given that many blockchain initiatives and partnerships are proliferating, there is a need for the different applications emerging in the shipping industry to be interoperable. As noted by observers, "it would be detrimental for the shipping industry if the different factions and initiatives compete head on trying to make their specific blockchain technology choice the de facto standard for the industry" (JOC.com, 2018). Blockchain promises secure transactions yet, according to some specialists, it may not be as secure as generally anticipated. The use of blockchain may help solve some security issues but may also lead to new, potentially more complex security challenges, as some methods can possibly still be used to hack into a maritime transaction blockchain, including compromising the private keys of users; cracking cryptography, given continuous advances in computing; obtaining control of a majority of the mining nodes used to implement blockchain; and abusing vulnerabilities in smart contracts or coded programmes supported and run within blockchains (Marine Electronics and Communications, 2018a).

There are also concerns that many developing countries, in particular the least developed countries, may be inadequately prepared to capture the opportunities and benefits emerging from digitalization. There is a risk that digitalization may lead to increased polarization and widening income inequalities, as productivity gains might accrue mainly to a few, already wealthy and skilled individuals, given that "winner-takes-all dynamics are typical in platform-based economies, where network effects benefit first movers and standard setters" and that "the overall effects of digitalization remain uncertain; they will be context-specific, differing greatly among countries and sectors [and this] makes it increasingly important for countries to ensure they have an adequate supply of skilled workers with strong non-cognitive, adaptive and creative skills necessary for 'working with the machines'" (UNCTAD, 2017b). Additional concerns have been raised about digitalization, as it could potentially lead to a fragmentation of the global provision and international trade of services. This could open up new avenues for the development strategies of developing countries, yet it is unclear whether digital-based services could provide similar employment, income and productivity gains as manufacturing has traditionally done; "disruptive technologies always bring a mix of benefits and risks [but] whatever the impacts, the final outcomes for employment and inclusiveness are shaped by policies" (UNCTAD, 2017c).

4. Autonomous ships, drones and other innovations in shipping

Autonomous ships: Potential benefits and challenges

Among the advances in cybersystems and digitalization in the maritime industry, maritime autonomous surface ships, also known as unmanned surface vessels, are attracting increased attention. As with autonomous technologies in other industries, autonomous ships have the potential to provide enhanced safety and cost savings by removing the human element from certain operations. The term "autonomous ship" is not the same as "unmanned ship", as the former may operate at various levels of autonomy, including partially autonomous (with human input) and fully autonomous (not requiring human intervention). However, such terms have not yet been completely defined either nationally or internationally, and many different formulations exist of the levels of autonomy (Danish Maritime Authority, 2017). In any event, human intervention will still be needed in most ship operations in the near future, and the transportation of cargo and passengers in fully autonomous ships remains a long-term ambition. Autonomous ships could potentially be used in a wide range of operations, including salvage, oil spill response, passenger ferrying, offshore supply, towing and the carriage of cargo. However, at present, they are mostly used for marine scientific research and various maritime operations in the defence sector (Comité Maritime International, 2017). The first remotely controlled or fully autonomous commercial cargo vessel may be in operation by 2020; for example, the first fully electric and autonomous container ship, with zero emissions, may be in operation on a short coastal route in either a remotely controlled or autonomous mode by 2020 (Marine Electronics and Communications, 2018b). The technology may first be deployed on vessels that undertake coastal and short sea routes, and remotely controlled and autonomous ships sailing open oceans could be in operation by 2030 or earlier. An autonomous, fully battery-powered short sea vessel with zero emissions is also currently in development (DNV GL, 2018).

Other recent developments with regard to autonomous ships include the following: a prototype of the world's first fully autonomous and cost-efficient vessel for offshore operations (Kongsberg, 2017); the first electrically powered inland container vessel in Europe, with five small ships in the series expected to be completed in 2018 and six larger ships in preparation with features that prepare them for autonomous operations (*The Maritime Executive*, 2018); an agreement between two companies, possibly a first in the marine sector, to develop an artificial intelligence-based classification system for detecting, identifying and tracking the objects a vessel can encounter at sea, aimed at making existing vessels safer and progressing towards making autonomous ships a reality (Rolls-Royce, 2017); the One Sea autonomous maritime ecosystem project, aimed at enabling fully remote-controlled vessels in the Baltic Sea by 2020 and achieving autonomous commercial operations by 2025 (IMO, 2018b); and the testing of remotely controlled vessels in the Pacific Ocean, due to begin in 2019, aimed at achieving autonomous vessels by 2025 (Bloomberg, 2017).

An area that might benefit from the use of autonomous ships is the safety and security of ship operations. Advances have been made in electronic navigational systems and tools, yet the human factor continues to have an important role in most marine incidents and casualties. Some studies estimate that 75–96 per cent of marine accidents can be attributed to human error and human error reportedly accounted for approximately 75 per cent of the value of almost 15,000 marine liability insurance claims in 2011–2016, equivalent to over $1.6 billion (Allianz Global Corporate and Specialty, 2017).

Crew costs can constitute up to 42 per cent of a ship's operating costs (Stopford, 2009). This cost decreases for vessels with fewer or no crew, as does the risk of piracy and hostage-taking and the respective insurance coverage rates and costs. Vessel construction costs may also be reduced, with less space required for seafarer accommodation and other amenities, which could instead be used for cargo storage. Vessel operations could also become more environmentally friendly, as new autonomous ships are designed to operate with alternate fuel sources, zero-emissions technologies and no ballast. In addition, given fewer or no crew on board, there would be less garbage and sewage to manage and treat.

