Evaluating the Application of International Laws on Navigation and Collision to Operating Autonomous Ships

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Declaration

I, Ali Movaghar, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

The advent of maritime autonomous surface ships (MASS) and the trend towards autonomous shipping mark a significant evolution in the seaborne trade and have generated much debate on the requirements and prospect of MASS operations. Research indicates that MASS have the potential to bring about significant safety, economic and environmental benefits. The question, therefore, is not whether international operation of such vessels should be banned, but how their design, construction and operation should be regulated. However, given that the current international maritime law framework was developed on the presumption that merchant vessels are operated by on-board crew members, operation of MASS presents a full range of legal challenges. Since the United Nations Convention on the Law of the Sea (UNCLOS) confers certain navigational rights on 'ships' or 'vessels', the first obvious challenge is whether a MASS may constitute a 'ship' or a 'vessel' for the purposes of UNCLOS. A further uncertainty is whether the existing maritime law conventions are capable of accommodating such innovative vessels and regulating their operation merely through amendments to the conventions, or whether completely new legal instruments should be developed to ensure safe MASS operations. From a safety perspective, one of the most important maritime conventions is the International Regulations for Preventing Collisions at Sea (COLREGs) as MASS vessels may collide with conventional vessels or with various marine structures and cause casualties and/or damage to the marine environment.

This thesis uses safety and instrumentalism as normative frameworks and the original contributions of the thesis to knowledge are as follows. First, it establishes that MASS enjoy the same navigational rights conferred on 'ships' or 'vessels' under UNCLOS. Second, it demonstrates that the existing dual framework and qualitative nature of COLREGs should be retained. Third, it shows that COLREGs need certain crucial amendments to enhance the safety of navigation. Finally, it argues that a suggested three-stage process should be adopted and followed for certification of MASS navigated by remote operators or by AI.

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List of Abbreviations

AAWA: Advanced Autonomous Waterborne Applications Initiative
AI: Artificial Intelligence
AIS: Automatic Identification System
BIMCO: Baltic and International Maritime Council
CLC: International Convention on Civil Liability for Oil Pollution Damage
CMI: Comité Maritime International
COLREGs: International Regulations for Preventing Collisions at Sea, 1972
CPA: Closest Point of Approach
ECDIS: Electronic Chart Display and Information System
EEZ: Exclusive Economic Zone
EMSA: European Maritime Safety Agency
EU: European Union
FPSO: Floating production storage and offloading
GRT: Gross Registered Tonnage
IACS: International Association of Classification Societies
ICAO: International Civil Aviation Organization
ICJ: International Court of Justice
IEEE: Institute of Electrical and Electronics Engineers
IFSMA: International Federation of Shipmasters' Association
ILC: International Law Commission
IMO: International Maritime Organization
IMCO: Inter-Governmental Maritime Consultative Organization
MARPOL: International Convention for the Prevention of Pollution from Ships
MLA: Maritime Law Association
NTSB: (the US) National Transportation Safety Board
ISM: International Safety Management
ITF: International Transport Workers' Federation
LLMC: Convention on Limitation of Liability for Maritime Claims
MAIB: (the UK) Marine Accident Investigation Branch
MCA: (the UK) Maritime and Coastguard Agency
OOW: Officer of the Watch
P&I: Protection and Indemnity
MASS: Maritime Autonomous Surface Ships
MAXCMAS: MAchine eXecutable Collision regulations for Marine Autonomous Systems
MSA: Merchant Shipping Act
MSC: Maritime Safety Committee
MUNIN: Maritime Unmanned Navigation through Intelligence in Networks
NAVSAC: (the US) Navigation Safety Advisory Council

NGO: Non-governmental Organisation
NUC: Not Under Command
RAM: Restricted in her Ability to Manoeuvre
RSE: Regulatory Scoping Exercise
RYA: Royal Yachting Association
SIRC: Seafarers International Research Centre
SOLAS: International Convention for the Safety of Life at Sea
STCW: International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TCAS: Traffic Collision Avoidance System
TCPA: Time to Closest Point of Approach
TSS: Traffic Separation Scheme
UAV: Unmanned Aerial Vehicle
UKHO: United Kingdom Hydrographic Office
UNCLOS: United Nations Convention on the Law of the Sea, 1982
UNCTAD: United Nations Conference on Trade and Development
USCG: United States Coast Guard
USV: Unmanned Surface Vehicle
UUV: Unmanned Underwater Vehicle
VCLT: Vienna Convention on the Law of Treaties
VHF: Very High Frequency
WIG: Wing-in-ground

Glossary of Technical Terms

Allision: An accident in which a moving vessel hits a 'stationary' object such as a jetty or a fixed platform.

Displacement: The mass of water that a ship displaces when afloat. A non-displacement craft, therefore, does not immerse in water and has zero 'draught'.

Dumb barge: The word 'dumb' is used to denote any vessel (here, a barge) that has no propulsion or steering system and therefore, unable to make way through water except by towing.

Floatel: A floating hotel, especially a ship which is used as a hotel.

Hopper barge: A dumb barge (with no means of self-propulsion) which is designed and used to carry materials like rocks, sand and rubbish for dumping into the ocean.

LIDARS (Light Detection And Ranging): a system for detecting objects which works on the principle of radar, but uses laser lights instead of radio waves.

Light ship: A merchant ship that is carrying no freight or cargo (not to be confused with lightship).

Lightship: A ship which is anchored at a specified location and guides vessels with a light.

List: A prolonged tilting of a ship to one side or another caused by internal forces such as shifting of the cargo.

MV (Motor Vessel): The prefix MV denotes a vessel which is propelled by machinery, as distinct from sailing vessels.

OOW: Officer of the watch; the officer who is responsible for controlling and navigating the ship during a specified watch at sea.

State (with an upper-case s, as used in UNCLOS): a nation or territory organised under one government.

VHF (Very High Frequency) radio: A piece of equipment which is used for ship-to-ship and ship-to-shore radio communications.

WIG (wing-in-ground) craft: A vehicle that looks like an aeroplane and flies close to the water's surface by using aerodynamic interaction between its wings and the water surface.

Water draught (or simply draught): The vertical distance between the lowest point of the ship and the surface of the water.

Chapter 1: Introduction

1.1. Background

Today the international shipping industry is responsible for the carriage of about 90% of the world's goods[1] and around 95% of the goods that are imported to or exported from the UK.[2] Without the shipping industry, therefore, the import and export of affordable food and fuel would be impossible. Perhaps the best quote to highlight the vital importance of the shipping industry is that without it 'half the world would starve and the other half would freeze'.[3] The shipping industry, therefore, is vital to the international community. Yet, the industry is currently suffering from the following issues and most of the issues may be addressed by introduction of Maritime Autonomous Surface Ships (MASS).

The first issue is maritime accidents that result in loss of life, damage to the environment, and loss of economy. The number of reported shipping casualties or incidents was 2,815 in 2019, which showed an increase of 5% compared to the previous year.[4] In regard to accidents involving ships flying a flag of one of the EU Member States, 320 accidents resulted in a total of 496 lives lost between 2014 to 2019.[5] With 438 fatalities, 'crew' is recognised as the most affected category of persons in the accidents.[6] A recent example demonstrating the seriousness of the issue of maritime accidents is the tragic collision between the oil tanker, *Sanchi*, and the bulk carrier, *CF Crystal*, off the coast of Shanghai on the 6th of January 2018. Carrying 136,000 tonnes of natural-gas condensate, *Sanchi* exploded immediately after the collision and continued burning for over a week until it

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[1] 'Shipping and World Trade: Top Containership Operators' (*International Chamber of Shipping*) <https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-top-containership-operators/> accessed 07 February 2023.

[2] 'Maritime 2050: Call for Evidence' (*UK Department for Transport*, 2018) para 1.2 <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/694879/maritime-2050-call-for-evidence.pdf> accessed 07 February 2023.

[3] 'Explaining Shipping' (*International Chamber of Shipping*) <https://www.ics-shipping.org/explaining/> accessed 07 February 2023.

[4] 'Safety and Shipping Review 2020: An Annual Review of Trends and Developments in Shipping Losses and Safety' (*Allianz Global Corporate & Specialty*, 2020) page 5 <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Safety-Shipping-Review-2020.pdf> accessed 07 February 2023.

[5] 'Annual Overview of Marine Casualties and Incidents 2020' (*European Maritime Safety Agency*, 2020) para 2.6.2.1 <http://www.emsa.europa.eu/newsroom/latest-news/item/4266-annual-overview-of-marine-casualties-and-incidents-2020.html> accessed 07 February 2023.

[6] Ibid.

sank on the 14th of January.[7] All 32 crew members of *Sanchi* lost their lives and the spillage of the condensate, which is extremely toxic and harmful to the environment, spread as far as Japan.[8] The collision was a direct result of 'human error' as both vessels failed to comply with Rules 5 and 7 of the International Regulations for Preventing Collisions at Sea (COLREGs).[9] In fact, it is estimated that up to 96% of all maritime casualties can be attributed to human error.[10] Accident statistics of the European Maritime Safety Agency (EMSA) also indicate that over the period of 2011-2015, about 62% of the incidents involving EU registered ships were attributed to a 'human erroneous action' and half of the casualties were of 'navigational nature'.[11] In addition to loss of life, maritime accidents caused by 'human error' also result in considerable economic loss. Marine liability insurance claims between 2011 and 2016 indicated that 'human error' accounted for 75% of the value of the claims, costing over $1.6 billion in losses.[12] By removing humans and thereby human error from ships, MASS can reduce accidents and thereby save lives and reduce economic loss. In fact, three researchers in a very important recent study investigated 100 maritime accidents which happened between 1999 and 2015 in various geographical locations, in order to assess whether each accident would have happened if the ships were 'unmanned'.[13] The study concluded that the likelihood of collisions and groundings may have been decreased significantly if the relevant vessels were 'unmanned' and thus, the introduction of remotely-operated and autonomous

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[7] 'Sanchi' (*Lloyd's List*) <https://lloydslist.maritimeintelligence.informa.com/hot-topics/Sanchi> accessed 07 February 2023.

[8] Ibid.

[9] 'Report on the Investigation of the Collision between MT Sanchi and MV CF Crystal' (*China Maritime Safety Administration*, 10 May 2018) para 4 <https://www.mardep.gov.hk/en/msnote/pdf/msin1817anx1.pdf> accessed 07 February 2023.

[10] 'Safety and Shipping Review 2017: An Annual Review of Trends and Developments in Shipping Losses and Safety' (*Allianz Global Corporate & Specialty*, 2017) page 3 <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Safety-Shipping-Review-2017.pdf> accessed 07 February 2023.

[11] 'Annual Overview of Marine Casualties and Incidents 2016' (*EMSA*, 2016) page 5 – available at <http://www.emsa.europa.eu/newsroom/latest-news/item/2903-annual-overview-of-marine-casualties-and-incidents-2016.html> accessed 07 February 2023.

[12] 'Safety and Shipping Review 2018: An annual review of trends and developments in shipping losses and safety' (*Allianz Global Corporate & Specialty*, 2018) page 5 <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Safety-Shipping-Review-2018.pdf> accessed 07 February 2023.

[13] Krzysztof Wróbela, Jakub Montewkab and Pentti Kujala, 'Towards the Assessment of Potential Impact of Unmanned Vessels on Maritime Transportation Safety' (2017) 165 Reliability Engineering and System Safety 155. (Although the term 'unmanned' is an established term in the literature, more neutral words such as MASS will also be used in this thesis).

vessels can decrease the number of collisions and groundings significantly.[14] Another research published in 2021 also illustrates the safety benefits of autonomous vessels and concludes that the implementation of autonomy on small cargo vessels (less than 120 metres in length) will have the largest safety benefits.[15] Although it is unlikely that MASS will reduce accidents to absolute zero, at least there will be no humans on board such vessels to lose their lives.

The second issue is operational costs and global shortage of ships officers. Depending on a ship's size and type, crewing cost accounts for up to half of the ship's total operating costs,[16] and it represents the single largest contributor to total running costs for almost all types of commercial ships.[17] This issue is further exacerbated by the current global shortage of about 11,000 ship officers which is estimated to increase to 17,000 by 2025.[18] While there is an accelerated growth in the world's merchant fleet,[19] seafaring as a career is becoming less and less attractive as fewer and fewer people are willing to spend weeks or months at a time away from their family and friends,[20] and there are therefore not enough ship officers to fill the potential jobs on board the ships. Thus, due to the shortage, some junior officers may be promoted into higher ranks without the required experience[21] and this can result in accidents and increased workload on other officers who will have to carry the burden. Furthermore, although the shortage is presently masked by the temporary idling of ships due to the Covid-19 pandemic, the latest 'Manning Annual Review and Forecast' report warns that it will re-emerge and will inflate future crewing

[14] Ibid 161.

[15] Jiri de Vos, Robert G Hekkenberg, Osiris A and Valdez Banda ,'The Impact of Autonomous Ships on Safety at Sea – A Statistical Analysis' (2021) 210(6) Reliability Engineering & System Safety 1.

[16] Martin Stopford, *Maritime Economics* (3rd ed, Routledge 2009) 226.

[17] 'Independent Economic Advice on the Impacts of Increasing MCA Fees: A Report Prepared for the Maritime and Coastguard Agency' (*Oxford Economics*, 2013) para 3.1 <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/552193/Oxford_Economics_independent_impact_assessment.pdf> accessed 07 February 2023.

[18] 'Global shortage of ships officers to grow' (*Nautilus International*, 11 June 2020) <https://www.nautilusint.org/en/news-insight/news/global-shortage-of-ships-officers-to-grow/> accessed 07 February 2023.

[19] UNCTAD, 'Handbook of Statistics 2017' (26 January 2018) page 76 – available at <https://unctad.org/en/PublicationsLibrary/tdstat42_en.pdf> accessed 07 February 2023.

[20] Oskar Levander, 'Autonomous Ships on the High Seas' (2017) 54(2) IEEE Spectrum 26, 29.

[21] 'A Nautilus International Survey of Seafarers' Living and Working Conditions' (*Nautilus International*, 2010) page 10 <https://www.nautilusint.org/globalassets/public-resources/pdfs/seafarers_conditions_survey_report_2010.pdf> accessed 07 February 2023.

costs once the shipping industry is fully reactivated.[22] Autonomous vessels will not only address the issue of shortage of ship officers, studies suggest that they can also reduce the operational costs by up to 20% in short-sea trades.[23] The cost of owning and operating an autonomous bulk carrier over a 25-year period is estimated to be 4.3 million US dollars lower than for a conventional bulk carrier.[24] Without the need for deckhouses, provision stores, freshwater tanks, air conditioning, and heating systems, autonomous vessels will also be lighter and more aerodynamic, and will therefore require less energy for propulsion.

Third, every year, thousands of tonnes of sewage, garbage, and oily waste are discharged into the sea by ships and the resulting pollution not only threatens the marine ecosystem, but also the livelihood of people whose food security depends on the living resources of the sea. A recent study draws attention to this issue which is currently developing in the Northern Bering Sea.[25] Without any crew on board, however, autonomous vessels will not generate any sewage or garbage. Furthermore, the international shipping industry emits around 940 million tonnes of CO_2 annually and is responsible for about 2.5% of global greenhouse gas emissions.[26] In 2015, the shipping industry was responsible for 2.6% of global CO_2 emissions and if treated as a country, it would have been the sixth largest emitter of CO_2 in that year just above Germany.[27] It seems that as a result of strict international policies, operation of vessels with high levels of carbon emission will become less feasible. For example, the EU Parliament decision to include maritime CO_2 emissions in the EU Emissions Trading System from 2022, will force shipowners to buy carbon permits to cover emissions during voyages in EU waters

[22] Rhett Harris, 'Officer Shortage to Widen and Inflate Manning Costs' (*Drewry*, 03 June 2020) <https://www.drewry.co.uk/news/officer-shortage-to-widen-and-inflate-manning-costs> accessed 07 February 2023.

[23] Abeera Akbara, Anna KA Aasen *et al*., 'An Economic Analysis of Introducing Autonomous Ships in a Short-sea Liner Shipping Network' (2021) 28 International Transactions in Operational Research 1740.

[24] Lutz Kretschmann, Hans-Christoph Burmeister and Carlos Jahn, 'Analyzing the Economic Benefit of Unmanned Autonomous Ships: An Exploratory Cost-comparison Between an Autonomous and a Conventional Bulk Carrier' (2017) 25 Research in Transportation Business & Management 76, 83.

[25] Melissa Parks, Austin Ahmasuk *et al*., 'Quantifying and Mitigating Three Major Vessel Waste Streams in the Northern Bering Sea' (2019) 106 Marine Policy 1.

[26] 'Reducing Emissions from the Shipping Sector' (*European Commission*) <https://ec.europa.eu/clima/policies/transport/shipping_en#:~:text=Maritime%20transport%20emits%20around%20940,not%20put%20in%20place%20swiftly.> accessed 07 February 2023.

[27] Naya Olmer, Bryan Comer *et al*., 'Greenhouse Gas Emissions from Global Shipping 2013-2015' (2017) The international Council on Ocean Transportation 1, 6 – available at <https://theicct.org/sites/default/files/publications/Global-shipping-GHG-emissions-2013-2015_ICCT-Report_17102017_vF.pdf> accessed 07 February 2023.

or during international voyages to or from EU ports.[28] However, autonomous ships like *Yara Birkeland*[29] that are fully battery-powered and zero-emission, can help reduce the atmospheric pollution and can also help shipowners to avoid carbon emission costs. It is estimated that *Yara Birkeland* will reduce diesel-powered truck transport in Norway by about 40,000 journeys per year,[30] and this seems to be one of the main drivers of developing such a vessel. The fact that some shipowners have been able to convert their saving in carbon emissions into carbon credit,[31] may be an incentive for some shipping companies to opt for all-electric or more fuel-efficient autonomous vessels. Whatever the real incentive for development of autonomous vessels, reports indicate that the autonomous ships market is flourishing and it is estimated to be valued at $85.84 billion in 2020, and to reach $165.61 billion by 2030.[32]

1.2. Rationale

Due to the above-mentioned benefits and incentives, different companies and organisations are increasingly investing in development of autonomous vessels. In the commercial sector, China's first autonomous vessel, *Jin Dou Yun 0 Hao*, made its maiden voyage in December 2019.[33] The vessel is a relatively small cargo vessel that reduces operation costs by 20% and fuel consumption by 15%.[34] Also, *Yara Birkeland*[35] and

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[28] Isabelle Gerretsen, 'Ships to Get Free Pass on Emissions until 2030, under Compromise Proposal' (*Climate Home News*, 15 November 2020) <https://www.climatechangenews.com/2020/10/15/ships-get-free-pass-emissions-2030-compromise-proposal/#:~:text=The%20IMO%20has%20set%20the,intensity%20reduced%2040%25%20by%202030.> accessed 07 February 2023.

[29] Kristin Nordal, 'Yara Birkeland Status' (*Yara*, November 2020) <https://www.yara.com/news-and-media/press-kits/yara-birkeland-press-kit/> accessed 07 February 2023.

[30] Asle Skredderberget, 'The First Ever Zero Emission, Autonomous ship' (*Yara*, 14 March 2018) <https://www.yara.com/knowledge-grows/game-changer-for-the-environment/> accessed 07 February 2023.

[31] Institute of Marine Engineering, Science and Technology, 'Making the Green Agenda Pay' (2015) page 10 – available at <https://www.imarest.org/reports/551-making-the-green-agenda-pay/file> accessed 07 February 2023.

[32] 'Autonomous Ships Market' (*Allied Market Research*, 2020) <https://www.alliedmarketresearch.com/autonomous-ships-market> accessed 07 February 2023.

[33] Katherine Si, 'China's First Autonomous Cargo Ship Makes Maiden Voyage' (*Seatrade Maritime News*, 16 December 2019) <https://www.seatrade-maritime.com/technology/chinas-first-autonomous-cargo-ship-makes-maiden-voyage> accessed 07 February 2023.

[34] Ibid.

[35] Asle Skredderberget, 'The First Ever Zero Emission, Autonomous ship' (*Yara*, 14 March 2018) <https://www.yara.com/knowledge-grows/game-changer-for-the-environment/> accessed 07 February 2023.

ReVolt[36] are all-electric, zero-emission and MASS Degree 4 cargo ships which are being developed in Norway by the Classification Society DNV. Rolls-Royce has also planned to launch MASS Degree 3 ocean-going ships by 2030 and MASS Degree 4 ocean-going ships by 2035.[37] In the research sector, *Mayflower* is the prominent example of a MASS Degree 4 and solar-powered vessel which completed a transatlantic voyage in June 2022.[38] In the military sector, the *Sea Hunter* is one of the most well-known examples – a submarine hunter that was launched by the US Navy in 2016.[39]

The autonomous ship technology, therefore, is rapidly developing and it is already in full operation in some parts of the world. The international maritime regulations, however, are lagging behind the technology. The risk associated with the *status quo* is that some classification societies have already published design criteria and guidelines for remotely-operated and autonomous vessels,[40] and some States have established national guidelines for the operation of such vessels within their jurisdiction,[41] and such national guidelines and regulations may prove difficult to harmonise through international regulation in the future. That is why in February 2017, a number of countries including the UK jointly submitted a paper to the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) and warned that 'as the number, type and size of MASS increase, these arrangements may become unsustainable and potentially unsafe … [and] the existence of different national regulatory frameworks may render the construction and operation of MASS unmanageable, and may hamper innovation and technological developments'.[42] The paper also invited the MSC to undertake a regulatory scoping

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[36] Hans Anton Tvete, 'The ReVolt: A new inspirational ship concept' (*DNV GL*) <https://www.dnvgl.com/technology-innovation/revolt/index.html> accessed 07 February 2023.

[37] Paul Dean, Tom Walters and Jonathan Goulding, 'Autonomous Vessels – Are Regulations Keeping up with Innovation? November 2017' (*HFW*) <http://www.hfw.com/Autonomous-vessels-are-regulations-keeping-up-with-innovation-November-2017> accessed 07 February 2023.

[38] 'AI-driven Robot boat Mayflower crosses Atlantic Ocean' (*BBC News*, 06 June 2022) <https://www.bbc.co.uk/news/uk-england-devon-61710706> accessed 07 February 2023.

[39] Paul Benecki, 'DARPA Christens (Mostly) Autonomous Vessel' (*The Maritime Executive*, 07 April 2016) <https://www.maritime-executive.com/features/darpa-christens-mostly-autonomous-vessel> accessed 07 February 2023.

[40] See, for example, DNV GL, 'Autonomous and Remotely Operated Ships' (September 2018) – available at <http://rules.dnvgl.com/docs/pdf/dnvgl/cg/2018-09/dnvgl-cg-0264.pdf> accessed 07 February 2023.

[41] See, for example, the fourth version of the 'Maritime Autonomous Ship Systems (MASS) UK Industry Conduct Principles and Code of Practice' published by Maritime UK in November 2020 – available at <https://www.maritimeuk.org/priorities/innovation/maritime-uk-autonomous-systems-regulatory-working-group/mass-uk-industry-conduct-principles-and-code-practice/> accessed 07 February 2023.

[42] Maritime Safety Committee, 'Maritime Autonomous Surface Ships Proposal for a Regulatory Scoping Exercise' (MSC 98/20/2, 27 February 2017) para 8-11 – available at <https://mlaus.org/wp-

exercise to ensure the safe, secure and environmentally sound operation of MASS within the existing IMO instruments.

There are, therefore, urgent policy-related and safety-related needs for international maritime regulations and conventions to be revised and amended in light of the new technology. From a safety point of view, COLREGs is one of the most important conventions that need to be revised. This is because although autonomous vessels can reduce accidents and there is no crew on board such vessels to lose their lives, such vessels may, nevertheless, collide with crewed vessels or platforms and result in casualties. Autonomous systems are not always error-free. For instance, in an accident in 2018, an Uber autonomous car hit and killed a pedestrian who was pushing a bike and crossing a road in Arizona.[43] A recent study suggests that where accidents involving MASS Degree 4 vessels do happen, the consequences can be much more serious as there is no crew on board such vessels to intervene and mitigate losses.[44] In researchers' own words, 'the potential consequences of maritime disaster can be massive and may include damage not only to the vessel itself, but also to her cargo, environment, infrastructure and people that happen to be nearby even unintentionally'.[45] Thus, it is of paramount importance that collision regulations eliminate or minimise the risk of collision in the first place. COLREGs, however, were designed for conventional crewed vessels about five decades ago without the concept of autonomous vessels in mind.

1.3. Literature Review

The IMO has provisionally defined MASS as 'a ship which, to a varying degree, can operate independently of human interaction.'[46] Depending on the level of autonomy, the IMO has also divided MASS into four degrees as follows:

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content/uploads/bp-attachments/6563/MSC-98-20-2-Maritime-Autonomous-Surface-Ships-Proposal-for-a-regulator...-STP.pdf> accessed 07 February 2023.

[43] 'Preliminary Report' (*NTSB*, 2018) <https://www.ntsb.gov/investigations/AccidentReports/Reports/HWY18MH010-prelim.pdf> accessed 07 February 2023.

[44] Krzysztof Wróbela, Jakub Montewkab and Pentti Kujala, 'Towards the Assessment of Potential Impact of Unmanned Vessels on Maritime Transportation Safety' (2017) 165 Reliability Engineering and System Safety 155.

[45] Ibid 165.

[46] 'IMO Takes First Steps to Address Autonomous Ships' (*IMO*, 25 May 2018) <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx> accessed 07 February 2023.

1) Degree **one**: Ship with automated processes and decision support: Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.
2) Degree **two**: Remotely controlled ship with seafarers on board: The ship is controlled and operated from another location, but seafarers are on board.
3) Degree **three**: Remotely controlled ship without seafarers on board: The ship is controlled and operated from another location. There are no seafarers on board.
4) Degree **four**: Fully autonomous ship: The operating system of the ship is able to make decisions and determine actions by itself.[47]

The existing literature mainly consists of short articles that focus on whether MASS degree 3 or 4 i.e. watercraft with no crew on board can be regarded as a 'vessel' or a 'ship' for the purposes of COLREGs or other regulations.[48] Although important, this issue is not insurmountable as it may be addressed simply through amendment of the relevant regulations if necessary. In fact, attention should be focused on potential issues or gaps in the existing regulations that may present safety challenges to operation of MASS after they have been recognised as 'vessels'.

With regard to the legal status of MASS under UNCLOS,[49] in the absence of a definition of 'ship' or 'vessel' in the Convention, Veal and Tsimplis argue that the better view is to assume that under Article 91(1) of UNCLOS, it is left to each State to decide whether a given watercraft is a 'ship' under its national laws.[50] This approach, however, may lead to a confused situation where a MASS is considered to be a 'ship' by one State but not by another. For example, in December 2016, China seized a US Navy Unmanned Underwater Vehicle (UUV) about 50 nautical miles northwest of Subic Bay in the South China Sea. While the US argued that the UUV was a sovereign immune 'vessel' entitled to the freedom of navigation under international law,[51] China asserted that it was an 'unidentifiable device' with no such rights.[52] Thus, it appears that a different approach

[47] Ibid.

[48] For example: Craig H Allen, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism vs Functionalism' (2018) 49 Journal of Maritime Law and Commerce 477.

[49] United Nations Convention on the Law of the Sea, 1982.

[50] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 309.

[51] 'Statement by Pentagon Press Secretary Peter Cook on Return of U.S. Navy UUV' (*US Dep of Defense*, 19 December 2016) <https://www.defense.gov/Newsroom/Releases/Release/Article/1034224/statement-by-pentagon-press-secretary-peter-cook-on-return-of-us-navy-uuv/> accessed 07 February 2023.

[52] 'China Gives America its Underwater Drone Back – with a Warning' (*The Register*, 20 December 2016) <https://www.theregister.co.uk/2016/12/20/china_returns_us_drone/> accessed 07 February 2023.

should be adopted to determine the legal status of remotely-operated and autonomous watercraft under UNCLOS.

In regard to compliance of MASS with COLREGs, there is no comprehensive analysis in the literature and most studies only scratch the surface of the issue. The 'Maritime Unmanned Navigation through Intelligence in Networks' (MUNIN) was a multi-partner European project that took place between September 2012 and August 2015 and aimed to develop a technical concept for the operation of 'unmanned dry-bulk ships' engaged in deep-sea voyages. Although the project also aimed to assess the legal challenges of 'unmanned shipping', the focus of the project gradually shifted more towards economic and environmental benefits of MASS.[53] The study describes the collision regulations, particularly those concerning the 'human' look out, as 'by and large the biggest issue'.[54] The study, however, does not provide any analysis as to how this issue might be addressed. The next important study, the Advanced Autonomous Waterborne Applications Initiative (AAWA) aimed to address the economic, technological and regulatory issues in order to make autonomous shipping a reality.[55] Completed by Rolls-Royce in 2017, the AAWA Position Paper states that two aspects of COLREGs are likely to pose challenges to MASS: situational awareness and operational decision-making when it comes to collision avoidance.[56] Like MUNIN, however, the report does not provide detailed analysis of these two issues. Another project in the context of COLREGs was MAXCMAS[57] which was completed in March 2018. This project, too, did not deal with regulatory issues of COLREGs and instead, aimed to develop a more comprehensive capability of MASS to comply with the current COLREGs in real-world sea trials.[58]

Rules 2, 5 and 18 of COLREGs have been specifically highlighted and debated in the literature. Rule 2 requires all vessels not only to comply with COLREGs, but also with the

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[53] Ziaul Haque Munim, 'Autonomous ships: A Review, Innovative Applications and Future Maritime Business Models' (2019) 6 Supply Chain Forum: An International Journal 1, 2.

[54] 'Final Report Summary - MUNIN (Maritime Unmanned Navigation through Intelligence in Networks)' (*CORDIS*, 04 April 2016) <https://cordis.europa.eu/project/rcn/104631/reporting/en> accessed 07 February 2023.

[55] Rolls Royce, 'Remote and Autonomous Ships: The Next Steps(AAWA Position Paper)' (2016) page 5 – available at <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 07 February 2023.

[56] Ibid 45.

[57] MAchine eXecutable Collision regulations for Marine Autonomous Systems.

[58] 'Project MAXCMAS' (*Solent University*) <https://www.solent.ac.uk/research-innovation-enterprise/rie-at-solent/projects-and-awards/project-maxcmas> accessed 07 February 2023.

‘ordinary practice of seamen’ which may be required under certain circumstances.[59] It also warns against a doctrinaire compliance with COLREGs and obliges vessels to depart from COLREGs when necessary.[60] Since Rule 2 is extremely human-oriented and difficult to codify, the Position Paper of the International Working Group on Unmanned Ships which was set up by the Comité Maritime International (CMI), argues that autonomous vessels fall foul of Rule 2 of COLREGs.[61] Rolls-Royce, however, argues that the MAXCMAS research project demonstrated that the operation of autonomous vessels can meet the current COLREGs.[62] Neither CMI nor Rolls-Royce has provided a compelling reason, and Rule 2 remains a challenging rule that warrants consideration. Rule 5 imposes an obligation on all vessels to maintain a proper look-out ‘by sight and hearing’ and the literature focuses on whether or not the reference to ‘sight and hearing’ requires physical presence of humans on board the vessel, or at least the exercise of human perception at some stage.[63] Similarly, the Position Paper of the CMI states that it must be clarified whether the lookout obligation can be discharged from a remote location.[64] The more important question, however, is whether an on-board autonomous lookout or a remote human lookout can actually meet the ‘purpose’ of Rule 5 and whether this rule should be amended.[65] The ‘navigational status’ of MASS under Rule 18 is another issue which is considered in the literature. Carey suggests that one solution is to define MASS as a vessel ‘not under command’[66] and the US Navigation Safety Advisory Council (NAVSAC) has proposed that a MASS operating autonomously should be categorised, under Rule 3(g), as a ‘vessel restricted in her ability to manoeuvre’.[67] The literature, however, fails to explain and justify *why* MASS should or should not be granted such

[59] Rule 2(a).

[60] Rule 2(b).

[61] Robert Veal and Henrik Ringbom, ‘Unmanned Ships and the International Regulatory Framework’ (2017) 23(2) Journal of International Maritime Law 100, 110.

[62] ‘MAXCMAS Success Suggests COLREGs Remain Relevant for Autonomous Ships’ (*Rolls-Royce*, 21 March 2018) <https://www.rolls-royce.com/media/press-releases/2018/21-03-2018-maxcmas-success-suggests-colregs-remain-relevant-for-autonomous-ships.aspx> accessed 07 February 2023.

[63] Robert Veal and Michael Tsimplis, ‘The Integration of Unmanned Ships into the *Lex Maritima*’ [2017] LMCLQ 303, 326.

[64] Robert Veal and Henrik Ringbom, ‘Unmanned Ships and the International Regulatory Framework’ (2017) 23(2) Journal of International Maritime Law 100, 111.

[65] That is, a full appraisal of the situation and of the risk of collision.

[66] Luci Carey, ‘All Hands off Deck: The Legal Barriers to Autonomous Ships’ (2017) 23(3) JIML 202, 209.

[67] NAVSAC, Resolution 12-08 – available at <https://homeport.uscg.mil/Lists/Content/Attachments/724/NAVSAC%20-%20April%202013%20Summary%20Record%20-%20Part%202%20of%202_2.pdf> accessed 11 October 2019 (archived).

navigational status. It seems that granting MASS such a status might have two undesirable consequences. First, arguing that MASS *are* vessels ‘not under command’ or vessels ‘restricted in their ability to manoeuvre’ may create a negative impact on shipowners as these categorisations may imply that such vessels are inherently unseaworthy.[68] Second, such categorisations would also mean that MASS will enjoy a navigational priority over crewed vessels and this would be in direct contradiction to the generally accepted view that machines should serve humans, not the other way round.

At its 101st session in June 2019, the MSC approved the Interim Guidelines for MASS Trials in order to address safe trials of MASS in the interim period. This is, no doubt, a monumental contribution to regulation of MASS trials in the absence of any other regulations. However, the guidelines raise a number of questions. For instance, it is not entirely clear whether compliance with the Guidelines is mandatory or recommendatory. Interestingly, unlike some other IMO interim guidelines that explicitly state the guidelines are recommendatory,[69] the Interim Guidelines for MASS Trials do not expressly provide such clarification. Hence, Veal argues that the ‘Guidelines’ are, by definition, recommendatory.[70] At first glance, this argument seems plausible especially because of the use of the recommendatory word ‘should’ throughout the Guidelines instead of more binding legal terms such as ‘must’ or ‘shall’. However, it seems that adopting a broader approach to the IMO regulatory framework would suggest otherwise.

Further, a significant study in the literature is the IMO ‘Regulatory Scoping Exercise for the Use of MASS’ which was carried out in two steps. The first step was an initial review of the entire COLREGs by all IMO Member States and the result of the review was submitted to the MSC by the Marshall Islands in August 2019.[71] The report highlights two schools of thought amongst the Member States in respect of necessary amendments to the existing COLREGs. In one camp, some States are of the opinion that instead of amending the existing COLREGs to accommodate MASS, MASS itself should develop so as to comply with the Convention as it stands today.[72] In the other camp, other States raise concerns that the current Convention may need considerable amendments. China,

[68] Robert Veal and Michael Tsimplis, ‘The Integration of Unmanned Ships into the *Lex Maritima*’ [2017] LMCLQ 303, 329.

[69] E.g. IMO Doc MSC.1/Circ. 1526, ‘Interim Guidelines on Maritime Cyber Risk Management’ (1 June 2016) para 2.2.3 – available at <https://www.gard.no/Content/21323229/MSC.1-Circ.1526.pdf> accessed 07 February 2023.

[70] Robert Veal, ‘IMO Guidelines on MASS Trials: Interim Observations’ [2019] 19(8) Lloyd’s Shipping & Trade Law 1, 1.

[71] IMO Doc: ISWG/MASS 1/2/19, ‘Summary of results of the first step of the RSE for the International Regulations for Preventing Collisions at Sea 1972 (COLREG)’ (August 2019).

[72] Ibid para 76.

for instance, argues that sections II and III of the Convention may need to be merged into one section for collision avoidance between MASS Degree 4 vessels (fully autonomous vessels)[73] which would be a fundamental change to the framework of the Convention. The report also emphasised that it would be necessary to establish (through the second step of the Scoping Exercise) whether MASS will require a new set of specific navigation lights.[74] However, the second step of the Scoping Exercise (which was published in February 2020) does not answer this question and concludes that MASS degrees 3 and 4 pose the greatest challenges to the existing COLREGs and these vessels increase the potential need for revision of the Convention.[75] The gap in the literature, therefore, is that it fails to answer normative questions as to how the collision regulations should be amended in light of the emerging autonomous ships technology.

1.4. Thesis Structure and Research Questions

The thesis consists of five chapters. The current (first) chapter includes the background to the research, rationale, research questions, literature review, and methodology. In analysing the relevant international regulations, the research will adopt a top-down approach i.e. from general to specific. Accordingly, the first convention that will be considered is the 'umbrella convention' i.e. the United Nations Convention on the Law of the Sea (UNCLOS), 1982. Although the main focus of the research is on international collision regulations, the first issue that needs to be addressed is the legal status of MASS Degrees 3 and 4 under UNCLOS. This is because UNCLOS entitles certain navigational rights to 'ships' or 'vessels'. For instance, Article 17 of the Convention entitles the right of innocent passage to 'ships' and if remotely-operated and autonomous watercraft do not constitute 'ships' under Article 17, then their innocent passage through the territorial sea may be refused by the relevant coastal State in which case studying international collision regulations may become uncertain or insignificant. Chapter 2 will, therefore, analyse this issue in order to answer the following question:

(1) *Do MASS constitute 'ships' or 'vessels' for the purposes of innocent passage, transit passage, and freedom of navigation on the high seas under UNCLOS?*

Once the legal status of MASS under UNCLOS has been determined, the next step is regulation and/or amendments to the existing collision rules which may be carried out at three levels: convention level, framework level, and rule level. There are currently some

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73 IMO Doc MSC 101/5/2, 'The Initial Review of the Mandatory IMO Instruments Related to Maritime Safety and Security' (2 April 2019) para 6.

74 IMO Doc ISWG/MASS 1/2/19, 'Summary of results of the first step of the RSE for the International Regulations for Preventing Collisions at Sea 1972 (COLREG)' (August 2019) para 82.3.

75 IMO Doc MSC 102/5/3, 'Summary of results of the second step and conclusion of the RSE for the International Regulations for Preventing Collisions at Sea 1972 (COLREG)' (6 February 2020) para 19.

suggestions as to amendments at convention level and framework level. As to convention level, Denmark has suggested that instead of developing fully COLREGs-compliant algorithms, a 'new' set of international regulations should be developed for MASS Degree 4.[76] With regard to framework level amendments, China has proposed that the two collision avoidance regimes of the current COLREGs should be merged into a single regime for MASS Degree 4.[77] Required amendments to COLREGs at both convention level and framework level will be analysed in Chapter 3 which will attempt to answer the following question:

(2) *What amendments to COLREGs at convention level or framework level are required in order to integrate MASS into an international collision avoidance regime?*

Being recognised as 'ships' or 'vessels' under UNCLOS, means that MASS are 'not precluded' by UNCLOS to operate on the high seas. It does not necessarily mean that MASS are unconditionally 'permitted' to do so. This is because UNCLOS is an umbrella convention and many of its provisions set out only the 'general principles' and such general principles can only be effectively implemented through adoption and implementation of other instruments.[78] Presently, such specific MASS-related instruments do not exist. Since some autonomous vessels like the *Mayflower* have already started their trial and/or operation on the high seas and because there is currently no international convention that specifically regulates or prohibits MASS operation on the high seas, Chapter 4 will address the trial and/or operation of MASS in the interim period. In February 2018, the International Federation of Shipmasters' Association (IFSMA) and the International Transport Workers' Federation (ITF) warned that unregulated activities of MASS on the high seas can create risk of collision and that the IMO should firmly establish that MASS Degree 3 and 4 ships are not permitted to operate on the high seas until an appropriate international regulatory framework is adopted and is in force.[79] In

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[76] IMO Doc MSC 99/INF.3, 'Final Report: Analysis of Regulatory Barriers to the use of Autonomous Ships' (2018) para 3.4.1.2.

[77] IMO Doc MSC 101/5/2, 'The Initial Review of the Mandatory IMO Instruments Related to Maritime Safety and Security' (2 April 2019) para 6.

[78] 'Marine Environment from the Conclusion of the United Nations Convention on the Law of the Sea to the World Summit on Sustainable Development' <https://www.un.org/Depts/los/convention_agreements/convention_20years/PresentationG_GoettscheWanli.pdf> accessed 07 February 2023.

[79] IMO Doc MSC 99/5/1, 'Comments and Proposals on the Way Forward for the Regulatory Scoping Exercise' (22 February 2018) para 11 and 20.8 – available at <https://www.itfglobal.org/sites/default/files/node/resources/files/2018%20MSC%2099-5-1%20-%20Comments%20and%20proposals%20on%20the%20way%20forward%20for%20the%20regulatory%20scoping%20exercise%20%28IFSMA%20and%20ITF%29_1.pdf> accessed 07 February 2023.

June 2019, the MSC approved the 'Interim Guidelines for MASS Trials'[80] which is the first ever IMO instrument to address MASS trials. There are, however, a number of questions that are left unanswered. First, as noted above, it is not entirely clear whether compliance with the Guidelines is mandatory or recommendatory. Second, the IMO Guidelines state that MASS should comply with the 'intent' of mandatory instruments.[81] It is not clear whether compliance with the 'intent' of COLREGs (i.e. collision avoidance) is sufficient even if specific rules are violated. Third, it is not clear whether the term 'trial' covers long distances, and whether such trials can take place in any geographical area on the high seas. For example, can a shipowner in the interim period frequently use an autonomous vessel to transport cargo in long international voyages under the pretext of 'trial'? Chapter 4 will attempt to answer the following question:

(3) *With reference to COLREGs, under what circumstances can or should MASS be operated or trialled on the high seas in the interim period?*

Chapter 4 will then go further into specifics of collision avoidance rules in the context of MASS. That is to say, if a new convention should be developed, then the rules of such a new convention should be determined and if the existing convention (with or without a change to its framework) should be preserved, then its rules should be revised and amended as required. For instance, Professor Craig Allen, the author of an essential text on COLREGs, opines that the advent of MASS will require the regulators to provide a 'quantifiable' definition of COLREGs key terms such as close-quarters situation, safe speed, and safe passing distance so that they can be operationalised by programmers and audited by flag States and classification societies.[82] Thus, another research question in Chapter 4 is as follows:

(4) *What amendments to the existing COLREGs at rule level are required to ensure safe operation of MASS and minimise risk of collision?*

Finally, Chapter 5 will consolidate the findings of this thesis and will conclude the research with recommendations. The overall original contribution of this thesis to knowledge is determining the most appropriate way of regulating MASS navigation in order to minimise risk of collision between all types of vessels, particularly between MASS and conventional crewed vessels.

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[80] IMO Doc MSC.1/Circ.1604, 'Interim Guidelines for MASS Trials' (14 June 2019) – available at <https://www.register-iri.com/wp-content/uploads/MSC.1-Circ.1604.pdf> accessed 07 February 2023.

[81] Ibid para 2.2.1.

[82] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) x (Preface to the Ninth Edition).

1.5. Methodology

Methodology is of paramount importance to any research in any discipline because the validity and reliability of research findings will heavily depend on the methodology employed. Methodology is described as the *overall* approach to the research and it should be distinguished from research *methods* which are various specific tools or techniques (e.g. questionnaires and data analysis software) that are used for data collection and data analysis.[83] Put differently, research methods are the tools that put the research methodology into practice. Since the main factor that drives the choice of methodology is the research question, no methodology is inherently better than others; the goal is simply choosing the most effective methodology for the research question at hand.[84] In finding which methodology can best answer the research question, it is necessary to determine what information is required to answer the question. Since the nature of the research question in each chapter of this thesis is different from that of the other chapters, each chapter will require different information and thus, a different methodology may have to be used in different chapters.

Chapter 2 concerns the legal status of MASS Degrees 3 and 4 under UNCLOS, and the authoritative information required to answer this question can only be found in legal texts e.g. in the text of the Convention itself and in the interpretations provided by competent courts such as the International Court of Justice in relevant cases. Thus, the methodology in Chapter 2 has to be doctrinal i.e. a positive analysis aiming at determining what the law is; whether the law is ambiguous or inconsistent; and what amendment(s) may be required to clarify the ambiguities within the law. Since the term 'doctrine' denotes a set of principles that are often established through precedent in the common law, it may be more appropriate to describe the methodology as rule-based or expository in the context of COLREGs that do not contain legal doctrines as such.

Having determined an expository approach as the appropriate methodology for the second chapter, the following research methods will be utilised for data collection and data analysis. First, the point of departure will be identifying relevant provisions in the text of UNCLOS and then analysing them under the Vienna Convention on the Law of Treaties. Second, customary international law is another source of the law that will be analysed. This is because apart from legislation and conventions, legal doctrines are also embedded in customs or international policies[85] and if a question concerning international law is not regulated through a convention or by the Vienna Convention on the Law of

[83] Lisa Chekassky, Julia Cressey *et al.*, *Legal Skills* (Palgrave Macmillan 2011) 94.

[84] John Dayton, *Legal Research, Analysis, and Writing: Everyone's Guide to Finding, Understanding, and Communicating the Law* (Wisdom Builders Press 2020) 3.

[85] P Ishwara Bhat, *Idea and Methods of Legal Research* (OUP 2019) 144ff.

Treaties, then it will be governed by the rules of customary international law.[86] Moreover, a rule that is set out in any convention (e.g. UNCLOS) may become binding on a third State as a customary rule of international law. Therefore, in addition to the text of UNCLOS, established or emerging relevant rules of customary international law will also be analysed to answer the question in Chapter 2. Third, legal data will also be collected from judicial decisions and interpretations of competent courts in relevant cases in order to complement the first and second methods and reach a firm conclusion. The biggest limitation of doctrinal research is that it can be subjective and open to interpretation i.e. different researchers may come to different conclusions as to what the law is and thus, establishing the validity of the findings of doctrinal research can be more difficult than that of other methodologies. Doctrinal legal research is epistemologically very different from research in natural or social sciences in that, while the former is concerned with the discovery of legal doctrines, the latter seeks to explain natural phenomena through studying the causal relationships between variables.[87] As a consequence, while the validity of scientific research is determined by empirical investigations, the validity of doctrinal research is unaffected by the empirical world and must inevitably be established through developing a consensus within the scholastic community rather than through an appeal to any external reality.[88]

Because of the nature of the research questions, the methodology utilised in the rest of the chapters will have to be a combination of expository and theoretical. For instance, Chapter 3 attempts to ascertain whether MASS are permitted to be trialled or operated on the high seas in the interim period under the existing international regulatory framework, and this can only be answered through adopting an expository approach. However, Chapter 3 also aims to determine whether regulations *should* permit MASS trials and/or operations on the high seas in the interim period and if so, under what circumstances. Similarly, the next chapters also aim to determine whether emergence of MASS Degree 4 necessitate any amendments to the existing collision regulations and if so, what those amendments should be. It goes without saying that the data required to answer such normative questions cannot be found in legal texts such as regulations or court judgments. Insights, therefore, have to be incorporated into the research from non-legal sources such as sociology and/or theoretical studies. Socio-legal research is the examination of how the law impacts on those who are touched by the law and the 'socio'

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[86] The Vienna Convention on the Law of Treaties, Preamble.

[87] Paul Chynoweth, 'Legal Research' in: Andrew Knight (ed) and Les Ruddock (ed), *Advanced Research Methods in the Built Environment* (Blackwell Publishing 2008) 30.

[88] Ibid.

in the term socio-legal signifies the societal context.[89] A socio-legal methodology, therefore, is not a possibility simply because autonomous vessels are still in their trial phase and there is no socio-legal data or study available on the effect of the existing COLREGs on seafarers in interacting with autonomous vessels. Put differently, since seafarers do not yet have the experience of interacting with autonomous vessels at sea, the impact of the existing COLREGs on seafarers' work and/or life at sea cannot be studied realistically. Thus, having ruled out a socio-legal methodology, a theoretical methodology is the most effective approach to answer the normative research questions in this thesis.

Evaluation of the law and answering a normative legal question may be carried out in various ways depending on the lens through which the researcher evaluates the law and looks at the question. For example, a particular evaluation of the law that suggests an amendment to collision regulations requiring certain ships to install an expensive piece of equipment, is likely to be welcomed as 'good law' by the manufacturers of that equipment within the shipping industry. The same amendment, however, might be viewed as unnecessary or 'bad law' by some shipowners who would have to put time and money into installing the equipment and bringing their vessels in line with the amendment. Another view may go beyond a purely economic evaluation and assess the law with particular attention to the effect of the additional equipment on navigators who work in already complex navigation bridges. Thus, depending on the viewpoint, the law may be evaluated in many different ways and each evaluation may require its own particular data collection and data analysis, and may result in a different finding. It is clear, therefore, that the researcher has to adopt a particular viewpoint in order to avoid being left with countless potential viewpoints which would make the task of data collection and data analysis extremely difficult, if not impossible. A viewpoint or yardstick by which the law is evaluated is called 'theoretical framework' and without a sound theoretical framework, the researcher will not be able to produce any testable or measurable concepts.[90] However, since 'theoretical' frameworks are more often employed in social science studies that attempt to answer 'explanatory' questions, it has been suggested that it may be more appropriate to use the term 'normative framework' to answer normative legal questions.[91] Since this thesis intends to determine what the law should be rather than explaining why the law is the way it is, it will need a reference point (or a normative framework as referred

[89] Lisa Webley, 'The *Why* and *How to* of Conducting a Socio-legal Empirical Research Project' in: Naomi Creutzfeldt (ed), Marc Mason (ed) and Kirsten McConnachie, *Routledge Handbook of Socio-legal Theory and Methods* (Routledge 2020) 59.

[90] Wing Hong Chui, 'Quantitative Legal Research' in: Mike McConville and Wing Hong Chui, *Research Methods for Law* (2nd edn, Edinburgh University Press 2017) 55.

[91] Sanne Taekema, 'Theoretical and Normative Frameworks for Legal Research: Putting Theory into Practice' (2018) Law and Method 1, 6.

to as by some researchers) to provide a yardstick for evaluating the law. The reference point can also support the findings of the research as to how the law should be amended. It is, therefore, crucial to determine what can serve as a reasonable framework as the validity and reliability of the answers to the normative questions of this research will depend on the framework employed.

In order to find or develop a framework systematically, it is useful to distinguish between internal and external frameworks.[92] 'Internal' refers to standards that are part of the law i.e. principles that are either explicitly stated or implicitly presupposed within a particular area of law.[93] For instance, the long-standing principle of privity of contract can serve as a sound internal framework to evaluate a piece of legislation or to answer a normative question in the context of contract law. 'External', on the other hand, refers to a theory that is not an integral part of the legal system and is employed to provide standards by which the law can be evaluated.[94] For instance, critical race theory may be utilised as an external framework in order to evaluate a new piece of legislation that may adversely affect ethnic minority groups in a country. Since a good law is one that conforms with both internal (legal) values and external (social and political) values, it is reasonable to combine internal and external frameworks in order to provide a comprehensive assessment of the law.[95]

Thus, in order to evaluate the existing COLREGs in the context of MASS and answer the normative questions in this thesis, it is necessary to find or develop sound internal and external frameworks. The choice for an internal framework is rather straightforward. The preamble of COLREGs explicitly cites maintaining 'a high level of *safety* at sea'[96] as the overall aim of the Convention. The standard of 'safety' is an established internal legal principle that can be found in many maritime regulations. For instance, the objectives of the International Safety Management (ISM) Code are ensuring safety of life, safety of environment, and safety of property.[97] In fact, the Convention on the International Maritime Organization indicates that adoption of the highest practicable standards in 'safety' is one of the most important responsibilities of the IMO.[98] Thus, 'safety' is an indispensable internal principle across all international maritime regulations, and can be

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[92] Ibid 7.

[93] Ibid 7ff.

[94] Ibid.

[95] Ibid 9.

[96] Emphasis added.

[97] IMO, *International Safety Management Code and Guidelines on Implementation of the ISM Code* (3rd edn, IMO 2010) para 1.2.1.

[98] Article 1(a).

used as a sound internal framework to evaluate any set of maritime regulations. Accordingly, ‘safety’ will be utilised as an internal framework throughout this research to evaluate the rules of COLREGs in the context of MASS and to determine what amendments to COLREGs may be required, if any. That is to say, any amendments to the existing COLREGs must, before anything else, ensure safety of life, safety of environment, and safety of property. However, COLREGs, like any other set of regulations, cannot be evaluated solely from a safety perspective and in isolation from their relationship with society or morality. Thus, an external framework should also be found or developed to assess the collision rules from a perspective other than pure safety. The question, however, is what can serve as a sound ‘external’ framework? Given that this research attempts to evaluate COLREGs in the context of MASS, and that the introduction of MASS will create novel human-machine interactions at sea, the starting point is that, a reasonable external framework should necessarily be capable of determining and justifying the role of artificial intelligence (AI) in the shipping industry. A sound external framework that can explain human-machine relationship is the instrumentalist view developed by Martin Heidegger in the 1950s. He provides two answers to the question ‘*what* is technology?’: technology is a means to an end; and it is a human activity.[99] Accordingly, he views technology as something ‘instrumental and anthropological’ which is used by humans merely as a means to an end.[100] The corollary of this view is that machines (and MASS for that matter) are merely instruments that are designed and employed by humans to serve their specific interests. It follows that AI should serve humans, and humans in the context of COLREGs and compliance with collision avoidance rules, means ship navigators.

There is a compelling reason as to why the instrumentalist view can serve as a sound external framework to answer the evaluative questions in this thesis. There is an international consensus amongst robotics, law, and ethics experts that AI should be designed, regulated, and implemented for the benefit of humanity. For example, in April 2018, the House of Lords Select Committee on Artificial Intelligence published a report in which it stated that artificial intelligence should be developed ‘for the common good and benefit of humanity.’[101] The Institute of Electrical and Electronics Engineers (IEEE) also published a collaborative work in 2019 in which it suggested that AI should be designed and operated in a way that ‘benefits humans’.[102] A study prepared for the European

[99] Martin Heidegger, ‘The Question Concerning Technology’ (1977) Environmental Ethics 1, 1.

[100] Ibid.

[101] The House of Lords Select Committee on Artificial Intelligence, ‘AI in the UK: Ready, Willing and Able?’ (2018) <https://publications.parliament.uk/pa/ld201719/ldselect/ldai/100/100.pdf> accessed 07 February 2023.

[102] IEEE, ‘Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems’ (2019) page 19 – available at <https://standards.ieee.org/content/dam/ieee-

Parliament also expressed the same view in 2020.[103] In the same year, another set of guidelines prepared by an independent expert group on AI which was set up by the European Commission, also stressed that AI should be used to 'benefit all human beings'.[104] When viewed collectively, these studies and guidelines indicate a widespread support for the instrumentalist view that AI should be developed and regulated in a way that serves humans and thus this view can be considered as an external value against which AI-related regulations can be assessed. Thus, in addition to safety as the internal (legal) value, the instrumentalist view will also be used as an external (societal) value to answer the normative questions in this thesis.

The following methods will be used to put the theoretical methodology into practice. Data regarding safety issues will be collected from secondary sources especially reports published by the UK Marine Accident Investigation Branch (MAIB) and by protection and indemnity (P&I) clubs which constitute the International Group of P&I Clubs and. The MAIB investigates marine accidents involving UK-registered vessels worldwide and all vessels in the UK territorial waters.[105] The P&I clubs provide liability cover for about 90% of the world's ocean-going ships[106] which means they cover a wide range of different ships registered in different States and operated by different companies and seafarers of different nationalities. This data, therefore, will provide a comprehensive picture of safety issues involving various vessels across the world with a particular attention to UK-flagged vessels. The data will then be analysed in light of the latest MASS technology in order to determine how the safety issues may be addressed through amendments to the collision regulations. Where the safety of navigation is ensured (internal standard) and there is a possibility to confer a navigational privilege on a vessel, the privilege should be conferred on conventional vessels rather than MASS (external standard).

In sum, doctrinal (expository) methodology will be utilised throughout this thesis to interpret provisions of COLREGs and propose amendments where the rules are

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standards/standards/web/documents/other/ead1e.pdf?utm_medium=undefined&utm_source=undefined&utm_campaign=undefined&utm_content=undefined&utm_term=undefined> accessed 07 February 2023.

103 Eleanor Bird *et al*., 'The Ethics of Artificial Intelligence: Issues and Initiatives' (2020) Scientific Foresight Unit, European Parliamentary Research Service 1, 45 – available at <https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf> accessed 07 February 2023.

104 The High-Level Expert Group on AI, 'Assessment List for Trustworthy Artificial Intelligence' (2020) – available at <https://ec.europa.eu/digital-single-market/en/news/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment> accessed 07 February 2023.

105 'About us' (*MAIB*) <https://www.gov.uk/government/organisations/marine-accident-investigation-branch/about> accessed 07 February 2023.

106 'About the International Group', (*International Group of P&I Clubs*) <https://www.igpandi.org/about> accessed 07 February 2023.

ambiguous or inconsistent in the context of MASS. The methods associated with this methodology include analysis of the text of the rules and their interpretation by the courts. In addition, theoretical methodology will also be employed to evaluate the rules, identify potential gaps or issues in the rules, and determine a set of principles upon which a modern version of COLREGs should be based. The methods that will put the theoretical methodology into practice are the use of internal and external frameworks as two yardsticks against which the internal and external effectiveness of the law will be assessed. The internal framework is safety and the external framework is the instrumentalist view. The combined effect of the application of these two frameworks to AI-related maritime regulations is that any amendment to such regulations should ensure two values: safety of all shipping operations, and putting humans before machines.

Chapter 2: Legal Status of MASS under UNCLOS

2.1. Scope and Objectives

Since the principal object of all maritime and admiralty law is 'the ship',[107] it is crucial to determine whether a watercraft with no crew on board can be regarded as a 'ship'. Given that many international maritime conventions including COLREGs make reference to 'ship' or 'vessel', in order to make autonomous shipping a reality, the legal status of MASS needs to be resolved first. Whether a MASS constitutes a 'ship' within the meaning of international maritime conventions will ultimately depend on the watercraft and the convention in question. Although the focus of this research is on COLREGs, the first and foremost international convention that should be considered is UNCLOS. This is because UNCLOS is the international convention that entitles ships to key navigational rights such as freedom of navigation on the high seas, transit passage and innocent passage through the territorial waters of other States. These navigational rights are pivotal to international shipping. If MASS do not constitute 'ships' under UNCLOS and if as a consequence they are not entitled to use the high seas or territorial waters of other States, then studying the application of any 'international' maritime convention (including COLREGs) to MASS would not be possible. In fact, UNCLOS is a framework or umbrella convention that sets out 'general principles which can only be effectively implemented following the adoption and implementation of other instruments'.[108] Therefore, once the first issue i.e. the legal status of MASS under UNCLOS has been addressed, attention can be then focused on specific conventions (in this case, COLREGs) that come under the umbrella Convention.

In analysing the legal status of MASS, a doctrinal methodology will be used. For the sake of comprehensiveness of the analysis, the following methods will be adopted to put the doctrinal methodology into practice and to look at the issue from different angles:

(1) national law interpretation approach
(2) treaty interpretation approach
(3) evolutionary interpretation approach
(4) comparison with the aviation industry
(5) customary international law approach

The objectives of this chapter, therefore, are to determine whether MASS may be classified as 'ships' under UNCLOS and regardless of the outcome, whether they can

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[107] William Tetley, *International Maritime and Admiralty Law* (International Shipping Publication 2002) 33.

[108] 'Marine Environment from the Conclusion of the United Nations Convention on the Law of the Sea to the World Summit on Sustainable Development' <https://www.un.org/Depts/los/convention_agreements/convention_20years/PresentationG_GoettscheWanli.pdf> accessed 07 February 2023.

enjoy any of the navigational rights that are authorised by UNCLOS to 'ships'. This chapter will also attempt to determine the maritime zones in which MASS can lawfully operate. The scope of this chapter will cover all types of civilian and military MASS – from small underwater research craft to large surface watercraft used for cargo transportation. Since the legal status of MASS is yet to be determined, the general word 'watercraft' will be used instead of 'ship' or 'vessel' in order to avoid causing any confusion.

2.2. Importance of the Legal Meaning of 'Ship' or 'Vessel'

At first sight, the discussion of what legally constitutes a 'ship' may seem trivial and of little or no practical importance as recognising a ship may seem rather straightforward. However, this would be true if the seas were still navigated by conventional ships only. Today, with many different types of floating craft such as dumb barges, hovercrafts, jet skis, submarines, amphibious craft, maritime drones and jack-up drilling rigs with various shapes and applications, determining whether a given structure is a 'ship' for legal or regulatory purposes can be challenging. Examples include a raft made of timbers lashed together and a large conventional 'ship' which is now used as a 'floatel'. The legal meaning of 'ship' may indeed be difficult to determine, but the following sections will discuss why the question is important.

2.2.1. International Importance

If a maritime object is not a 'ship', then it might not be entitled to enjoy the navigational rights such as freedom of navigation on the high seas,[109] innocent passage[110] and transit passage[111] which are granted by UNCLOS to 'ships'. As a result, the question arises as to whether a coastal State may deny the rights of innocent and/or transit passage for a MASS on the grounds that the watercraft does not constitute a 'ship'. Such uncertainties about the legal status of MASS in different maritime zones would at the very least interrupt international trade.

As another example, in December 2016, the Chinese Navy seized a US Navy Unmanned Underwater Vehicle (UUV) about 50 nautical miles northwest of Subic Bay in the South China Sea. The UUV was captured when it had come to the surface after completing a military oceanographic survey. The US contended that the UUV was a sovereign immune 'vessel' entitled to the freedom of navigation under international law[112] whereas China

[109] UNCLOS, Article 87(1)(a).

[110] UNCLOS, Article 17.

[111] UNCLOS, Article 38(1).

[112] 'Statement by Pentagon Press Secretary Peter Cook on Return of U.S. Navy UUV' (*US Dep of Defense*, 19 December 2016)

asserted that it was an ‘unidentifiable device’ with no such rights.[113] Ambiguities surrounding the legal status of MASS, therefore, pose a threat to peace and order at sea and can cause conflicts between countries.

The meaning of the term ‘ship’ becomes important in international oil and gas contracts too. Floating production storage and offloading (FPSO) units are specialised vessels which are used by the offshore oil and gas industry for storage and/or processing of hydrocarbons.[114] The similarities between these units and oil tankers and the fact that FPSO units are frequently converted oil tankers, raise the question as to whether they are legally ‘ships’. The importance of this question lies in the fact that as offshore drilling operations increase and move into deep waters, catastrophic oil pollution accidents are occurring more frequently and pose a significant risk to the environment and human health.[115] Where an accident involving an FPSO unit causes oil pollution, personal injury, death, or damage to property, being regarded as a ‘ship’ will entitle the owners of the FPSO to limit their liability under the relevant conventions i.e. the Convention on Limitation of Liability for Maritime Claims (LLMC) and the International Convention on Civil Liability for Oil Pollution Damage (CLC). However, LLMC does not define the term ‘ship’ and CLC’s definition of ‘ship’ given in Article I(1) is so complex that it poses some fundamental questions in the context of FPSO units.[116] Because of environmental and financial concerns, nearly every party involved in an FPSO project (especially the vessel’s owners, operators, governments, financiers and insurers) will want to know whether or not limitation of liability under LLMC and CLC will be available in the event of future third-party claims relating to the operation of the FPSO.[117] Without the right to limit their liability, some of those parties may face staggering sums of third-party liabilities, so the question is whether FPSOs can be treated as ‘ships’ and thereby entitling those parties to limit

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<https://www.defense.gov/Newsroom/Releases/Release/Article/1034224/statement-by-pentagon-press-secretary-peter-cook-on-return-of-us-navy-uuv/> accessed 07 February 2023.

[113] ‘China Gives America its Underwater Drone Back – with a Warning’ (*The Register*, 20 December 2016) <https://www.theregister.co.uk/2016/12/20/china_returns_us_drone/> accessed 07 February 2023.

[114] ‘Floating Production Storage and Offloading’ <https://en.wikipedia.org/wiki/Floating_production_storage_and_offloading> accessed 07 February 2023.

[115] Yuan Yang, ‘Liability and Compensation for Oil Spill Accidents’ (2017) 57(2) Natural Resources Journal 465, 467ff.

[116] The Article provides:

> “Ship” means any sea-going vessel and sea-borne craft of any type whatsoever constructed or adapted for the carriage of oil in bulk as cargo, provided that a ship capable of carrying oil and other cargoes shall be regarded as a ship only when it is actually carrying oil in bulk as cargo and during any voyage following such carriage unless it is proved that it has no residues of such carriage in bulk aboard.

[117] ‘The Legal and Regulatory Treatment of FPSOs, with a Focus on Limitation of Liability’ <http://www.hfw.com/Legal-and-regulatory-treatment> accessed 07 February 2023.

liability under LLMC and CLC. Currently, there is no clear legal guidance[118] and the lack of clarity on what legally constitutes a 'vessel' or a 'ship' under certain international conventions can raise political and regulatory issues as well as uncertainty in international oil and gas contracts.

2.2.2. National Importance

In addition to the international importance, the meaning of the term 'ship' may also have national importance under different domestic laws. For example, under UK law, apportionment of liability in collision cases is determined under section 187 of the 1995 Merchant Shipping Act (MSA) which provides:

> Where, by the fault of two or more *ships*, damage or loss is caused to one or more of those *ships*, or their cargoes or freight, or to any property on board, the liability to make good the damage or loss shall be in proportion to the degree in which each *ship* was at fault.[119]

It follows that the provision applies only if a collision occurs between two or more 'ships'. If one of the structures involved in a collision was not a 'ship', then principles of common law would apply instead of section 187 of the MSA.[120]

Ambiguity as to what constitutes a ship under national laws can also impact on safety. For instance, pursuant to section 95 of the 1995 MSA, a dangerously unsafe watercraft in a UK port or at sea in UK waters can be detained if the watercraft is a 'ship'. In the absence of certainty on whether a given crewless waterborne structure is a 'ship' and therefore detainable, dangerously unsafe structures pose a threat to the environment, to individuals and to vessels in UK waters. This raises the question whether MASS are 'ships' under UK law and therefore detainable. This issue will be analysed in due course. Furthermore, determining whether a subject matter will fall under the jurisdiction of the Admiralty Court will also depend on whether the structure which was involved in the incident and gave rise to the cause of action was a 'ship'.[121] The upshot, therefore, is that it is essential to establish whether MASS legally constitute 'ships' or, as the case may be, 'vessels' under international and national laws. The following sections attempt to determine the legal status of MASS under international and national laws.

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[118] Sharmini Murugason, 'Definition of a ship – applicability of CLC 1992 and Fund Convention 1992 and 1976 LLMC to FPSO and FSU' <https://www.standard-club.com/media/1557823/definition-of-a-ship.pdf> accessed 07 February 2023.

[119] Emphasis added.

[120] Alexandra Mandaraka-Sheppard, *Modern Maritime Law and Risk Management* (2nd edn, Informa 2009) para 8.1.

[121] Ibid.

2.3. Legal Status of MASS under International Law

About four decades ago, there was no generally accepted definition of 'ship' under international law[122] and the current *status quo* seems no different. Consequently, it is not straightforward to determine whether MASS collectively or even any given MASS falls under the international legal framework applicable to ships.[123] Therefore, a maritime object that does not look like a conventional ship may still qualify as a 'ship' under certain international conventions. As mentioned above, the most important convention in this regard is UNCLOS and the initial issue regarding the legal status of MASS under UNCLOS is that the Convention does not define the term 'ship'. Accordingly, it has been suggested that various shipping conventions may be examined to reach a common understanding with regard to key elements of a 'ship' in international law.[124] Describing definition of 'ship' as a conundrum of international maritime law,[125] Gahlen argues that there are four core criteria that can be used to shape a uniform understanding of what constitutes a 'ship':

a) ability to float;
b) ability to be used in controlled movement on water;
c) ability to carry goods or persons beyond its own mass; and
d) capacity to go to sea as opposed to navigating in rivers or inland waters.[126]

A large MASS would, *prima facie*, meet all these criteria. Under the third criterion, however, a small MASS which is used for research purposes and unable to carry persons or goods would not constitute ships. MASS have been in use for several decades but because of their relatively small size and limited operational usage, they have not attracted much attention.[127] However, with the rapid development of autonomous vessels technology, it is not hard to envisage MASS growing in size and usage in the near future. MASS that are used for research are, therefore, desirable to be recognised as 'vessels' under international law so that they can carry out research which will benefit the international community. As a solution, it has been argued that MASS which are used for

122 DP O'Connell, *The International Law of the Sea*, Vol II (OUP 1984) 747ff.

123 Robert Veal, Michael Tsimplis and Andrew Serdy, 'The Legal Status and Operation of Unmanned Maritime Vehicles' (2019) 50 Ocean Development & International Law 23, 26.

124 Katharina Bork, Johannes Karstensen, Martin Visbeck and Andreas Zimmermann, 'The Legal Regulation of Floats and Gliders — In Quest of a New Regime?' (2008) 39(3) Ocean Development & International Law 298, 307.

125 Sarah Fiona Gahlen, 'Ships Revisited: A Comparative Study' (2014) 20(4) JIML 252, 252.

126 Ibid 269.

127 Robert Veal, 'Unmanned Ships and Their International Regulation' [2016] 9 Lloyd's Shipping & Trade Law 1, 1.

marine surveys and data retrieval activities, carry a modern form of 'electronic cargo'.[128] In other words, the data they retrieve is sourced from one place, stored on board the craft and then transported to the place of recovery.[129] Nevertheless, it is submitted that not being able to carry goods or persons does not, *per se*, preclude a MASS from being regarded as a ship or vessel. This is because various conventions give varying radii to the sphere of the definition of 'ship' and carriage capability is not always a necessary characteristic. As a result, what constitutes a 'ship' can significantly vary from convention to convention and thus, a given MASS may be a 'ship' under one convention but not under another. In fact, within the multilateral conventions there are over 30 definitions of ship and vessel with varying ambits.[130] The ambit of definition of ship under some conventions is very exclusive. For example, Article I(1) of the CLC Convention provides:

> "Ship" means any sea-going vessel and sea-borne craft of any type whatsoever constructed or adapted for the *carriage of oil in bulk as cargo*, provided that a ship capable of carrying oil and other cargoes shall be regarded as a ship only when it is *actually carrying oil in bulk as cargo* and during any voyage following such carriage unless it is proved that it has no residues of such carriage in bulk aboard.[131]

Therefore, for the purposes of the CLC Convention, even a huge container vessel is not a 'ship' let alone a small MASS not capable of carrying anything. This is because based on this definition, only oil tankers can be considered as ships and even then, not all oil tankers can be ships. An oil tanker may be considered as a 'ship' only when it is 'actually carrying oil in bulk as cargo'.

On the other hand, other conventions adopt a very broad and inclusive definition. For instance, Article 2(4) in the first chapter of the International Convention for the Prevention of Pollution from Ships (MARPOL) 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.' Under the broad ambit of this definition, almost no maritime object can escape from the reach of the definition of 'ship'; not even 'fixed platforms' let alone MASS which are designed for carriage of cargo and are generally ship-like structures. It goes without saying that the rationale behind such an inclusive definition is to ensure protection of the environment, This definition, therefore, does not make a fixed platform or a MASS a 'ship' for the purposes of any convention

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[128] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 308 (footnote 23).

[129] Ibid.

[130] John AC Cartner, Richard P Fiske and Tara L Leiter, *The International Law of the Shipmaster* (Informa Law 2009) para 6.1.3.

[131] Emphasis added.

other than MARPOL. In fact, as Tetley has pointed out, it is not surprising that the legal definition of 'ship' under international maritime law significantly varies in scope because the definition is 'very much a function of the subject matter concerned'.[132]

Returning to the convention in question (UNCLOS), the lack of definition of 'ship' in the Convention provides some regulatory flexibility. The downside, though, is that it is not clear who decides when and how the definition should be adapted for new situations, and if it is to be decided by the rules of customary international law, the required 'state practice' may introduce long delays in such adaptations.[133] As a result, it has been suggested that the better view is to assume that it is left to each State to decide whether a given watercraft is a 'ship' under its national laws.[134] Article 91(1) of UNCLOS obliges every State to 'fix the conditions for the grant of its nationality to *ships*, for the registration of *ships* in its territory, and for the right to fly its flag.'[135] Hence, States have exclusive power and discretion as to whether or not to grant their nationality to a watercraft as a 'ship'. As a result, a State may refuse to register a watercraft on the basis that it does not consider that watercraft to be a 'ship'. Since the rules of ship registration are laid down by national laws of each State, the foregoing argument means that the question whether or not a given watercraft is a ship, may be answered by each individual flag State under its own national laws. The question then becomes: what is meant by 'ship' under national laws?

2.4. National Law Interpretation Approach

Section 313(1) of the UK Merchant Shipping Act (1995) provides: '"ship" includes every description of vessel used in navigation'. It follows that, to be a ship, a given watercraft must be a 'vessel' and it also must be used in 'navigation'. The first limb of the definition concerns the 'physical appearance' of the watercraft in question i.e. it must be a 'vessel'. That is to say, it must resemble a container or receptacle that can hold goods or people. In *Steedman v Scofield*,[136] where the court had to decide whether a jet ski was a 'ship', Sheen J stated: 'the word "boat" conveys the concept of a structure… which by reason of its *concave shape* provides buoyancy for the carriage of persons or goods… A person cannot sit in a jet ski, which is stopped in the water, as he can in a boat.' He also said that 'a vessel is usually a *hollow receptacle for carrying goods or people*. In common parlance "vessel" is a word used to refer to craft larger than rowing boats and it includes every

[132] William Tetley, *International Maritime and Admiralty Law* (International Shipping Publication 2002) 35.

[133] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 309.

[134] Ibid.

[135] Emphasis added.

[136] [1992] 2 Lloyd's Rep 163, 165 (emphasis added).

description of watercraft used or capable of being used as a means of transportation on water.'[137] However, as will be noted below, in a more recent case,[138] the Court of Appeal held that the capability to convey persons or cargo is not an essential characteristic so long as 'navigation' is a significant part of the function of the craft. The physical appearance and carriage capacity of MASS is, therefore, unlikely to push them outside the definition of 'ship' under English law.

The second limb of the definition, which is more important than the first limb, requires that the watercraft in question must be used 'in navigation'. According to Sheen J in *Steedman v Scofield*, '[n]avigation is planned or ordered movement from one place to another. A jet ski is capable of movement on water at very high speed under its own power, but its purpose is not to go from one place to another.' This view was upheld in *R v Goodwin*[139] where the Court of Appeal interpreted the words 'vessel used in navigation' as vessels which are 'used to make ordered progression over the water from one place to another' and excluded watercraft that are 'simply used for having fun on the water without the object of going anywhere'.[140] This view, with respect, seems questionable because there are many large pleasure boats which are exclusively used for recreational purposes and roam the coastal waters without any plan of going anywhere and yet, they hardly fall outside the meaning of ship. However, since the House of Lords dismissed the appeal, currently the Court of Appeal's decision represents the law in England and Wales.[141] Thus, the 'navigation' characteristic of a watercraft is the key to determining whether or not it is a ship under English law. In *The Gas Float Whitton (No 2)*,[142] a crewless lightship which was shaped like a boat, was held not to be a ship within the meaning of MSA and therefore, not a proper subject of maritime salvage. This was because the lightship could not be navigated or towed; it was simply moored in tidal waters to give light to vessels. Lord Herschell said: '[i]t was not constructed for the purpose of being navigated or of conveying cargo or passengers. It was, in truth, a lighted buoy or beacon. The suggestion that the gas stored in the float can be regarded as cargo carried by it is more ingenious than sound.' [143]

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137 Ibid (emphasis added).

138 *Perks v Clark* [2001] EWCA Civ 1228; [2001] 2 Lloyd's Rep 431.

139 [2006] 1 Lloyd's Rep 432.

140 Ibid [33].

141 Sarah Derrington and James Turner, *The Law and Practice of Admiralty Matters* (2nd edn, OUP 2016) para 2.69.

142 [1897] AC 337.

143 Ibid 343.

The decision of the Court of Appeal in *Perks v Clark*,[144] where a jack-up oil rig was held to be a ship, reflects a more inclusive approach towards definition of ship. Although the oil rig was a mobile rig capable of being towed from place to place, its real work was its 'stationary' drilling function with its legs resting on the seabed. The critical question, therefore, was whether the oil rig was 'used in navigation'. The Court stated that:

> [S]o long as "navigation" is a significant part of the function of the structure in question, the mere fact that it is incidental to some more specialized function, such as dredging or the provision of accommodation, does not take it outside the definition…"navigation" does not necessarily connote anything more than "movement across water"; the function of conveying persons and cargo from place to place…is not an essential characteristic.[145]

In the context of MASS, the question is, therefore, whether presence of a crew on board is a prerequisite to 'navigation'. Under English law, some crewless barges have been held to be 'ships'. In the case of *The Mudlark*,[146] a crewless hopper barge while moored in harbour broke adrift and caused serious damage to a moored ship and the quay wall. The barge had no means of self-propulsion and was simply used for carrying away and discharging the mud from a dredger. The Admiralty Court held that the barge was a 'ship' within the meaning of the 1894 Merchant Shipping Act, and thus, her owners were entitled to limit their liability for the damage caused by the barge. This may imply that, under English law crewless vessels are 'ships'. It should be noted, however, that in such 'unmanned barge' cases over the past decades, the term 'unmanned' simply meant the barge was navigated by seafarers who were on board another vessel, for example, on board a tug that towed the crewless barge. In the contemporary context, on the other hand, 'unmanned' means there are no seafarers involved in the direct navigation or towage of the watercraft. Such cases, therefore, provide little guidance as to whether 'unmanned' watercraft in the contemporary context can be categorised as ships under English law. Nonetheless, English case law does not preclude such categorisation either. In other words, English case law does not present any direct barrier to integrating MASS into the English law as 'ships'. In fact, the UK Ship Register signed up its first ever MASS, *C-Worker 7*, to the UK flag in November 2017.[147] By registering *C-Worker 7* which is a small autonomous vessel capable of being used for subsea positioning, surveying and

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144 [2001] EWCA Civ 1228; [2001] 2 Lloyd's Rep 431.

145 [2001] 2 Lloyd's Rep 431 [42].

146 [1922] P 116.

147 'UKSR Signs First Autonomous Vessel to UK Flag' (*ASV Global*, 13 November 2017) <https://www.asvglobal.com/uksr-signs-first-autonomous-vessel-uk-flag/> accessed 07 February 2023.

environmental monitoring, the UK Ship Register is 'hoping to keep the UK at the forefront of the global maritime industry.'[148]

The situation, however, is not quite the same under some other national jurisdictions. Veal and Tsimplis wrote in 2017 that the only national definition of ship that *might* serve to exclude MASS may be found in Article L. 5000-2 of the French Transport Code.[149] An English translation of the Article in an academic context reads:[150]

> Except as indicated to the contrary, for the purposes of the present Code ships are:
> 1) Any floating craft, built and manned for maritime merchant navigation, or for fishing, or for yachting, and dedicated to it.
> 2) Any floating craft, built and manned for maritime navigation, dedicated to administrative or industrial and commercial public services.[151]

The difficulty is presented by the equivocal French word 'équipé' which may refer to 'équipement' as in 'equipment' necessary to conduct the voyage safely, or 'équipage' which means 'crew'. While both interpretations have academic support, no case law supports either of them.[152] The ambiguity, though, was to some extent clarified in the following years. In 2015, the CMI established an International Working Group for Maritime Law and Unmanned Craft to identify the legal issues in integration of MASS into the legal and regulatory framework of the international regulations governing shipping.[153] In March 2017, the CMI Working Group produced and circulated a questionnaire among the 52 National Maritime Law Associations which are members of the CMI, and in February 2018, it received a total of 19 responses to the questionnaire.[154] The questionnaire focused on how national laws will respond to operation of MASS Degrees 3 and 4 ships

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[148] Ibid.

[149] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 311.

[150] Robert Veal, Michael Tsimplis, Andrew Serdy, Alexandros Ntovas and Simon Quinn, 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 34ff (available from Paul O'Brien of the European Defence Agency at paul.obrien@eda.europa.eu).

[151] The French text can be found at 'Code Des Transports' <http://codes.droit.org/CodV3/transports.pdf> accessed 07 February 2023.

[152] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 311.

[153] IMO Doc MSC/99, 'Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships' (13 February 2018) <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Submission-to-MSC-99.pdf> accessed 07 February 2023.

[154] Ibid para 3.

in the context, *inter alia*, of UNCLOS, COLREGS and the STCW Convention.[155] The first question of the questionnaire reads:

> 1.1. Would a "cargo ship" in excess of 500 grt, without a master or crew on board, which is either
>
> 1.1.1 controlled remotely by radio communication; [or]
>
> 1.1.2 Controlled autonomously by, *inter alia*, a computerized collision avoidance system,
>
> without any human supervision, constitute a "ship" under your national merchant shipping
>
> law?

Seventeen Maritime Law Associations answered that a MASS Degree 3 or 4 cargo ship would, or most likely would constitute a ship under their national law. The response of the French Maritime Law Association to above question was as follows:

> Under French law, the definition of the ship is given by Article L. 5000-2 of the French Transport Code: "Any floating craft built, equipped or assigned to commercial, fishing or pleasure craft (...) or engaged in administrative, industrial or commercial public services".[156]

The French Maritime Law Association, therefore, construed the word 'équipé' to mean 'équipement' i.e. 'equipment' and stated that presence of a crew is not a necessary prerequisite to 'ship' status under French law. However, since this statement is not legally authoritative, it is still uncertain whether a French court would hold a MASS Degree 3 or 4 to be a ship under Article L. 5000-2 of the French Transport Code. Furthermore, the French Maritime Law Association also stated that there are three criteria for a watercraft to be regarded as a 'ship' under most French doctrines:

1) It must be a floating craft;
2) It must be equipped with a means of propulsion; and
3) It must be able to face the perils of the sea.

It follows that a watercraft which is unseaworthy cannot be a 'ship' under French law. Since French law does not explicitly state that in order for a watercraft to be seaworthy it must be crewed, if a crewless floating craft that has a means of propulsion and is able to face the perils of the sea, then it will most likely be a ship under French law. Under some

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[155] The full name of the STCW Convention is 'International Convention on Standards of Training, Certification and Watchkeeping for Seafarers'.

[156] 'Replies of French Maritime Law Association to the Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-FRANCE.pdf> accessed 07 February 2023.

jurisdictions, however, presence of a crew on board is a necessary prerequisite to seaworthiness. For example, in response to the CMI questionnaire, the Croatian Maritime Law Association stated that MASS Degree 3 or 4 would not constitute 'ships' under Croatian law because their Maritime Code 'determines that a ship is deemed seaworthy provided that she, among other things, satisfies the minimal qualified crew requirement.'[157] This answer implies that even if MASS Degree 3 or 4 do constitute 'ships' under Croatian law, they cannot be registered or operated since they are unseaworthy. The answer of Panama to the question is equivocal. On the one hand, it states that the answer to the question is 'yes'. On the other hand, it goes on to say that although the definition of 'vessel' under Panamanian law is broad enough to give full leeway to the Administration (Maritime Authority of Panama) to define what a vessel is, based on some informal inquiries that the Panamanian Maritime Law Association made with the Administration, 'it is not clear at all whether unmanned ships will be considered "vessels" in legal terms'.[158] Australia stated that while a MASS Degree 3 ship controlled remotely may constitute a 'vessel' for the purposes of Australian law, 'it is somewhat less likely that a wholly autonomous vessel would do so.'[159]

Thus, taking into account that only 19 countries responded to the questionnaire, it is likely that MASS Degree 3 or 4 would not be classified as 'ships' under a few jurisdictions. It should also be noted that the subject matter of the questionnaire was MASS Degree 3 or 4 'cargo' ships and the responses of the countries were accordingly based on the assumption that the MASS Degree 3 or 4 ship is capable of carrying goods. Taking into consideration those MASS Degree 3 or 4 watercraft which are used for purposes other than conveyance of goods or persons, e.g. for research purposes, the number of national jurisdictions under which these MASS Degree 3 or 4 watercraft would not constitute 'ships' will increase. For example, under Brazilian Law a ship is 'any construction, including floating platforms and, when towed, fixed, subject to registration in the maritime authority and susceptible of moving in water, by their own means or not, *carrying people or cargo*'.[160] Along the same lines, German case law understands a ship to be 'a floating

[157] 'CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-CROATIA.pdf> accessed 07 February 2023.

[158] 'CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-PANAMA.pdf> accessed 07 February 2023.

[159] 'CMI Questionnaire on unmanned ships Australia' <https://comitemaritime.org/wp-content/uploads/2018/05/Australia.docx> accessed 07 February 2023.

[160] 'Reply by the Brazilian Maritime Law Association ("ABDM") to the CMI Questionnaire of March 2017 on the Study Relating to Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-BRAZIL.pdf> accessed 07 February 2023 (emphasis added).

hollow body able and designated to *carry persons or objects* on or under water'.[161] The term 'ship' or 'vessel' under US law includes 'every description of watercraft or other artificial contrivance, except aircraft, *used or capable of being used as a means of transportation on water*, whether or not it is actually afloat.'[162] In Greek law, according to Article 1 of the Code of Public Maritime Law, a 'ship' is 'any craft intended to move at sea for the purposes of *carriage of persons or goods*, towage, salvage, fishing, pleasure, scientific or other purposes.'[163]

Furthermore, in some jurisdictions the 'size' of the watercraft is also material to its legal status. For example, in German law, while there is no legislative definition of 'ship', case law suggests that a ship is 'every vehicle of *more than insignificant size*, capable of floating and provided with a hollow, the purpose of which is to be moved on water'.[164] It follows that under German law, small MASS Degree 3 or 4 may not constitute 'ships'. In Greek law, in addition to 'ship' mentioned above, the term 'vessel' is also used and is defined by Article 1 of the Code of Private Maritime Law as 'any craft of *at least 10 net registered tones* intended to navigate at sea by its own means of propulsion.'[165] Spanish law defines a ship as 'any vehicle with structure and capacity to navigate the sea and to transport people or things, with a running deck and a length equal to or greater than twenty-four metres.'[166] A watercraft less than 24 metres in length and with no running deck is categorised as a 'vessel' rather than a 'ship'.[167] Whether there is any meaningful distinction between 'ship' and 'vessel' under UNCLOS will be investigated in due course.

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[161] 'CMI IWG Questionnaire "Unmanned Ships" — DVIS response' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-GERMANY.pdf> accessed 07 February 2023 (emphasis added).

[162] 'Response of MLA to CMI Questionnaire Re Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-US.pdf> accessed 07 February 2023 (emphasis added).

[163] 'CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-QUESTIONNAIRE-ON-UNMANNED-SHIPS-Greece.pdf> accessed 07 February 2023 (emphasis added).

[164] Sarah Fiona Gahlen, 'Ships Revisited: A Comparative Study' (2014) 20(4) JIML 252, 254 (emphasis added).

[165] 'CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-QUESTIONNAIRE-ON-UNMANNED-SHIPS-Greece.pdf> accessed 07 February 2023 (emphasis added).

[166] 'CMI IWG Questionnaire Unmanned Ships — AEDM Response' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-SPAIN.pdf> accessed 07 February 2023 (emphasis added).

[167] Ibid.

It would appear, therefore, that MASS, collectively, may not constitute ships under a few jurisdictions, and those which are too small or lack carriage capacity may not be considered as ships in several jurisdictions. Even in States where MASS would legally be considered as 'ships', some States may still have reservations or face legal barriers about 'registering' such MASS as 'ships'. The second question of the questionnaire asked:

> 1.2. Would an unmanned ship face difficulty under your national law in registering as such on account of its unmanned orientation?

The Argentinian Maritime Law Association (MLA) responded that under national laws of Argentina, MASS would constitute 'ships' and that there are no rules regarding the registration of MASS.[168] However, it also added that on-board presence of a crew is absolutely necessary for a ship to be considered seaworthy and thus, 'unmanned ships would not be registered by the National Registry of Ships'.[169] The response also stated that since Argentinian maritime authorities usually follow IMO regulations regarding vessels' safety, new national regulations would seem unlikely to be enacted 'without a previous IMO input'. Brazilian, Croatian, Maltese and Spanish MLAs also replied in the same way and stated that shipowners would not be able to register MASS under their national flag.[170]

In light of the above, it would appear that resolving the issue of the legal status of MASS by recourse to domestic laws of each individual flag State is not free from problems. First, this approach may lead to a confused situation where a given MASS is recognised as a 'ship' by one State but not by another, and this is a threat to peace and order at sea as was previously seen in the case of the China/US incident. Giving weight and currency to such a view and the absence of clarification on ship status of MASS under UNCLOS, may be seen by a coastal State as a licence to deny the navigational rights of MASS through its territorial waters on the basis that such craft are not 'ships' within the meaning of UNCLOS.

Second, the 1952 Arrest Convention does not define a ship but Article 4 of the Convention states that 'a ship may only be arrested under the authority of a Court or of the appropriate judicial authority of the contracting State in which the arrest is made'. Under Article 6 of the same Convention, the 'rules of procedure relating to the arrest of a ship, to the application for obtaining the authority referred to in Article 4, and to all matters of

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[168] 'Argentine Maritime Law Association Response to the CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-ARGENTINA.pdf> accessed 07 February 2023.

[169] Ibid.

[170] 'CMI Questionnaire' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-MALTA.pdf> accessed 07 February 2023.

procedure which the arrest may entail, *shall be governed by the law of the Contracting State in which the arrest was made or applied for*.'[171] This means all matters regarding the arrest of a ship are governed by the law of the State in which the arrest was made or applied for. Again, if the ship status issue of MASS is not resolved by recourse to international conventions, the relevant State may decide that the watercraft in question is not a 'ship' and therefore not subject to arrest. Since ship arrest is a powerful tool for potential claimants to secure their claims in cases such as collision, leaving the decision of ship status to each individual state may significantly reduce the effectiveness of the Arrest Convention. UNCLOS does not define a ship and the national law approach would create difficulties. Recourse, therefore, may be had to 'interpretation' of UNCLOS provisions.

2.5. Treaty Interpretation Approach

Since treaties must be interpreted under the rules established in the Vienna Convention on the Law of Treaties (VCLT), the provisions of this Convention will be used to shed some light on the legal status of MASS under UNCLOS. Article 31(1) of the VCLT states that a treaty must be interpreted 'in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' Article 31(3)(b) provides that 'any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation' must also be taken into account. Article 32 reads:

> Recourse may be had to supplementary means of interpretation, including the preparatory work of the treaty and the circumstances of its conclusion, in order to confirm the meaning resulting from the application of article 31, or to determine the meaning when the interpretation according to Article 31
>
> (a) leaves the meaning ambiguous or obscure; or
> (b) leads to a result which is manifestly absurd or unreasonable.

According to Article 17 of UNCLOS '*ships* of all States … enjoy the right of innocent passage through the territorial sea.'[172] Similarly, Article 38 provides that 'all *ships* and aircraft enjoy the right of transit passage'.[173] Another important navigational right is the freedom of navigation on the high seas under Article 87(1)(a). In this regard, Article 90 entitles states to sail 'ships' on the high seas. Therefore, it would appear that all navigational rights are granted to 'ships'. What happens if a watercraft is classified as a 'vessel' rather than a 'ship'? Since the Convention makes multiple references also to

[171] Emphasis added.

[172] Emphasis added.

[173] Emphasis added.

‘vessels’, the question arises whether ‘vessels’ can equally enjoy the navigational rights which are given to ‘ships’. Thus, it should first be investigated whether there is any difference between ‘ship’ and ‘vessel’ under UNCLOS.

2.5.1. Difference between ‘Ship’ and ‘Vessel’ under UNCLOS

When directly regulating the rights of innocent passage and transit passage in Articles 17 and 38, UNCLOS only employs the term ‘ship’ and not ‘vessel’. When it comes to pollution, however, the term ‘vessel’ is generally preferred to its counterpart. And in certain contexts, the Convention uses both terms interchangeably. Is there any difference between the two terms?

From a practical point of view, the rights of innocent passage and transit passage can be enjoyed only by watercraft which are large enough to engage in international voyages and enter other States’ territorial seas. A small boat, although arguably able to enjoy the right of innocent passage by sailing through the territorial seas of a neighbouring country, in practice, is unable to engage in sea-going voyages to enjoy the right of innocent passage in the wider meaning. Thus, the right of innocent passage and transit passage is ‘generally’ meaningful only in the context of sea-going watercraft. And in this sense, UNCLOS uses the term ‘ship’ only. Thus, the term ‘ship’, at least in the context of UNCLOS, means a large watercraft which is capable of engaging in international voyages.

On the other hand, Article 211(2) of the Convention requires States to adopt laws and regulations for the prevention, reduction and control of pollution of the ‘marine environment’. The marine environment encompasses the high seas where sea-going watercraft operate as well as territorial waters and ‘estuaries’ where many small watercraft operate too.[174] Thus, here the size of watercraft is immaterial; all watercraft from gigantic oil tankers to small pleasure boats must comply with pollution prevention laws and regulations. In this sense, UNCLOS mainly uses the term ‘pollution from *vessels*’.[175] This implies that the term ‘vessel’ may be the mother term that encompasses large as well as small watercraft. This argument makes sense because the word ‘vessel’ originates from Latin *vascellum* which means ‘vas’ and connotes a hollow container.[176] In the China/US incident, it was probably based on this notion that the US contended that its UUV was a ’vessel’ rather than a ‘ship’. Thus, it may be argued that the term ‘vessel’

[174] UNCLOS, Article 1(4).

[175] Emphasis added.

[176] Aleka Mandaraka-Sheppard, *Modern Maritime Law*, vol 1: *Jurisdiction and Risks* (3rd edn, Informa Law 2013) para 7.2.2.

embraces all types of watercraft irrespective of their size whereas the term ‘ship’ connotes ