UNMANNED SHIPS: COPING IN THE MURKY WATERS OF TRADITIONAL MARITIME LAW

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Technological development is advancing more rapidly than regulatory regimes. The adaptability of regulatory regimes and integration with technological advances are hindered by cumbersome legislative and bureaucratic processes. The wind of change which technology brings to the world has blown through the maritime industry as with many other industries. This article seeks to discuss the areas of maritime law which will be affected by the introduction of unmanned vessels and will consider ways to sidestep or deal with potential quagmires in the light of this inevitable technological development.

Keywords: *maritime; technology; law; unmanned ships.*

1. INTRODUCTION

In a fast-paced world where technology has become part of our day-to-day life, the evolution of technology and its impact on modern life is quite immense. Technology continues to advance in all industries, from healthcare to education. The introduction of technology in a particular industry may either be an improvement to existing technologies, i.e., "sustaining technologies", or a technology that displaces an established technology and shakes up the industry, a ground breaking product that creates a completely new industry, i.e. "disruptive technology".[1] Recently, the wind of disruption has been blowing through all industries, and the maritime industry is no exception.

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[1] Christensen, Clayton M., *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (The Management of Innovation and Change Series), 1st edn, Perseus Book LLC (Ingram), (2013).

Unmanned ships can be said to be the most disruptive twentieth-century development in the maritime industry since the invention of the diesel engine. The invention of automated vessels is capable of bringing a change to the entire landscape of shipping and its business model. It can also affect the role of shipping in society. These new, conceptually different vessels have started to appear thanks to their systems driven by Artificial Intelligence.[2] Although the application of autonomous technology is not entirely new to the maritime industry given the use of unmanned underwater vehicles, recently there have been rapid advances in the development and use of unmanned autonomous and semiautonomous technology.

Unmanned ships are vessels capable of controlled movement on the sea and inland waters in the absence of onboard crew.[3] Broadly speaking, unmanned ships can generically be divided into two types. The first is the remote ship where the system is controlled by the use of remote control and a shore-based remote operator who uses a computer and joystick to operate the unmanned ship's movement while using radio and satellite communications. The second type includes ships enabled by autonomous operating systems that will no longer depend on any form of human control but will rather operate at the same level as humans.[4]

However, organisations have gone further to identify different levels of autonomy. The Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) has identified four degrees of autonomy: [5]

- **Degree one**: A ship with automated processes and decision support: seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.

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[2] The concept of unmanned vessels was conceived in the early 1970s. In 1973, in his book *Ships and Shipping of Tomorrow*, Rolf Schönknecht described the ships of the future where a captain would be able to perform his duties in an office building somewhere onshore, while the ship would navigate itself with onboard computers. See Andrews, Crispin, Robot Ships and Unmanned Autonomous Boats, (2016), https://eandt.theiet.org/content/articles/2016/09/robot-ships/, (accessed on 10 March 2019).

[3] CMI IWG. CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework, 2018, https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf, (accessed on 10 June 2020).

[4] Hopster, Gerald; Kołacz, Marta K., When Technology Takes the Wheel – Is the CMR Ready to Meet the Demand for Autonomous Transportation?, (2017) 9(1-2) *European Journal of Commercial Contract Law*, 41, https://repub.eur.nl/pub/106767, (accessed on 3 March 2019).

[5] IMO, Autonomous Shipping, 2019, http://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx, (accessed on 3 June 2020).

- **Degree two**: A remotely controlled ship with seafarers on board: the ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.
- **Degree three**: A remotely controlled ship without seafarers on board: the ship is controlled and operated from another location.
- **Degree four**: A fully autonomous ship: the operating system of the ship is able to make decisions and determine actions itself.

Similarly, the Maritime Autonomous Surface Ships (MASS) UK Code of Practice recognises six (6) levels of vessel autonomy referring to levels of control as listed in Table 1 below.[6]

Level	Name	Description
0	Manned	Vessel/craft is controlled by operators aboard
1	Operated	Under Operated control all cognitive functionality is controlled by the human operator. The operator has direct contact with the Unmanned Vessel over e.g., continuous radio (R/C) and/or cable (e.g., tethered UUVs and ROVs). The operator makes all decisions, directs and controls all vehicle and mission functions.
2	Directed	Under Directed control some degree of reasoning and ability to respond is implemented into the Unmanned Vessel. It may sense the environment, report its state and suggest one or several actions. It may also suggest possible actions to the operator, such as e.g. prompting the operator for information or decisions. However, the authority to make decisions is with the operator. The Unmanned Vessel will act only if commanded and/or permitted to do so.
3	Delegated	The Unmanned Vessel is now authorised to execute some functions. It may sense environment, report its state and define actions and report its intention. The operator has the option to object to (veto) intentions declared by the Unmanned Vessel during a certain time, after which the Unmanned Vessel will act. The initiative emanates from the Unmanned Vessel and decision-making is shared between the operator and the Unmanned Vessel.

[6] Table reproduced from Maritime Autonomous Surface Ships – UK Code of Practice. Available online: https://www.maritimeuk.org/media-centre/publications/maritime-autonomous-surface-ships-uk-code-practice/, (accessed on 30 May 2020).

4	Monitored	The Unmanned Vessel will sense environment and report its state. The Unmanned Vessel defines actions, decides, acts and reports its action. The operator may monitor the events.
5	Autonomous	The Unmanned Vessel will sense environment, define possible actions, decide and act. The Unmanned Vessel is afforded a maximum degree of independence and self-determination within the context of the system capabilities and limitations. Autonomous functions are invoked by the on-board systems at occasions decided by the same, without notifying any external units or operators.

There are also other organisations that have classified the different degrees of autonomy in unmanned vessels. Examples are the MASS Levels of Control according to the DNV GL class guideline for autonomous and remotely operated ships, and the MASS Level of Control Definitions according to the Lloyd's Register guidance document on autonomous ships.

With the world's first fully electric and autonomous container ship,[7] with zero emissions set to sail in 2020,[8] unmanned vessels will inevitably be a reality in our world.

For the purposes of this paper, "unmanned vessels" refers to both "remote controlled vessels" and "autonomous vessels".

2. A NEW DAWN FOR MARITIME STAKEHOLDERS?

Advocates of unmanned vessels have enumerated many benefits that will accrue to the maritime industry and the environment at large.

The lack of human presence on a vessel provides a large number of benefits to shipowners. Shipowners would benefit from crew wage savings and the lack of workplace injuries and claims by crew. Maritime Unmanned Navigation through Intelligence in Networks (MUNIN) performed a cost-benefit analysis

[7] The Yara Birkeland will be the world's first fully electric and autonomous container ship, with zero emissions. KONGSBERG is responsible for the development and delivery of all key enabling technologies, including the sensors and integration required for remote and autonomous ship operations, in addition to the electric drive, battery and propulsion control systems.

[8] She will be operated by an onboard crew in 2020 while the autonomous systems are being tested and certified as safe. By 2022 she is expected to be ready to load cargo and navigate autonomously without onboard crew.

on the commercial viability of unmanned merchant shipping, compared to a conventional bulker as a reference point. It was noted that the largest cost savings are due to the savings in crew costs.[9] In particular, this refers to crew wages, food and other ancillary expenses.

According to the United States Department of Transportation, crew costs take up about 68% of total operating costs on U.S. flagged vessels and 35% on foreign-flagged vessels.[10] Saving such significant costs would be hugely welcomed by shipowners. Although an unmanned vessel would require a shore-based operator ("SBO") on land in a shore control centre, fewer operators would be required and their wages are estimated to be lower than for seafarers who would be compelled to experience the maritime adventure of the seas and leave their families for several months.

Cost savings will also be made in terms of the build and construction of the ship. This is attributable to the fact that there would be no need for structures for accommodation and the deckhouse[11] and this will save on costs, weight, and space, thereby increasing cargo-carrying capacity.[12] The removal of accommodation would lead to lighter vessels, resulting in a decrease in fuel consumption.[13]

Another benefit of the autonomous or unmanned vessel is its possible effect on emissions. In April 2018, the IMO Marine Environment Protection Committee (MEPC) adopted an initial strategy for reducing the total annual greenhouse gas (GHG) emissions from shipping by at least 50% by 2050. A reduction of GHG emissions could be achieved with the advent of unmanned vessels. Emissions from ships are closely linked to the energy requirements of a vessel.[14] The energy which a ship uses during propulsion depends on several factors, including ship resistance and the efficiency of the propulsion train. Ship resistance is affected by its shape, speed and draught. It is also affected by environmental

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9 Deketelaere, Pol, The Legal Challenges of Unmanned Vessels (Universitiet Gent, 2017).

10 United States Department of Transportation Maritime Administration, Comparison of U.S. and Foreign-Flag Operating Costs, (2011).

11 Pritchett, Paul W., Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology, (2015) 40(1) *Tulane Maritime Law Journal*, 197.

12 Carey, Lucy, All Hands Off Deck? The Legal Barriers to Autonomous Ships, (2017) *SSRN Electronic Journal*.

13 Pritchett, Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology, *op. cit*.

14 Vartdal, Bjørn Johan; Skjong, Rolf; Lera St. Clair, Asun, Group Technology and Research Position Paper 2018, Remote Controlled and Autonomous Ships in the Maritime Industry (DNV GL, 2018).

factors, such as wind, waves and current. Although there is no direct connection between the level of manning a ship and the speed of the ship, the level of manning may be an incentive to reduce the speed of a ship. It has been suggested that a ship speed of 6 knots be adopted for an unmanned container ship.[15] If this were applied, two unmanned ships operating at 6 knots would use about fifty percent less energy than one ship operating at 12 knots. This theory would be difficult to adopt in manned ships because of the increased operation costs associated with crew members, feeding the crew and other expenses associated with transportation at sea with a manned vessel.

The impact of unmanned ships on safety is likely to be another driver behind the transition to unmanned vessels. Most marine accidents can be attributed to human error.[16] A study estimates that between 75% and 96% of maritime accidents are the direct result of human error.[17] The above study further states that "fatigue, inadequate communication, and inadequate technical knowledge" are the three biggest factors contributing to human error.[18] Unmanned ships have the potential to reduce human errors. This reason might have been a major factor in the industry taking great interest in the increasing automation of vessels.

Notwithstanding all the above-mentioned benefits of autonomous/unmanned vessels, they are not without obstacles and challenges.

One major challenge that unmanned vessels would pose to society is the number of jobs that may be lost as a result of this innovation. The United Nations Conference on Trade and Development (UNCTAD) states that the international shipping industry employs about 1,545,000 seafarers and global demand for seafarers is still increasing.[19] In the event that unmanned shipping finally takes over our oceans, jobs would be lost. Although other jobs would be created, such as those for information technology engineers, maintenance crew and shore-based operators, it is unlikely that the number would match the current number of employed seafarers. There have been contrary points of view on the

[15] Tvete, Hans Anton, Unmanned Vessels – THE DNV GL "REVOLT" Project (2015), https://iumi.com/images/Berlin2015/3Pressies/1609_HansAntonTvete.pdf, (accessed on 6 March 2019).

[16] Chwedczuk, Michal, Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime Law, (2016) 47(2) *Journal of Maritime Law and Commerce*, 123, https://search.proquest.com/docview/1793648292.

[17] Rothblum, Anita M., Human Error and Marine Safety, http://bowles-langley.com/wp-content/files_mf/humanerrorandmarinesafety26.pdf, (accessed on 7 March 2019).

[18] *Ibid*.

[19] United Nations Conference on Trade and Development, *Review of Maritime Transport 2016*, (2016).

issue of the loss of jobs. According to a study prepared by the Hamburg School of Business Administration on behalf of the ICS:[20]

> "Few vessels will be entirely autonomous in the next decade or two. With an overall increase of the world fleet, at least the number of officers on board will remain stable. At the same time the number of 'crew' on shore in supporting functions will increase, possibly significantly".

The study concluded that there would be no shortage of jobs for seafarers in the near future. Despite this study, the general belief is that unmanned ships will lead to a loss of jobs.

There are also the technical obstacles facing unmanned vessels. For a ship to be safely navigated, the danger to safe navigation must be detected in a timely manner. Nevertheless, the current literature shows that the technological tools in autonomous vessels surpass standard crew capabilities and that autonomous vessels will be as safe as modern crewed vessels.[21] However, elements that could affect safe navigation and consequently have an impact on manoeuvrability range from bathymetry, geography and objects which may be fixed or floating.[22] For example, detections are currently ascertained by the combined use of people, sensors and *a priori* information. However, to replace the crew, sensors must be capable of replacing the senses of crew members on board ship. Sensor technology can do this without major problems in fair weather conditions, but when the weather is sultry and harsh, such as in fog, heavy seas or snowfall, there might be a challenge.[23] *Wei et al*[24] propose light detection and ranging and camera detection fusion in a real-time industrial multi-sensor collision avoidance system. However, *Felski et al*[25] argue that such a solution can be used only on relatively short distances, for land mobile robots. Whatever the solution to such navigational threats, one important aspect is the need to develop countermea-

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[20] Hamburg School of Business Administration, Seafarers and Digital Disruption – The Effect of Autonomous Ships on the Work at Sea, the Role of Seafarers and the Shipping Industry (October 2018).

[21] Felski, Andrzej; Zwolak, Karolina, The Ocean-Going Autonomous Ship—Challenges and Threats, (2020) 8(1) *Journal of Marine Science and Engineering*, 41, https://doaj.org/article/57280f68e8d6419192a7f6e73c3975bb.

[22] Vartdal, Skjong and Lera St. Clair, Group Technology and Research Position Paper 2018, Remote Controlled and Autonomous Ships in the Maritime Industry, *op. cit.*

[23] *Ibid.*

[24] Wei, Pan and others, LiDAR and Camera Detection Fusion in a Real-Time Industrial Multi-Sensor Collision Avoidance System, (2018) 7(6) *Electronics*, 84, https://search.proquest.com/docview/2125335660.

[25] Felski and Zwolak, The Ocean-Going Autonomous Ship—Challenges and Threats, *op. cit.*

sure technologies. The current system in unmanned vessels must be improved in the case of autonomous vessels to such a degree that the operator can be very confident that critical subsystems will not fail during a sea voyage.[26]

There is also the complex situation where autonomous vessels are faced by a manned vessel. Whilst the autonomous ship will always behave according to an algorithm (barring any malfunction of its components), the behaviour of people is not predictable. Ignorance of the rules may also affect human decision on board.

Another downside of the autonomous vessel is that it may increase cargo claims. The existing position is that the master and first officer supervise cargo loading and stowing. For the crew, the appropriate loading and stowing of a vessel could be essential to its stability and, as such, serves as a personal incentive to ensure the correct loading and stowing of the cargo.[27] This incentive would not relate to shore-based operators to whom the task would most likely be given.

Another issue in relation to the autonomous or unmanned vessel is the latency of the teleoperation system. Latency is the period of time it takes for a signal, expressed by the operator, to reach the vessel via satellites or other means.[28] If the latency becomes too long, this could jeopardise the safe and efficient operation of the vessel. Infiltration of cyber security could also cause the latency period to increase and consequently to jeopardise the safe and efficient operation of the vessel.

MUNIN also states that unmanned ships would be less vulnerable to pirate attacks. This assertion may be partly true in relation to the traditional kind of piracy that now occurs, i.e. the physical hijacking of a vessel for a ransom. However, it would be naïve to think that there would be no "pirates and terrorists" involved in the operation of unmanned vessels. The advent of unmanned ships may introduce a new kind of piracy where cyber attacks would allow *hacker-pirates* to illegally take over the remote-control system of the vessel for the purpose of stealing the cargo and/or kidnapping the ship for ransom. Therefore, the ICT systems of vessels will require a higher level of security than they have today to withstand these cyber attacks which may be attempted via ICT infrastructures.

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[26] Rødseth, Ørnulf Jan; Burmeister, Hans-Christoph, Developments Toward the Unmanned Ship, International Symposium "Information on Ships" (August 2012).

[27] Rolls Royce, Autonomous Ships – The Next Step, https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/rr-ship-intel-aawa-8pg.pdf, (accessed on 8 March 2019).

[28] Deketelaere, The Legal Challenges of Unmanned Vessels, *op. cit.*

Some stakeholders have argued that pirates may even think that these new ships would be softer targets, and would bring new players to the scene.[29] However, whether the hacker of ICT systems will be said to be a pirate within the meaning of the UN Convention on the Law of the Sea is still to be seen.[30] The maritime sector is not unfamiliar with cyber attacks. In 2017, Maersk was affected by Not-Petya ransomware, resulting in the shutdown of its systems and costing it about USD 300 million.

Despite the challenges identified above, the autonomous vessel is an innovation that is here to stay. Although there are many unanswered questions connected to the efficiency of unmanned vessels, their technical abilities, public acceptance, and insurable risks which need to be resolved over time, another nagging question remains: can existing maritime law and policy be applied? Would maritime law need to undergo a rigorous revamp and amendment?

3. THE EXISTING FRAMEWORK: PERFECT, TO BE ADAPTED, OR ARE ADDITIONAL LAWS NEEDED?

3.1. Defining a Ship

Ships have been defined by several international conventions. However, before a discussion on the applicability of maritime law can be delved into, it is pertinent to discover if a craft without a crew, i.e. an unmanned ship, can be said to be a ship.

It is difficult to agree on a uniform definition of a ship. *Gahlen* states that there are certain characteristics inherent in a vessel. These characteristics are floatability; capacity for controlled movement on water; capacity for the carriage of goods and persons beyond its mass; and engagement in maritime navigation.[31] *Bork* notes, in addition to the above features, that such a craft must not be of an insignificant size.[32]

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[29] Aro, Tommi; Heiskari, Lauri, Challenges of Unmanned Vessels: Technical Risks and Legal Problems (Yrkeshögskolan Novia 2018).

[30] Hooydonk van, Eric, The Law of Unmanned Merchant Shipping – An Exploration, (2014) 20(6) *The Journal of International Maritime Law,* 403, https://www.openaire.eu/search/publication?articleId=od_____232::423b7ca7d8565eea1b6623acea871a87.

[31] Gahlen, Sarah Fiona, Ships Revisited: A Comparative Study, (2014) 20(4) *The Journal of International Maritime Law*, 252.

[32] Bork, Katharina and others, The Legal Regulation of Floats and Gliders—In Quest of a New Regime? (2008) 39(3) *Ocean Development & International Law,* 298, http://www.tandfonline.com/doi/abs/10.1080/00908320802235338.

To further complicate the position on the lack of a uniform definition, even international conventions do not agree on one. The UN Convention on the Law of the Sea does not define a ship.

The United Nations Convention on Conditions for Registration of Ships[33] defines a ship as "any self-propelled sea-going vessel used in international seaborne trade for the transport of goods, passengers, or both, with the exception of vessels of less than 500 gross registered tons".

The International Convention for the Prevention of Pollution from Ships[34] also defines a "ship" as "a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms".

The Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation[35] (the **SUA Convention**) describes a ship as "a vessel of any type whatsoever not permanently attached to the sea-bed, including dynamically supported craft, submersibles, or any other floating craft".

The Convention on the International Regulations for Preventing Collisions at Sea (**COLREGS**) provides that a "vessel" is "every description of water craft, including non-displacement craft, WIG craft and seaplanes, used or capable of being used as a means of transportation on water".

The Nairobi International Convention on the Removal of Wrecks defines a ship as "a seagoing vessel of any type whatsoever and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft … except when such platforms are on location engaged in the exploration, exploitation or production of seabed mineral resources".

According to the International Convention for the Unification of Certain Rules of Law relating to Bills of Lading[36] (the **Hague Rules**), a "ship" means any vessel used for the carriage of goods by sea".

Despite the differences in the definitions cited above, it can be seen that there is no requirement(s) for a watercraft to have humans on board or to be navigated

[33] The United Nations Convention on Conditions for Registration of Ships, (adopted: 7 February 1986) (Art 2).

[34] International Convention for the Prevention of Pollution from Ships (MARPOL 1973) as modified by the Protocol 1978 relating thereto (MARPOL 73/78), (adopted: 2 November 1973; entry into force: 2 October 1983).

[35] Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, (adopted: 10 March 1988; entry into force: 1 March 1992) UNTS 29004.

[36] International Convention for the Unification of Certain Rules of Law relating to Bills of Lading (The Hague Rules) (Brussels), (adopted: 25 August 1924; entry into force: 2 June 1931).

by humans on board for it to be seen as a ship. All definitions relied on above, including other definitions not explored here,[37] do not consider having a crew on board, including a master, as an essential part of the notion of ship in the regulatory definitions of ship available to us.[38]A further look into national laws suggests the same position. The UK's 1995 Merchant Shipping Act[39] provides that a "ship" includes "every description of vessel used in navigation". The Nigerian Merchant Shipping Act[40] also defines a ship as "a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft, and fixed or floating platforms or mobile offshore units when such platforms or units are not on location engaged in the exploration, exploitation, storage or production of sea-bed mineral resource".

Article 11 of the UAE Maritime Law[41] defines a ship as follows:

"1. A vessel shall mean any structure normally operating, or made for the purpose of operating, in navigation by sea, without regard to its power, tonnage, or the purpose for which it sails.

2. In applying the provisions of the Law, hovercraft used for commercial or non-commercial purposes shall be deemed to be ships.

3. All appurtenances of the ship necessary for the operation thereof shall be deemed to be part of the ship and of the same nature".

It is interesting to note that there are no international conventions or national laws that make the presence of a crew a criterion for a watercraft or a structure to be a ship. Many scholars agree that for the purposes of the Law of the Sea unmanned vessels must be regarded as ships.[42] There is a strong argument for unmanned ships to be considered "ships" so that they may be integrated into

[37] See definitions of ships under the Convention on Limitation of Liability for Maritime Claims (LLMC), (adopted: 19 November 1976; entry into force: 1 December 1986); Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS), (adopted: 20 October 1972; entry into force: 15 July 1977) (Rule 3); Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, (adopted: 29 December 1972 as amended; entry into force: 30 August 1975); International Convention on Civil Liability for Oil Pollution Damage (CLC),(adopted: 29 November 1969; entry into force: 19 June 1975).

[38] Hooydonk, The law of Unmanned Merchant Shipping – An Exploration, *op. cit.*

[39] United Kingdom Merchant Shipping Act 1995, Section 313.

[40] Nigerian Merchant Shipping Act 1995, Section 361.

[41] The UAE Federal Law No. 26 of 1981 on Maritime Commercial Law, as amended.

[42] Henderson, Andrew H., Murky Waters: The Legal Status of Unmanned Undersea Vehicles, (2006) 53 *Naval Law Review,* 55; Kraska, James, The Law of Unmanned Naval Systems in War and Peace, (2010) 5(3) *The Journal of Ocean Technology,* 44.

existing legal frameworks because their operations will pose many of the same collision and pollution risks as manned vessels.[43]

Although the definitions of ships may differ in different statutes and conventions given that the legal definitions are tilted in line with the subject matter of the laws or convention, it is very clear that human presence is never one of the conditions for a structure to be defined as a ship. More importantly, the lack of a uniform definition can be a "blessing in disguise", affording flexibility to the definition of ships.[44]

Against this background, despite the lack of uniformity on the definition of a ship, it is easy to see that the definitions of ships under international conventions and national laws are broad enough to admit the unmanned ship as a ship within these contexts. States will be able to admit the unmanned vessel considering that the United Nations Convention on the Law of the Sea (UNCLOS)[45] does not define a ship and Article 91 stipulates that a State has the powers to grant a ship the power to fly its flag, consequently leaving the State to determine what a ship is.

3.2. Genuine Link to a Flag State?

The nationality of a ship as distinct from the nationality of its owner is said to have emerged as a matter of State practice at the beginning of the nineteenth century.[46] Registration of a ship is necessary as a matter of practice because a vessel or its owner may need the assistance or intervention of the flag State.[47] For a vessel to hoist a flag, there must exist a genuine link between the State and the flag as stipulated by UNCLOS and the United Nations Convention on Conditions for Registration of Ships.[48] UNCLOS requires that every State assume jurisdiction under its domestic laws over each ship flying its flag, its master, officers and crew in respect of administrative, technical and social matters concerning

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43 CMI IWG. CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework, *op. cit.*

44 Veal, Robert; Tsimplis, Michael, the Integration of Unmanned Ships into the Lex Maritima, (2017) (2) *Lloyd's Maritime and Commercial Law Quarterly,* 303.

45 Adopted: 10 December 1982; entry into force: 16 November 1994.

46 Cogliati-Bantz, Vincent P., *Means of Transportation and Registration of Nationality,* (2015).

47 Kontorovich, Eugene, Arctic Sunrise (Netherlands v. Russia); In re Arctic Sunrise (Netherlands v. Russia), (2016) 110(1) *The American Journal of International Law,* 96.

48 Article 91 UNCLOS.

the ship.[49]Article 94 UNCLOS states the duties of the flag State. More particularly, Article 94(3) UNCLOS states that:

"Every State shall take such measures for ships flying its flag as are necessary to ensure safety at sea with regard, *inter alia*, to:

a) the construction, equipment and seaworthiness of ships;

b) the manning of ships, labour conditions and the training of crews, taking into account the applicable international instruments;

c) the use of signals, the maintenance of communications and the prevention of collisions".

Article 94(4)(b) & (c) UNCLOS states that:

"Such measures shall include those necessary to ensure:

b) that each ship is in the charge of a master and officers who possess appropriate qualifications, in particular in seamanship, navigation, communications and marine engineering, and that the crew is appropriate in qualification and numbers for the type, size, machinery and equipment of the ship;

c) that the master, officers and, to the extent appropriate, the crew are fully conversant with and required to observe the applicable international regulations concerning the safety of life at sea, the prevention of collisions, the prevention, reduction and control of marine pollution, and the maintenance of communications by radio".

Looking at the above provisions, each flag State bears the duty of providing the necessary conditions to be fulfilled by the ship flying its flag in respect of manning, labour conditions and the training of crews. Article 94(4)(b) UNCLOS further states that each ship is in the charge of a master and officers who possess appropriate qualifications, and that the crew is appropriate in qualification and numbers for the type of ship. The position will, however, be different in unmanned vessels. The intention behind this provision is to ensure that there is safety at sea. In particular, Article 94(3) UNCLOS uses the word *"inter alia"*. The implication is that the measures to be taken are not exhaustive and a State may determine the relevant measures to help it guarantee safety at sea for ships hoisting its flag. Against this backdrop, once it can be ascertained by a flag State that an unmanned vessel does not require the listed measures to ensure safety, the said provision can be rendered redundant and inapplicable by flag States in relation to unmanned vessels.

[49] Article 94(2)(b) UNCLOS.

Article 94(4)(b) & (c) stipulates that a flag State must ensure that each ship is in the charge of a master. In the case of an unmanned vessel, the ship will not be in the charge of a traditional master since humans are not on board. However, some commentators argue that the SBO who controls the navigation of the vessel ashore should be seen as the master for the purpose of this provision. In line with such a view, flag States will ensure that the SBO fulfils the requirements set out in UNCLOS. As effective as this may seem, the challenge of this application is that the task of a shore-based vessel controller is not entirely similar to that of a ship's master.[50] There is something called "Captain's Law", which covers a whole spectrum of rules that determine the legal status of a master.[51]

Against this backdrop, in the case of an unmanned vessel with no human on board, the legal powers exercised by the master will cease. Traditionally, the master is the person on board who is responsible for the nautical command of the ship, or, in the case of an emergency, performs legal acts on behalf of the owners, or exercises the employer's authority over a community of workers temporarily isolated from society. All these responsibilities are rather different from those that an SBO will possibly hold in the future.

Furthermore, it is unlikely that an SBO will require qualifications in seamanship, navigation, communications and marine engineering to operate a vessel from shore. As such, the provision may be inapplicable in the case of an unmanned vessel. Accordingly, the general assumption that an SBO is a ship's master in respect of this provision may lead to absurdity. Considering that States have the duty to implement this provision of UNCLOS, it is accordingly suggested that States put in place measures to ensure safety and to regularly update the relevant qualification of shore-based operators.

With respect to determining a genuine link to a flag State, criteria are reduced particularly in relation to open registries or flags of convenience. The United Nations Convention on Conditions for Registration of Ships[52] is most likely never going to enter into force and so uniformity on a genuine link is difficult to foresee.

Currently, a genuine link is created if a ship is owned by nationals of the State which exercises control over the ship, **is manned by nationals of that State**, and

[50] Hooydonk, The Law of Unmanned Merchant Shipping – An Exploration, *op. cit.*

[51] Aro and Heiskari, Challenges of Unmanned Vessels: Technical Risks and Legal Problems, *op. cit.*

[52] The United Nations Convention on Conditions for Registration of Ships, Geneva, (adopted: 7 February 1986).

frequently stops in the ports of that State.[53] According to *Hooydonk,* a genuine link may be illusionary in respect of unmanned shipping, particularly in an era where the "…owner of the unmanned ship is not necessarily established in that state, when the ship never calls in the ports of that state and when it is controlled and monitored by an anonymous operator sitting at a control desk somewhere in a distant low-cost country, or by a computer program created in one or other country and operating 'in the cloud'? Instead of being genuine, the link would then be virtual in the highest degree".[54]

It is true that UNCLOS does not define a genuine link, and an extremely slender relationship between the flag State and a fictitious legal person not necessarily based in the flag State with an address would be sufficient to serve as a genuine link. Despite the desirability of the normative insistence of a real link between a vessel and the flag State, the International Tribunal on the Law of the Sea (ITLOS) has stated that the need for the genuine link requirement in Article 91 UNCLOS is "to secure more effective implementation of the duties of the flag State, and not to establish criteria by reference to which the validity of the registration of ships of a flag State may be challenged by other States".[55]

The concept in respect of an unmanned vessel may be simply idealistic because the genuine link between the owner of an unmanned ship and the flag ship is difficult to find. The owner of an unmanned ship is not necessarily domiciled in that State, the ship never calls at the State and the SBO is operating from a low-cost nation or even by a computer program in the case of a fully automated vessel. Whilst it is common knowledge that shipping holds on to very old traditions, the whole concept of a genuine link might be unnecessary in the era of unmanned shipping.

Further, States have discretion to lay down guidelines that a ship needs to comply with to be able to show a genuine link between the State, the ship and the owners.[56] It is up to the States to indicate to their own maritime administration authorities what a genuine link is. It is therefore submitted that creating a genuine link for an unmanned ship will not pose a problem under the existing framework.

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[53] Shaughnessy, Tina; Tobin, Ellen, Flags of Inconvenience: Freedom and Insecurity on the High Seas, (2006) *Journal of International Law & Policy*, https://www.law.upenn.edu/journals/jil/jilp/articles/1-1_Shaughnessy_Tina.pdf.

[54] Hooydonk, The Law of Unmanned Merchant Shipping – An Exploration, *op. cit.*

[55] Churchill, Robin R.; Hedley, Christopher, The Meaning of the "Genuine Link" Requirement in Relation to the Nationality of Ships (International Transport Workers' Federation 2000).

[56] *Ibid.*

3.3. Complying with Different Conventions in Relation to Safety, Manning and Qualifications

Most international conventions relating to shipping envisage conventional manned ships. The IMO Principles of Safe Manning is the primary international standard on safe maning. The principles are non-binding guidance on how to set minimum safe manning requirements for vessels. A safe manning level is therefore subjective,[57] and each flag State may decide on the minimum manning it prefers to adopt. In the United Kingdom, a ship owner is to submit to the Secretary of State its proposal for safe manning numbers according to the type of vessel and nature of the voyage. This means that an owner of an autonomous ship may submit that a safe manning number is zero. A contrary position is held by Nigeria where the Merchant Shipping (manning) Regulation 2010 stipulates the minimum manning for each vessel. In jurisdictions where there are statutory safe manning principles, such countries can amend or may simply adopt a position similar to that of the United Kingdom.

Another convention that partly regulates manning is the 1974 International Convention for the Safety of Life at Sea (**SOLAS**). Paragraph 1 of Annex 2 of the SOLAS Convention states that "Every ship to which chapter I of the Convention applies shall be provided with an appropriate safe manning document or equivalent issued by the Administration as evidence of the minimum safe manning". This implies that SOLAS envisages traditional ships as being manned and, as such, for a vessel to be SOLAS compliant, it will have to have appropriate manning documents.

SOLAS also requires that survival craft be available on board and a sufficient number of crew members must also be aboard the vessel to operate it.[58] Clearly, the rationale behind this is that conventional ships are always manned and, consequently, an avenue for escape in the case of emergency must be made available. Considering that there would be no need for crew to escape on unmanned vessels, this regulation is not important and unmanned vessels may be exempted.[59]

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (**STCW**) is a convention that regulates and sets minimum qualification standards for seafarers. Its purpose is to promote the safety of life and property at sea and to protect the marine environment by establishing

[57] See Hong Kong Fir Shipping Co v Kawasaki Kisen Kaisah [1962] 2 WLR 474.

[58] Part B – Requirements for ships and life-saving appliances, Regulation 10.

[59] Pritchett, Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology, *op. cit.*

an international agreement on the standards of training, certification and watchkeeping for seafarers. The STCW Convention applies to all seafarers *on board* seagoing vessels, except for seafarers working on military ships, state-owned ships and non-commercial governmental ships.[60] Whilst the STCW Convention does not define a seafarer, the Maritime Labour Convention 2006 defines a "seafarer" as "any person who is employed or engaged or works in any capacity on board a ship to which this Convention applies". A combined reading of both conventions would mean that the STCW Convention applies to persons employed or engaged to work on a ship.

Among other things, STCW chapter VIII provides for watchkeeping arrangements. More importantly, Regulation VIII/2 uses the phrase "physically present".[61] It is easy to see that the relevant manning conventions which were made to promote the safety of life and property at sea cannot directly be adapted to a person operating a vessel ashore. Accordingly, there might be a need to amend the manning conventions or for a protocol on autonomous vessels.

3.4. Does It Obliterate Piracy?

The menace of piracy has always been a concern for maritime stakeholders and other industry players. Although the menace of piracy seems to have declined in the last few years, the crime continues to put people lives and economies at risk.[62] Article 101 UNCLOS provides that:

"Piracy consists of any of the following acts:

a) any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed:

i. on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;

ii. against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

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60 See Article III of the STCW Convention.

61 Vartdal, Skjong and Lera St. Clair, Group Technology and Research Position Paper 2018, Remote Controlled and Autonomous Ships in the Maritime Industry, *op. cit.*

62 Satkauskas, Rytis, Piracy at Sea and the Limits of International Law, (2011) 1(2) *Aegean Review of the Law of the Sea and Maritime Law,* 217.

b) any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft;

c) any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b)".

The above provisions stipulate that any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft on the high seas against another ship or aircraft will amount to piracy. A closer review of the UNCLOS regime shows that for an action to be considered piracy, it must include violence or detention.

An unmanned vessel would most likely not be susceptible to traditional maritime piracy. An unmanned vessel may, however, be hijacked by "cyber pirates". The question is whether taking control of an unmanned vessel by exploiting weaknesses in its electronic information systems would be considered violent. The United States courts have noted that acts of "violence" do not have to be directed at a person: malicious acts against inanimate objects also comport with the commonsense understanding of the term.[63] Accordingly, an unauthorised person who hijacks a vessel even by electronic means may fall under the description of being violent.

The use of the word "or" in the definition of piracy provides that an alternative to the condition of violence is detention. A look at the definition shows that it is possible for a cyber hijacking to be an illegal act of detention.[64] *Black's Law Dictionary* defines detention as the "custody of property". It is arguable that the hijacking of an unmanned vessel will be an illegal act of detention. The hijacker will most likely be able to navigate the vessel to anywhere he desires and control the vessel during the period the vessel is hijacked.

Finally, an important issue is whether detention must be committed by crew members or a passenger of a private ship or aircraft. A literal reading of this feature of an act of piracy shows that piracy of a ship can only be committed by people who are physically aboard a ship.[65] A cyber pirate would most likely be ashore and may not fall within the traditional meaning of piracy, thus making UNCLOS not a perfect regulation for an unmanned vessel in relation to piracy.

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63 Inst. of Cetacean Research v. Sea Shepherd Conservation Society, 725 F3d 940, 944, 2013 AMC 1695, 1698 (9th Cir. 2013).

64 Pritchett, Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology, *op. cit.*

65 *Ibid.*

In light of this, it is suggested that UNCLOS be expanded to assimilate and absorb the variants of piracy which may extend to cyber pirates. In addition, because of the difficulty that comes with amending conventions, States can expand domestic laws to cover the intrinsic characteristics of what cyber piracy may look like.

3.5. COLREGS

The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS), is the primary international instrument with respect to the prevention of collisions at sea and navigational rules. The COLREGS Convention is an attempt to make navigation safer by establishing common navigational behavioural patterns and standardising certain equipment on vessels.[66] Rule 2 COLREGS stipulates that nothing in COLREGS "shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case".

Rule 5 COLREGS states that "Every vessel shall at all times maintain a **proper look-out by sight and hearing** as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision".

By the above rules, it appears that it is expected that a crew would be on board always to ensure that the requirement of a lookout by sight and hearing is met. However, there are arguments that this can be satisfied with the use of audio-visual technology given that courts have recognised the use of information from a shore-based radar facility in the *Nordic Ferry* case,[67] and the use of radar as an appropriate means.[68] It is nonetheless important for the SBO to be in a position to respond appropriately in complex and changing situations[69].

Accordingly, unless an autonomous ship can satisfy the requirement of Rule 5 and react to potential collisions with at least the same level of skill and intuition as an experienced mariner, COLREGS may need to be amended to allow autonomous ships to operate legally.

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66 *Ibid.*

67 [1991] 2 Lloyd's Rep 591.

68 See Maritime Harmony 13 [1982] 2 Lloyd's Rep. 400 and the Roseline 17 [1981] 2 Lloyd's Rep 410.

69 Carey, All Hands Off Deck? The Legal Barriers to Autonomous Ships, *op. cit.*

Again, in relation to collision, the 1910 Collision Convention adopts a fault-based regime envisaging liability. Many issues may arise in relation to complying with the 1910 Convention. Ascertaining who is at fault in the case of an unmanned vessel might pose a problem. Can artificial intelligence be "at fault" and therefore to blame? Would the position be different if there were a collision between a manned ship and an unmanned ship? On the presumption that computers do not make errors, will the manned vessel alone be to blame? Bearing in mind that a ship as an object cannot be at fault, is it necessary to extend the circle of persons to be held liable for the actions of an unmanned ship to the manufacturer of the systems[70] or the operators? Should a regime of strict liability be introduced?[71]

Soyer[72] suggests that a strict liability regime be adopted for autonomous regimes. Of course, the use of strict liability regimes is not new to international conventions.[73] The justification for this is that in building an autonomous vessel, the number of individuals involved is likely to be enormous. The courts will then be dealing with apportioning liability between hardware manufacturers, sensor programmers, software developers and other relevant persons. This will be time consuming and may be unfair to the third-party claimant. Another justification for a strict liability regime is that, over the years, intelligent machines adapt to the instructions they receive from humans which were not used at the time of their creation. If this is true, a test of fault-based liability may be impossible in a situation where an autonomous vessel has adapted to the subsequent instructions received through its operation, and where those instructions are different from those originally programmed into the vessel.

Soyer[74] also suggests that there should be exceptions to the strict liability regime. For example, if an autonomous vessel is involved in a collision when it is not under operation, a strict liability regime should not be applied because the action of the vessel did not create a risk of navigation. *Soyer* further argues that

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70 Volvo's CEO announced that it will accept full liability if any of its cars crash while in full autonomous driving mode.

71 Howse, Tim, Maritime Autonomous Surface Ships – Identifying and Covering the Risks, (2019), http://www.gard.no/web/updates/content/27188643/maritime-autonomous-surface-ships-identifying-and-covering-the-risks, (accessed on 21 March 2019).

72 Soyer, Barış, Autonomous Vessels and Third-Party Liabilities, in Soyer, Barış; Tettenborn , Andrew (eds.), *New Technologies, Artificial Intelligence and Shipping Law in the 21st Century* (1st edn, Routledge 2020), 105.

73 Article 3 of the International Convention on Civil Liability for Oil Pollution Damage (CLC), (adopted: 27 November 1992; entry into force: 30 May 1996).

74 Soyer, Autonomous Vessels and Third-Party Liabilities, *op. cit.*

where the vessel is in the charge of an operator, a fault-based system be used in apportioning liability. To further complicate the liability issue of collision, where a cyber attack leads to collision, who should bear liability? It is suggested that it is only fair that liability is taken by the shipowner who put an autonomous vessel at sea knowing that once there is an attack, it is difficult for shore-based controllers to intervene.

Even when a strict liability regime is put in place, the question arises as to who is liable, the manufacturer or the shipowner? It is quite appealing to say the manufacturer of the software should be liable for a collision considering that he understands every detail of the software and should be responsible for loss attributable to a breakdown of software. However, it is more pragmatic to claim that the shipowner be held responsible because: (1) it is an age-long maritime principle that anyone who engages in hazardous activity should be held responsible; (2) a shipowner is expected to maintain and inspect the software after the vessel has been delivered; (3) the P&I clubs have cover extending to shipowners which would ensure that the 3rd party is duly indemnified for loss as a result of a collision.

Accordingly, the importance of safety cannot be over emphasised. It is therefore crucial that the issue of compliance with COLREGS by unmanned vessels be resolved. This may be by creating a new set of seaway rules for these vessels. Such rules will take into consideration the traffic regulation between unmanned ships and manned ships. They will also take into account ethical dilemmas connected with unmanned ships.[75] Such rules will form part of the international regulation and revision of seaway. Indeed, the determination of liability in collision is highly important and should be considered in detail.

3.6. Carriage of Goods by Sea

The Hague Rules[76] and the Hague-Visby Rules provide that a carrier may be allowed complete immunity if it can be proven that the cargo losses were caused by a negligent act or omission relating to the navigation or management of the ship.[77] Relating this to an unmanned vessel, when will the defence be applicable? It has been argued by some scholars that if the SBO is negligent, the

[75] CORE Advokatfirma and Cefor, *Maritime Autonomous Surface Ships – Zooming in on Civil Liability and Insurance* (Cefor, December 2018).

[76] The International Convention for the Unification of Certain Rules of Law relating to Bills of Lading.

[77] Article 4(2) of the Hague Rules.

shipowner will be able to rely on the provisions of Article 4(2) of the Hague (Visby) Rules and escape liability.[78] This argument may seem to resolve the issue in instances where the vessels are remote controlled but, considering that the level of automation of unmanned ships will differ, the same cannot be said in instances where the vessel is fully automated and needs no shore-based controller. Such an interpretation will be impracticable, unworkable, and the provisions redundant.

It may be possible to argue that where cargo losses are caused by a technical fault which is attributable to the manufacturers and technology providers, such liability will fall on the product manufacturers which have caused the loss. Whether the manufacturers would be prepared to accept liability remains to be seen.

The Hague Rules require the carrier "to exercise due diligence to make the ship seaworthy" before a voyage. A seaworthy vessel is one that is "reasonably fit to carry the cargo which she has undertaken to transport". Vessels will be said to be unseaworthy where they have been found unseaworthy for sailing due to incorrect charts,[79] insufficient bunkers for the voyage,[80] the absence of documents required to satisfactorily prosecute the contemplated voyage,[81] defective navigational equipment,[82] and "**having unqualified crew members**".[83]

Findings of unseaworthiness under these standards in the context of remotely operated and fully autonomous USVs are not difficult to imagine. However, in relation to crew members, it is arguable that for vessels with SBOs, the SBO would be the crew in such instances, and, where the SBO is incompetent, the ship would be unseaworthy and the shipowner would be liable. The unanswered question in this context is what will be used to determine the SBO's competence.

The Advanced Autonomous Waterborne Applications Initiative (AAWA) opines that Shore-Based Operators will be master mariners with years of seagoing experience.[84] If this is the case, in decades to come shore-based operators

[78] Rodriguez-Delgado, Juan Pablo, The Legal Challenges of Unmanned Ships in the Private Maritime Law: What Laws Would You Change?, (2018) *SSRN Electronic Journal.*

[79] The Marion [1984] AC325.

[80] McFadden v Blue Star Line [1905] 1 KB 697, at p. 704.

[81] The Madeleine [1967] 2 Lloyd's Rep 224.

[82] Complaint of Thebes Shipping Inc., 486 F. Supp. 436 (S.D.N.Y. 1980).

[83] Hong Kong Fir Shipping v KKK [1962] 2 QB 26 (see also The Eurasian Dream [2002] 1 Lloyd's Rep 719).

[84] Advanced Autonomous Waterborne Applications Initiative (AAWA) Remote and Autonomous Ship – The Next Steps, 70 https://www.utu.fi/en/units/law/research/research-projects/Pages/aawa.aspx, (accessed on 24 March 2019).

who meet such a requirement will be difficult to find because, as more ships become automated, fewer people will be going to sea.[85]

3.7. Cyber Security and Insurance

The advent of the internet and its increased use has significantly increased the vulnerability of organisations to information theft, identity theft, disclosure of sensitive information, vandalism, business interruption and denial-of-service attacks, thereby bringing information security issues to the top of the agenda for corporate executives.[86]A cyber attack could also result in unquantifiable reputational damage and erosion of trust, which would have dire economic consequences.

Risks associated with data exchange are prevalent in all sectors. However, with the introduction of unmanned vessels, it is expected that exposure to cyber risk will increase. Cyber risk is defined as "operational risks to information and technology assets that have consequences affecting the confidentiality, availability, or integrity of information or information systems".[87] Safety continues to be an important issue in maritime navigation and, as such, maritime stakeholders are worried about cyber security. Stakeholders including the IMO are focusing on identifying risk mitigation instruments, optimising internal procedures and anchoring cyber resilience in top-level management.[88]

In relation to unmanned vessels, crimes such as cyber piracy[89] could become a trend. It is therefore important for regulations to be adopted to ensure that cyber security is good enough to reduce the possibility of cyber crime with the advent of unmanned ships. However, cyber security is not just about preventing hackers gaining access to systems and information, potentially resulting in the loss of confidentiality and/or control. It also addresses the maintenance of integrity and the availability of information and systems, ensuring business continuity and the continuing utility of digital assets and systems. It is thus important that adequate attention is given not only to protecting ship systems from attack

[85] Carey, All Hands Off Deck? The Legal Barriers to Autonomous Ships, *op. cit.*

[86] Gordon, Lawrence A.; Loeb, Martin P.; Sohail, Tashfeen, A Framework for Using Insurance for Cyber-Risk Management, (2003) 46(3) *Communications of the ACM*, 81.

[87] Cebula, James J.; Young, Lisa R., A Taxonomy of Operational Cyber Security Risks (ACI Information Group, December 2010).

[88] CORE Advokatfirma and Cefor, *Maritime Autonomous Surface Ships – Zooming in on Civil Liability and Insuran*ce, *op. cit.*

[89] The piracy which would be prevalent with unmanned shipping is different from traditional piracy. See discussion above on piracy in unmanned vessels.

but also to ensuring the design of the systems and supporting processes is resilient and that appropriate reversionary modes are available in the event of a compromise.[90]

This is important because a ship is naturally connected to a large web of networks. Running such complex systems could be an entry point for cyber criminals to perpetrate malicious acts. Finally, particular attention must be given to inside threats from shore-based operators who may decide to behave maliciously. Regulations on the necessary precautions to be taken by every shipowner, shore-based operator and other players in relation to cyber security must be made in view of the imminent takeover of our oceans by unmanned ships. Failure to comply with such regulation or the failure of an organisation to have adequate cyber risk management could make the unmanned ship unseaworthy.

Marine safety and security have been one of the main objectives of the IMO. The International Safety Management Code (ISM) and International Ship and Port Facility Security Code (ISPS) are regulations to ensure safety in ship and harbour operations, as well as in the working environment, which includes personnel on shore and on board vessels.[91] The above-mentioned codes are focal points in relation to risk identification, accident prevention and emergencies in the maritime industry.

On 5 July 2017, the IMO issued Guidelines on Maritime Cyber Risk Management, which provide recommendations on the protection of ships from the emerging threat of cyber attacks. According to the Guidelines, member governments are encouraged to ensure that cyber risks are appropriately addressed in safety management systems no later than the first annual verification of the company's Document of Compliance after 1 January 2021. The IMO also amended two of its general security management codes to explicitly include cyber security.[92]

Stakeholders appear to be happy with the inclusion of cyber risk management under the ISM Code with effect from 1 January 2021 as adopted by the IMO. However, there is a lack of clarity about the standards that will be used to assess the risk management of unmanned ships. Internationally recognised non-marine specific standards like the International Electrotechnical Commission, the International Organization for Standardization, and cyber risk management programmes, such as the National Institute of Standards and Technology Cyber-

[90] Lagouvardou, Sortiria, Maritime Cyber Security: Concepts, Problems and Models (Technical University of Denmark, 2018).

[91] *Ibid.*

[92] The International Ship and Port Facility Security Code (ISPS) and International Security Management Code (ISM).

security Framework, are expected to be applicable together with guidelines and procedures from classification societies.[93] Shipowners should take a risk-based approach to ensuring cyber security. They have to see the nexus between strong cyber-security practices and the survival of their business.

3.8. Unresolved Issues

Despite discussing several issues above, this paper cannot exhaustively consider all the legal aspects related to the introduction of unmanned ships. The issue of the definition of the word "seafarer" under the Maritime Labour Convention 2006 (MLC) and whether MLC will be applied to shore-based operators has not been discussed.

The issue of the pilot and the pilot's status have also not been considered in this paper. Although the status of the pilot is not defined in any international convention, it is important that their status be determined under national laws in view of the introduction of unmanned vessels. Traditionally, a pilot is regarded as an advisor with local knowledge who assists the master on board with advice about navigation in the pilotage waters in the approaches to ports and in waterways.[94]

There are some places where the pilot gives advice from the shore by means of radio communications. In such instances, the pilot would be an advisor and cannot be said to be liable for negligence. However, because of the underlying determinative factor of efficient pilotage which depends on the effectiveness of the communications and information exchange between the pilot, the master and the bridge personnel, while the unmanned ship requires tug assistance upon entering and leaving ports, the question arises about who has command of the tow. In most jurisdictions, the law is that the master of the vessel is not relieved of responsibility for the conduct and navigation of the vessel only because the vessel is under pilotage.[95] In the case of unmanned vessels, who takes responsibility for the conduct of the vessel? Should this be the shore-based operators, who may not directly be employees of the shipowners, or the shipowners?

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[93] CORE Advokatfirma and Cefor, *Maritime Autonomous Surface Ships – Zooming in on Civil Liability and Insurance*, *op. cit.*

[94] Aro and Heiskari, Challenges of Unmanned Vessels: Technical Risks and Legal Problems, *op. cit.*

[95] For example, see Section 326 of the Australian Navigation Act 2012.

4. CONCLUSION

It is impracticable to transplant the existing liability rules applicable in the context of traditional manned maritime activity to its unmanned counterpart. Although SBOs may be placed side by side with conventional seafarers, there is a shift in the impact of responsibilities.

Unmanned ships will rely heavily on information technology, software and communication systems. These vessels will have no one on board to diagnose and "troubleshoot" even glitches. The role of the remote controller of an unmanned ship is believed to be similar to that of the master in that both assume real-time command of, among other things, the movement and signalling of the relevant ship. However, in the case of a fully automated vessel which is not controlled ashore, there may be complications because a pre-programmer of an autonomous unmanned ship enjoys a role unparalleled in the traditional maritime domain. He is potentially the last human input into the ship's navigational course but, unlike a master, does not exercise real-time decision-making influence.[96]

The pre-programmer is in this sense more akin to an engineer or even a component manufacturer but, unlike each of these, in the context of an autonomous collision avoidance system with no onboard oversight, his before-the-event conduct potentially has a far more profound bearing on the ship's navigational safety than the ordinary component manufacturer of a manned ship. Applying ordinary principles, liability arising from an accident involving a programmed autonomous unmanned ship is to be apportioned between the shipowner, the software manufacturer and the pre-programmer. Each of these could be separate or the same corporate entities, which further adds to the complexity. To what extent liability between these parties should be joint and several must be considered, as must the entitlement or otherwise of the pre-programmer to invoke the liability limitations of the shipowner.[97] New regulations and practices will need to be developed to cover the activities introduced by unmanned operations.

The most important consideration in the regulation of unmanned cargo is safety. Due to the innovative technology involved, the level of safety currently guaranteed by cruise boats is a clear standard. It is unrealistic to expect regulators or the entire maritime community to accept lower standards. Given the advent of the new technology, the most appropriate regulatory approach is to in-

[96] CMI IWG. CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework, *op. cit.*

[97] *Ibid.*

clude unmanned vessels in existing frameworks, with some significant changes based on the findings of the earlier pages of this work.

It is important to note that considerable amendments to the existing framework are needed for the operation of pre-programmed unmanned ships. It may take a long time to change the established IMO rules, as an agreement between a small number of States alone cannot bring about international change. International conventions are politically difficult to achieve, especially when it comes to international transport. Based on the foregoing, it may be more appropriate and easier for these changes to be effected from a State and domestic level.

National regulations play an important part in providing safety information for unmanned vessels to national authorities. The governments of these countries play a crucial role in the provision of supply as they relate to technology that meets international requirements. Currently, the IMO has introduced more than 50 international regulations and conventions. Most of the obligations imposed by these regulations are administered by flag States who consequently enforce them by national regulations that reflect internationally agreed standards. Accordingly, it is suggested that rather than the current position of having an international framework before having a domestic framework, stakeholders must now put the "horse behind the cart".

As far as international regulation is concerned, some problems must be solved before establishing an international framework for unmanned vessels. A more detailed review of the current legal framework is needed to assess its applicability to unmanned ships, as well as to determine whether unmanned ships can comply with the current international conventions governing maritime law and to what extent they need to be changed or clarified. It might also be important to distinguish provisions which are prescriptive and compulsory in nature from those which are permissive. It is expedient to identify if there is a need to adapt conventions and regulations, to amend conventions and regulations, protocols and in some cases to adopt new regulations to ensure that there are no legal impediments for the use of unmanned vessels. Until then, domestic regulations for coastal States might just be a step in the right direction to achieve an international uniform framework that closes the loopholes and deals with the uncertainties that unmanned ships will bring to the world.

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Sažetak:

AUTONOMNI BRODOVI: SNALAŽENJE U OKVIRIMA TRADICIONALNOG POMORSKOG PRAVA

Tehnologija se razvija znatno brže nego pravo. Prilagodbu pravnih režima tehnološkim unaprjeđenjima ometa komplicirana zakonodavna procedura i birokracija. Promjene koje u svijetu donosi tehnologija osjećaju se u pomorskoj industriji kao i u drugim industrijama. U svjetlu nezaobilaznog tehnološkog razvoja, u radu se proučavaju područja pomorskog prava na koja djeluje otkriće autonomnih plovila i mogući putevi zaobilaženja prepreka u njihovom pravnom uređenju.

Ključne riječi: *pomorstvo; tehnologija; pravo; autonomni brodovi.*