There are a number of potential benefits, yet challenges in implementation, which include concerns about the following: cybersecurity, although this is not unique to autonomous ships; safety, related to the lack of crew on board; undue impacts on seafarer jobs and shipping rates; and whether insurance cover would be offered by underwriters, insurers and protection and indemnity insurance clubs for commercial autonomous ships (Fairplay, 2017). The potential loss of seafarer jobs is a particular concern in developing countries, as a significant majority of seafarers are from these countries.

Autonomous ships: Regulatory issues

The operation of autonomous ships is closely related to the roles of master and crew on board, a feature that affects the full spectrum of applicable maritime laws and regulations. Regulatory frameworks governing the maritime industry have had to adapt over the years to accommodate new technologies, yet they do not take into consideration the operation of ships without a crew. Therefore, the traditional on-board roles of master and crew, as well as artificial intelligence and shore-based staff supervising remotely controlled or autonomous ships will need to be assessed and redefined. At the international level, aspects of the regulatory framework that need to be considered in the context of autonomous ships include the following:

- Jurisdictional rules specifying the rights and obligations of States with regard to ships in various marine areas and, more specifically, the principles and rules related to flag, port and coastal State jurisdictions, which are mostly covered by the United Nations Convention on the Law of the Sea, 1982. This is a widely ratified framework convention, with 168 States Parties as at 31 July 2018, which defines the rights and responsibilities of nations with regard to their use of the world's oceans, the protection of the marine environment and the management of marine natural resources.
- Technical rules related to, among others, safety, security and the environment, seafarer issues, training and watchkeeping standards, which impose obligations on flag States to enact national legislation reflecting the internationally agreed standards developed by and adopted at IMO.
- Private law rules covering liability for, among others, personal injury, pollution, cargo-related losses and collisions, which are in some instances subject to relevant international legal instruments but may also be subject to national laws.

Recent international regulatory developments of note include a scoping exercise for the review of relevant instruments, to ensure the safe design, construction and operation of autonomous ships, initiated at IMO in 2017 following a decision by the Maritime Safety Committee. A similar review was proposed by the Legal Committee in April 2018, aimed at ensuring that the legal framework set out in legal instruments under its purview provides for the same level of protection for autonomous ships as that provided for operations with non-autonomous ships (IMO, 2018b). Other committees, including the Facilitation Committee and the Marine Environment Protection Committee, may need to undertake similar reviews, as some of the IMO instruments that may need to be considered as part of a comprehensive regulatory review fall under their purview. The Technical Cooperation Committee may also have inputs, in particular when implementation issues are considered.

A cross-divisional task force has been established to facilitate the coordination of work between different committees (IMO, 2018c; IMO, 2018d). In May 2018, the Maritime Safety Committee requested the IMO secretariat to review the work undertaken to date by several organizations that had considered regulatory arrangements and submitted the results of their work to the Committee, and to submit a consolidated report for its consideration at its 100th session in December 2018 (IMO, 2018d; for further information, see the following documents: MSC 99/5, MSC 99/5/1-12, MSC 99/INF.3, MSC 99/INF.5, MSC 99/INF.8, MSC 99/INF.13, MSC 99/INF.14 and MSC 99/INF.16).

Some of the most pertinent IMO instruments with requirements that may need to be evaluated in the context of the navigation of autonomous ships are addressed in this section.

International Convention for the Safety of Life at Sea, 1974

This Convention is the most important of all of the international conventions concerning the safety of commercial ships, and is widely ratified, with 164 States Parties as at 31 July 2018. It applies to over 99 per cent of the world's tonnage and specifies the minimum standards for the construction, equipment and operation of ships, compatible with their safety. This Convention is one of the key IMO conventions, along with the International Convention for the Prevention of Pollution from Ships, 1973/1978, and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended. In addition, the Maritime Labour Convention, 2006, with 88 ratifications as at 31 July 2018, and representing 91 per cent of the world's tonnage, is the main international instrument setting out seafarers' rights to decent conditions of work. These Conventions constitute the four pillars of the international regulatory regime for quality shipping.

A review of 12 chapters of the International Convention for the Safety of Life at Sea, as follows, may be needed to determine how autonomous ships may be covered by the provisions: chapter I, general provisions, including definitions; chapter II-1, construction, including structure, subdivision and stability, machinery and electrical installations; chapter II-2, fire protection, fire detection and fire extinction; chapter III, life-saving appliances and arrangements; chapter IV, radiocommunications; chapter V, safety of navigation; chapter VI, carriage of cargoes; chapter VII, carriage of dangerous goods; chapter VIII, nuclear ships; chapter IX, management for the safe operation of ships; chapter X, safety measures for high-speed craft; chapter XI-1, special measures to enhance maritime safety; and chapter XII, additional safety measures for bulk carriers.

For example, a review of relevant provisions in chapter V on the safety of navigation may be particularly relevant, as some of the provisions require that, from the point of view of safety, all ships must be sufficiently and efficiently staffed. Other provisions relate to the establishment of control of a ship in hazardous navigational situations and the obligation for the master of a ship to provide assistance to persons in distress at sea. A ship operating autonomously without any human oversight would not be able to comply with such provisions and, should an incident occur, issues related to safety and liability might arise. Such functions may have to be taken over by shore-based staff supervising remote-controlled or autonomous ships, and many of the liabilities may have to be assumed by shipowners, shipbuilders and manufacturers of ship components, as has been addressed in similar situations involving autonomous vehicles (The Conversation, 2018b). A way of apportioning responsibility between these parties and third parties needs to be identified, as existing liability rules applicable in the context of traditional staffed maritime activity cannot be simply transplanted to autonomous counterparts.

The provisions in chapter XI on special measures to enhance maritime safety are also particularly relevant, as they require compliance with the International Ship and Port Facility Security Code, and deal with, among others, the specific obligations of ship companies with regard to security, including security procedures, the employment of security-focused personnel and certification and verification requirements. The unique security challenges posed in the context of autonomous operability are relevant in this regard, in particular with regard to cyberinfiltration. Regulation 6 in this chapter requires ships to have a security alert system that transmits ship-to-shore security alerts to designated authorities that indicate the location of a ship and that its security is under threat, which must be able to be engaged from the bridge and at least one other location. A similar alert mechanism might therefore need to be established in an autonomous ship. Regulation 8 requires that the discretion of a master not be constrained by the company or any other person in respect of ship safety. In an autonomous ship, this role might need to be transferred to a shore-based remote controller.

International Regulations for Preventing Collisions at Sea, 1972

The Regulations set out navigational rules to be followed by vessels, aimed at avoiding collisions. A review of the five parts, as follows, may be needed to determine how autonomous ships may be covered: part A, general, including provisions related to applicability; part B, steering and sailing; part C, lights and shapes; part D, sound and light signals; and part E, exemption.

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

The Convention as amended prescribes qualification standards for masters, officers and watchkeeping personnel on board seagoing ships, along with watchkeeping procedures. Article 3, for example,

specifies that the Convention applies to seafarers serving on board seagoing ships entitled to fly the flag of a State Party. The provisions would therefore need to be amended before they could apply to autonomous ships.

International Convention for the Prevention of Pollution from Ships

This Convention is the main international convention covering the prevention of pollution of the marine environment by ships from operational or accidental causes and is widely ratified, with 157 States Parties as at 31 July 2018, and applies to over 99 per cent of the world's tonnage. It includes six technical annexes, as follows: annex I, regulations for the prevention of pollution by oil; annex II, regulations for the control of pollution by noxious liquid substances in bulk; annex III, prevention of pollution by harmful substances carried by sea in packaged form; annex IV, prevention of pollution by sewage from ships; annex V, prevention of pollution by garbage from ships; and annex VI, prevention of air pollution from ships.

Autonomous ships, when in operation, would have to comply with relevant provisions in the Convention to the same extent as traditional staffed vessels including, among others, provisions with regard to construction and equipment-related requirements for various types of ships such as oil tankers; operational and procedural requirements such as discharge limits and ship-to-ship transfers; and reporting requirements in the event of spills. These provisions will therefore need to be reviewed.

Paris Memorandum of Understanding on Port State Control, 1982

This Memorandum was concluded by 14 European shipping nations and aims to ensure an effective system for controlling the technical condition and safety of ships, in addition to inspections by the flag State. The Memorandum was also motivated by the fact that a number of flags of convenience had historically proven to not be able to effectively control ships flying their flags. The Memorandum establishes a system for port State control of ships from all countries calling at a port in States Parties. At present, the Memorandum covers all member States of the European Union, as well as Canada, Iceland, Norway and the Russian Federation, and the United States is affiliated as a cooperating country. Port State control under the Memorandum includes the inspection of seafarer certificates of competency and qualifications according to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, as well as compliance with the International Convention for the Safety of Life at Sea, the International Convention for the Prevention of Pollution from Ships and the Maritime Labour Convention. Inspired by the Memorandum, similar regional port State control agreements have been concluded in Asia and the Pacific and in Latin America. In the European Union, Directive 2009/16 of 23 April 2009 on port State control, based on the Memorandum, sets out a number of additional obligations for information exchanges and reporting between member States of the European Union with regard to port State control, as well as on the professional qualifications of ship surveyors. Such instruments will also need to be reviewed with regard to autonomous ships.

Examples of international legal instruments and legal issues that the Legal Committee of IMO may need to examine with regard to autonomous ships are outlined below.

Nairobi International Convention on the Removal of Wrecks, 2007

This Convention, with 41 States Parties as at 31 July 2018, representing 72.41 per cent of the world's tonnage, provides the legal basis for States to remove or have removed shipwrecks that may have the potential to adversely affect the safety of lives, goods and property at sea, as well as the marine environment. With regard to autonomous ships, the terms "master" and "operator" and the requirement for the master and operator of a ship to report a wreck may need to be reviewed. In addition, the requirement that the master and operator report without delay on the nature of the damage may need to be reviewed. The requirement under various liability conventions that certificates attesting that insurance or other financial security is in place must be carried on board may not be relevant if there is no crew on board (IMO, 2018b).

Other relevant instruments

Other relevant instruments that may be covered under the scoping exercise include the following: Convention on Facilitation of International Maritime Traffic, 1965; International Convention on Load Lines, 1966; International Convention on Tonnage Measurement of Ships, 1969; International Convention on Maritime Search and Rescue, 1979; Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation, 1988; and International Convention on Salvage, 1989.

Autonomous ships: Jurisdictional issues

According to the United Nations Convention on the Law of the Sea, which in large part codifies established customary international law, the nationality of a ship is determined by its flag, that is, by its country of registration, and the law of the flag State applies to the ship or any conduct that takes place on it (articles 91 and 94). Each State has the right to determine the conditions for granting its nationality to ships, for registering ships in its territory and for the right to fly its flag (article 91 (1)), as well as the obligation to maintain a register of ships flying its flag (article 94 (2) (a)). Flag States have an important role in the implementation and enforcement of international conventions, including

those dealing with the technical and safety aspects of shipping, seafarer working conditions and crew training, and in monitoring compliance with relevant mandatory standards (article 94). In parallel with flag State jurisdiction, which applies to a ship irrespective of its location, port and coastal State jurisdiction also applies, depending on the maritime zone in which the ship is located, that is, a port, internal waters, a territorial sea, an exclusive economic zone or the high seas (Comité Maritime International, 2017).

Autonomous ships: Definitions

Certain concepts such as master and crew and related qualifications that may already exist in various international conventions that presume there is a crew on board, such as article 94 (4) (b) of the United Nations Convention on the Law of the Sea, may need to be clarified with regard to their applicability to autonomous ships. The definition of the terms "vessel" and "ship" may also need to be reviewed, as they may exist in various international conventions based on their area of focus, such as the Nairobi International Convention on the Removal of Wrecks, the International Convention on Salvage and the International Convention on Civil Liability for Oil Pollution Damage, 1969, and its 1992 Protocol.

Autonomous ships: Liability rules

Liability rules applicable in the context of traditional staffed maritime activity cannot be applied to the various levels of autonomy in the context of autonomous ships. New regulations and practices may need to be developed that will likely "involve further standards of due diligence on the part of the shipowner, additional certification requirements for component/software developers and new training and qualification standards for pre-programming and shore-based navigation" (Comité Maritime International, 2017).

Drones

Drones, that is, unmanned aircraft, may offer benefits to the maritime industry with regard to, for instance, cost reduction, the saving of time and the enhancement of safety for operations traditionally conducted by staff. A number of companies are developing autonomous drones to enable the following: inspect and survey ships and offshore installations (DNV GL, 2017; UASweekly.com, 2018); map oil spills and assist in rescue operations (see, for example, www.planckaero.com/maritimedrone); monitor emissions from ships (SUAS News, 2017); and carry and deliver goods and supplies (Baird Maritime, 2018; Fast Company, 2017; *The Maritime Executive*, 2017). However, the relevant jurisdictional issues and implications for the legal framework governing combined aviation and maritime operations need to be further explored and better understood.

B. REGULATORY DEVELOPMENTS RELATED TO THE REDUCTION OF GREENHOUSE GAS EMISSIONS FROM INTERNATIONAL SHIPPING AND OTHER ENVIRONMENTAL ISSUES

1. Reduction of greenhouse gas emissions

Carbon dioxide emissions from international shipping have increasingly been in the spotlight, in particular as they are not covered under the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change. Relevant regulations have been considered under the auspices of IMO, including the adoption in 2011 of a set of technical and operational measures to reduce emissions from international shipping and related guidelines (UNCTAD, 2011a; UNCTAD, 2012a). More recently, following the adoption in 2015 of the Paris Agreement under the Convention, further progress has been made, including the adoption in 2016 of a road map for developing a comprehensive IMO strategy on the reduction of greenhouse gas emissions from ships (IMO, 2016, annex 11), and the adoption of an initial strategy in 2018.

Initial strategy on greenhouse gas emissions

According to IMO estimates, in 2012, greenhouse gas emissions from international shipping accounted for 2.2 per cent of anthropogenic carbon dioxide emissions and relevant emissions could increase by between 50 and 250 per cent by 2050 (IMO, 2014). This is of particular concern, given the internationally agreed goal in the Paris Agreement of limiting the global average temperature increase to below 2°C above pre-industrial levels, which will require worldwide emissions to be at least halved from the 1990 level by 2050. The implementation of technical and operational measures for ships could increase efficiency and reduce emissions by up to 75 per cent and further reductions could be achieved by implementing innovative technologies (IMO, 2009).

In April 2018, the seventy-second session of the Marine Environment Protection Committee, at a meeting attended by more than 100 member States of IMO, adopted an initial strategy on the reduction of greenhouse gas emissions from ships (IMO, 2018e). The strategy envisions reducing greenhouse gas emissions from international shipping and phasing them out as soon as possible before 2100. This complements international efforts to address greenhouse gas emissions, including under the Paris Agreement and the 2030 Agenda for Sustainable Development, in particular Sustainable Development Goal 13 on taking urgent action to combat climate change and its impacts. In addition, the strategy sets out relevant guiding principles, including the principles of non-discrimination and of no more

favourable treatment, as enshrined in the International Convention for the Prevention of Pollution from Ships and other IMO conventions, as well as the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances, as enshrined in article 4 of the United Nations Framework Convention on Climate Change, including the Kyoto Protocol and the Paris Agreement. The strategy identifies candidate short-term, midterm and long-term further measures, with possible timelines and their impacts on States, stating that specific attention should be paid to the needs of developing countries, in particular the least developed countries and small island developing States. It also identifies supportive measures, including capacity-building, technical cooperation and research and development.

According to the 2016 road map, a revised strategy is to be adopted in 2023. Under short-term measures to be further developed and agreed upon by member States in 2018–2023, the initial strategy includes technical and operational energy efficiency measures for both new and existing ships, including for speed optimization and reduction, and the use of alternative low-carbon and zero-carbon fuels for marine propulsion and other new technologies. Under midterm measures to be agreed upon in 2023–2030, the strategy includes innovative emissions-reduction mechanisms, possibly including market-based measures, to incentivize the reduction of greenhouse gas emissions. Under long-term measures to be undertaken beyond 2030, the strategy aims for measures that will lead to zero-carbon or fossil-free fuels, to enable the potential decarbonization of the shipping sector after 2050. The strategy notes that "technological innovation and the global introduction of alternative fuels and/or energy sources for international shipping will be integral" to achieving the overall ambition, and includes the following levels of ambition (IMO, 2018f, annex 1):

> "1. Carbon intensity of the ship to decline through implementation of further phases of the energy efficiency design index for new ships: to review with the aim to strengthen the energy efficiency design requirements for ships with the percentage improvement for each phase to be determined for each ship type, as appropriate; 2. carbon intensity of international shipping to decline: to reduce [carbon dioxide] emissions per transport work, as an average across international shipping, by at least 40 per cent by 2030, pursuing efforts towards 70 per cent by 2050, compared to 2008; and 3. [greenhouse gas] emissions from international shipping to peak and decline: to peak [greenhouse gas] emissions from international shipping as soon as possible and to reduce the total annual [greenhouse gas] emissions by at least 50 per cent by 2050 compared to 2008 whilst pursuing efforts towards phasing them out as called for in the vision as a point on a pathway of [carbon dioxide] emissions reduction consistent with the Paris Agreement temperature goals."

Energy efficiency

Energy efficiency measures have been legally binding in the maritime industry since 2013, following the entry into force of relevant amendments to annex VI of the International Convention for the Prevention of Pollution from Ships, and include the energy efficiency design index, which sets standards for new ships and associated operational energy efficiency measures for existing ships. In April 2018, the Marine Environment Protection Committee was advised that nearly 2,700 new ships had been certified as complying with energy efficiency standards, and adopted amendments to annex VI, regulation 21 on energy efficiency design index requirements for roll-on roll-off cargo and passenger ships (IMO, 2018e). A correspondence group is expected to present an interim report in October 2018 and a final report in 2019 with recommendations on the time periods and reduction rates for requirements for phase 3 of the energy efficiency design index and the possible introduction of requirements for phase 4. In addition, amendments to the Convention have entered into force that make a data collection system for the fuel oil consumption of ships of 5,000 gross tons and above mandatory, with data collection from 1 January 2019. The data must be reported to the flag State after the end of each calendar year and subsequently transferred to the IMO database.

In addition to technical and operational measures, discussions on market-based measures to reduce emissions from international shipping have been ongoing at IMO, yet an agreement has not yet been reached (UNCTAD, 2011a; UNCTAD, 2012a; for a summary of potential market-based measures currently under discussion, see chapter 3). In 2013, formal discussions on market-based measures at the Marine Environment Protection Committee were suspended (IMO, 2013). The topic was considered at meetings of the Intersessional Working Group on Reduction of Greenhouse Gas Emissions from Ships in June and October 2017 with regard to its possible inclusion in a strategy on the reduction of emissions (IMO, 2017d; IMO, 2017e). The reports of the meetings reflect the different views expressed, in particular that measures "will include technical and operational measures, but market-based measures may be needed in the medium term whilst alternative fuels are developed" and that "market-based measures should be addressed as candidate midterm measures in order to help incentivize uptake of alternative fuels; potentially market-based measures can be designed not to only remove funds from the sector but also to bring funds into the sector to support greater emissions reductions" (IMO, 2017d; IMO, 2017e). The initial strategy on the reduction of emissions from ships includes among candidate midterm measures new and innovative emission-reduction mechanisms, possibly including market-based measures, to incentivize the reduction of greenhouse gas emissions (IMO, 2018f).

2. Ship-source pollution and protection of the environment

Other recent regulatory developments under the auspices of IMO regarding ship-source pollution control and environmental protection, aimed at ensuring clean and environmentally sustainable shipping, cover air pollution, ballast water management, hazardous and noxious substances and marine litter.

Air pollution

Sulphur oxides and nitrogen oxides, through chemical reactions in the air, are converted into fine particles that, in addition to particles directly emitted by ships such as black carbon and other carcinogenic particles, increase the health-related impacts of shipping pollution and are linked to premature deaths. The Review of Maritime Transport 2017 noted that an important decision had been adopted at IMO, whereby the global limit of 0.5 per cent on sulphur in fuel oil, as set out in annex VI, regulation 14.1.3 of the International Convention for the Prevention of Pollution from Ships, would come into effect on 1 January 2020 (UNCTAD, 2017a). Within emission control areas in which more stringent controls on sulphur oxide emissions apply, the sulphur content of fuel oil must be no more than 0.1 per cent (1,000 parts per million) from 1 January 2015. The first two sulphur oxide emission control areas were established in Europe, in the Baltic Sea and the North Sea, and took effect in 2006 and 2007, respectively; the third was established in North America and took effect in 2012; and the fourth was established as the United States Caribbean Sea, covering waters adjacent to the coasts of Puerto Rico and the United States Virgin Islands, and took effect in 2014. The consistent implementation of a global sulphur content limit for all ships is expected to bring positive results for human health and the environment, in particular as shipping emissions are associated with a large number of fatalities and illnesses at the global level (Independent, 2018).

In April 2018, the Marine Environment Protection Committee approved draft amendments to annex VI of the International Convention for the Prevention of Pollution from Ships, concerning the prohibition on the carriage of non-compliant fuel oil, with sulphur content exceeding 0.5 per cent, for combustion purposes for propulsion or operation on board a ship (IMO, 2018e). Ships fitted with an approved equivalent arrangement to meet the sulphur limit, such as an exhaust gas cleaning system or scrubber, permitted under annex VI, regulation 4.1, would be exempt. Under regulation 3.2, ships undertaking research trials of emissions reduction and control technology could also be exempt. Guidelines to support the implementation of the sulphur limit to come into effect on 1 January 2020 are in preparation at IMO. Finally, the Committee approved guidance on best practices for fuel oil purchasers and users for assuring the quality of fuel oil used on board ships.

Ballast water management

A significant achievement in 2017 was the entry into force on 8 September of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004. As at 31 July 2018, the Convention had 75 States Parties, representing 75.34 per cent of the world's tonnage. The Convention aims to prevent the risk of the introduction and proliferation of non-native species following the discharge of untreated ballast water from ships. This is considered one of the four greatest threats to the oceans and one of the major threats to biodiversity that, if not addressed, could have severe public health-related, environmental and economic impacts (UNCTAD, 2011b; UNCTAD, 2015; see http://globallast.imo.org). From 8 September 2017, ships are required to manage their ballast water to meet standards referred to as D-1 and D-2; the former requires ships to exchange and release at least 95 per cent of ballast water by volume far away from a coast and the latter raises the restriction to a specified maximum amount of viable organisms allowed to be discharged, limiting the discharge of specified microbes harmful to human health. In April 2018, the Marine Environment Protection Committee adopted amendments to the Convention that clarify when ships must comply with the D-2 standard. New ships, constructed on or after 8 September 2017, shall meet the D-2 standard from the date they enter into service. Existing ships constructed before 8 September 2017 shall comply with the D-2 standard after their first or second five-year renewal survey associated with the International Oil Pollution Prevention Certificate under annex I of the International Convention for the Prevention of Pollution from Ships conducted after 8 September 2017, and in any event not later than 8 September 2024 (IMO, 2017f). Given the entry into force of the Ballast Water Management Convention, the Committee also approved a plan with specific arrangements for data gathering and analysis during the experience-building phase and approved guidance related to the form of the certificate, system and type approval process.

Hazardous and noxious substances

In April 2018, the Legal Committee noted the latest States Parties to the 2010 Protocol to the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 1996, namely Canada and Turkey (IMO, 2018g). To enter into force, the Convention requires accession by at least 12 States, representing at least 40 million tons of contributing cargo. As at 31 July 2018, it has been ratified by Canada, Norway and Turkey and the total of contributing cargo has reached 28.7 million tons or nearly 72 per cent of the amount required for its entry into force. Other States are encouraged to address, with a view to overcoming

them, any practical issues and concerns related to implementing the Convention and to consider becoming Parties to it, to help cover a significant gap in the global liability and compensation framework. A comprehensive and robust international liability and compensation regime is in place with regard to oil pollution from tankers through the International Oil Pollution Compensation Fund regime, which includes the International Convention on Civil Liability for Oil Pollution Damage and its Protocol and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971, and its 1992 and 2003 Protocols; and with regard to bunker oil pollution from ships other than tankers through the International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001. However, at present, there is no international liability and compensation regime in place for hazardous and noxious substances that may cause significant personal injury and marine pollution (for an analytical overview of the international legal framework, see UNCTAD, 2012b, and UNCTAD, 2013).

Marine litter

In April 2018, the Marine Environment Protection Committee agreed to include a new item on its agenda to address the issue of marine plastic litter from shipping in the context of Sustainable Development Goal 14 (IMO, 2018e). Member States and international organizations were invited to submit proposals on the development of an action plan to the next session of the Committee. The issue of marine debris, plastics and microplastics in the oceans has been receiving increasing public attention and was the topic of focus at the seventeenth meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea in 2016 (United Nations, 2016). Marine debris in general, and plastics and microplastics in particular, are one of the greatest current environmental concerns, along with climate change, ocean acidification and the loss of biodiversity, which directly affect the sustainable development aspirations of developing States, in particular small island developing States, which, as custodians of vast areas of oceans and seas, face "an existential threat from and [are] disproportionately affected by the effects of pollution from plastics" (United Nations, 2016). Target 14.1 to, by 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution, is particularly relevant in this context. Given the cross-cutting nature of the issue, other Goals are also relevant, including Goal 4 on education, Goal 6 on water and sanitation, Goal 12 on sustainable consumption and production patterns and Goal 15 on the sustainable use of terrestrial ecosystems.

C. OTHER LEGAL AND REGULATORY DEVELOPMENTS AFFECTING TRANSPORTATION

1. Seafarers' issues

In April 2018, the Legal Committee highlighted the increased number of cases of abandonment of seafarers, as recorded in a joint IMO and International Labour Organization database; from 12–19 annual cases in 2011–2016, the number had risen to 55 cases in 2017 (IMO, 2018g). Shipowners in financial difficulty may abandon seafarers in ports far from home, leaving them without food, water, medical care, fuel or pay for months at a time. The 2014 amendments to the Maritime Labour Convention that entered into force in January 2017 make insurance to cover such abandonment, as well as claims for the death or long-term disability of seafarers, compulsory for shipowners. The worldwide population of seafarers serving on internationally trading merchant ships is estimated at 1,647,500, and most are from developing countries; China, the Philippines, Indonesia, the Russian Federation and Ukraine are estimated as the five leading seafarer supply countries (International Chamber of Shipping, 2017). The secretariats of IMO and the International Labour Organization were requested to consult on the inclusion in the database of information related to insurance for each new case and to prepare a list of competent authorities and organizations that could assist in resolving cases (IMO, 2018g). In addition, the Committee was advised of guidance being developed by the International Transport Workers' Federation and Seafarers' Rights International to support the implementation of the IMO and International Labour Organization guidelines on the fair treatment of seafarers in the event of a maritime accident, in view of the different approaches that States had taken in implementing the guidelines. The guidelines aim to ensure that seafarers are treated fairly following a maritime accident and during any investigation and detention by public authorities and that detention is for no longer than necessary. A comprehensive survey conducted by Seafarers' Rights International in 2011–2012 had suggested that the rights of seafarers as detailed in the guidelines were often subject to violation (IMO, 2018h).

2. Fraudulent registration

In the last few years, several member States have reported to the IMO secretariat cases of fraudulent use of their flags, with many illegally registered ships, some of which have been involved in illicit activities. In April 2018, the Legal Committee agreed that the fraudulent registration of ships needed to be addressed and that effective enforcement measures to discourage the practice and prevent ships with fraudulent registration from operating should be considered. The issue is complex, however, as it involves aspects of public

international law and private law, and a multipronged approach is needed. The IMO secretariat was requested to conduct a study of cases received and provide information on the capability of the Global Integrated Shipping Information System of IMO to address the issue, potentially including contact points, sample certificates and a list of registries (IMO, 2018g). The consideration of measures to prevent unlawful practices associated with the fraudulent registration and registries of ships was included in the work programme of the Legal Committee, with a target completion date of 2021.

3. Legally binding instrument under the United Nations Convention on the Law of the Sea

Under this Convention, resources found in the seabed beyond the limits of national jurisdiction are to be used for the benefit of humanity as a whole, with particular consideration for the interests and needs of developing countries (article 140). However, the Convention does not include a provision on the use of marine genetic resources found in the water column, which are commercially valuable and hold considerable potential for the development of advanced pharmaceuticals. Their exploitation may, in the near future, become a promising activity in areas beyond the limits of national jurisdiction. In the absence of a specific international legal framework regulating related issues, negotiations have been ongoing since 2016 at the United Nations on key elements for an international legally binding instrument under this Convention on the conservation and sustainable use of marine biological diversity of areas beyond the limits of national jurisdiction. The outcome of the fourth meeting of the preparatory committee established in accordance with General Assembly resolution 69/292 of 19 June 2015, held in July 2017, included a number of elements recommended for consideration by the General Assembly in the elaboration of a text (UNCTAD, 2017a; see www.un.org/Depts/los/biodiversity/prepcom.htm). The General Assembly, in its resolution 72/249 adopted on 24 December 2017, decided to convene an intergovernmental conference under the auspices of the United Nations to consider the recommendations of the preparatory committee on the elements and to elaborate the text of an international legally binding instrument under the Convention. The first session is scheduled to be held from 4 to 17 September 2018.

Table 5.1 Contracting States Parties to selected international conventions on maritime transport, as at 31 July 2018

Title of convention	Date of entry into force or conditions for entry into force	Contracting States
United Nations Convention on a Code of Conduct for Liner Conferences, 1974	6 October 1983	Algeria, Bangladesh, Barbados, Belgium, Benin, Burkina Faso, Burundi, Cameroon, Cabo Verde, Central African Republic, Chile, China, Congo, Costa Rica, Côte d'Ivoire, Cuba, Czechia, Democratic Republic of the Congo, Egypt, Ethiopia, Finland, France, Gabon, Gambia, Ghana, Guatemala, Guinea, Guyana, Honduras, India, Indonesia, Iraq, Italy, Jamaica, Jordan, Kenya, Kuwait, Lebanon, Liberia, Madagascar, Malaysia, Mali, Mauritania, Mauritius, Mexico, Montenegro, Morocco, Mozambique, Niger, Nigeria, Norway, Pakistan, Peru, Philippines, Portugal, Qatar, Republic of Korea, Romania, Russian Federation, Saudi Arabia, Senegal, Serbia, Sierra Leone, Slovakia, Somalia, Spain, Sri Lanka, Sudan, Sweden, Togo, Trinidad and Tobago, Tunisia, United Republic of Tanzania, Uruguay, Venezuela (Bolivarian Republic of), Zambia (76)
United Nations Convention on the Carriage of Goods by Sea, 1978 (Hamburg Rules)	1 November 1992	Albania, Austria, Barbados, Botswana, Burkina Faso, Burundi, Cameroon, Chile, Czechia, Dominican Republic, Egypt, Gambia, Georgia, Guinea, Hungary, Jordan, Kazakhstan, Kenya, Lebanon, Lesotho, Liberia, Malawi, Morocco, Nigeria, Paraguay, Romania, Saint Vincent and the Grenadines, Senegal, Sierra Leone, Syrian Arab Republic, Tunisia, Uganda, United Republic of Tanzania, Zambia (34)
United Nations Convention on International Multimodal Transport of Goods, 1980	Not yet in force – requires 30 Contracting Parties	Burundi, Chile, Georgia, Lebanon, Liberia, Malawi, Mexico, Morocco, Rwanda, Senegal, Zambia (11)
United Nations Convention on Conditions for Registration of Ships, 1986	Not yet in force – requires 40 Contracting Parties with at least 25 per cent of the world's tonnage as per annex III to the Convention	Albania, Bulgaria, Côte d'Ivoire, Egypt, Georgia, Ghana, Haiti, Hungary, Iraq, Liberia, Libya, Mexico, Morocco, Oman, Syrian Arab Republic (15)
International Convention on Maritime Liens and Mortgages, 1993	5 September 2004	Albania, Benin, Congo, Ecuador, Estonia, Lithuania, Monaco, Nigeria, Peru, Russian Federation, Spain, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Serbia, Syrian Arab Republic, Tunisia, Ukraine, Vanuatu (18)
International Convention on Arrest of Ships, 1999	14 September 2011	Albania, Algeria, Benin, Bulgaria, Congo, Ecuador, Estonia, Latvia, Liberia, Spain, Syrian Arab Republic (11)

Note: For official status information, see the United Nations Treaty Collection, available at https://treaties.un.org, and UNCTAD, Conventions on commercial maritime law, available at http://unctad.org/en/Pages/DTL/TTL/Legal/Maritime-Conventions.aspx.

D. STATUS OF CONVENTIONS

A number of international conventions in the field of maritime transport were prepared or adopted under the auspices of UNCTAD. Table 5.1 provides information on the status of ratification of each of these conventions as at 31 July 2018.

E. OUTLOOK AND POLICY CONSIDERATIONS

Ongoing incidents against systems on board ships and in ports, which have significantly affected the maritime industry, highlight the importance of cybersecurity and cyberrisk management. At the international level, in addition to the IMO guidelines on maritime cyberrisk management adopted in 2017, an IMO resolution encourages administrations to ensure that cyberrisks are appropriately addressed in existing safety management systems, from 1 January 2021. This is the first compulsory deadline in the maritime industry related to cyberrisks and is an important step in protecting the maritime transportation system and the maritime industry from ever-increasing cybersecurity threats. In addition, the strategic plan for IMO adopted in 2017 recognizes the need to integrate new and emerging technologies into the regulatory framework for shipping, by balancing the benefits derived from such technologies "against safety and security concerns, the impact on the environment and on international trade facilitation, the potential costs to the industry and finally their impact on personnel, both on board and ashore" (IMO, 2017c). At the same time, the shipping industry is taking a proactive approach to incorporating cyberrisk management in its safety culture, to prevent the occurrence of any serious incidents. Relevant guidance has been and continues to be developed by classification societies and other industry associations, as well as by individual States, providing practical recommendations on maritime cyberrisk management and including information on insurance issues.

With regard to distributed ledger technology such as blockchain, at present, many initiatives and partnerships are emerging and proliferating, including in the shipping industry. Greater numbers of stakeholders are exploring its utilization, including for digitalizing and automating paper filing, documents, smart contracts and insurance policies, to save time and reduce costs in the clearance and movement of cargo. Such initiatives need to be interoperable, as competition between them in a bid to make a specific technology the chosen standard for the industry may be detrimental for shipping. In addition, blockchain promises secure transactions yet, according to some specialists, may not be as secure as generally anticipated. The use of blockchain may help solve some security issues but may also lead to new, potentially more complex security challenges. UNCTAD has also noted related general concerns about the mix of benefits and risks of digitalization as a disruptive technology. Many developing countries, in particular the least developed countries, may be inadequately prepared to capture the opportunities and benefits emerging from digitalization, and there may be a risk that this could lead to increased polarization and widening income inequalities.

The development and use of autonomous ships present numerous benefits, yet it is unclear whether this advance in technology will be fully accepted by Governments and by the traditionally conservative maritime industry. There are concerns about the safety and security of operations and the reliability of autonomous ships, as well as the diminishing role of and loss of jobs for seafarers, the majority of which are from developing countries. In addition, the use of autonomous ships poses a number of legal and regulatory compliance-related issues that need to be considered and addressed. Conducting regulatory reviews and scoping exercises are therefore of particular importance. Similar issues arise in connection with the use of drones, which has the potential to generate important benefits and may be encouraged; at the same time, the applicable regulatory framework needs to be further studied and developed.

Complementing international efforts to address greenhouse gas emissions – including under the Paris Agreement and the 2030 Agenda, in particular Goal 13 – in 2018, an important achievement at IMO related to the determination of the fair share of emissions reduction by international shipping was the adoption of an initial strategy on the reduction of greenhouse gas emissions from ships, according to which total annual greenhouse gas emissions should be reduced by at least 50 per cent by 2050, compared with 2008. The strategy identifies candidate short-term, midterm and long-term further measures, with possible timelines and their impacts on States, stating that specific attention should be paid to the needs of developing countries, in particular the least developed countries and small island developing States. It also identifies supportive measures, including capacity-building, technical cooperation and research and development.

The implementation of technical and operational measures, as well as the development of innovative technologies for ships, are ongoing. Amendments to the International Convention for the Prevention of Pollution from Ships have entered into force that make data collection systems for the fuel oil consumption of ships of 5,000 gross tons and above mandatory, with data collection from 1 January 2019. The data must be reported to the flag State after the end of each calendar year and subsequently transferred to the IMO database. With regard to ship-source air pollution, the global limit of 0.5 per cent on sulphur in fuel oil outside emission control areas will come into effect on 1 January 2020. The consistent implementation of the

limit for all ships is expected to bring positive results for human health and the environment. Guidelines to support the implementation of the limit are being prepared by IMO. It is important for shipowners and operators to continue to consider and adopt various relevant strategies, including installing scrubbers and switching to liquefied natural gas and other low-sulphur fuels.

Given the importance of implementing and effectively enforcing strong international environmental regulations and in the light of the policy objectives under Sustainable Development Goal 14, developed and developing countries are encouraged to consider becoming parties to relevant international conventions for the prevention and control of marine pollution as a matter of priority. The widespread adoption and implementation of international conventions addressing liability and compensation for shipsource pollution, such as the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, is also desirable in view of the significant gaps that remain in the international legal framework.

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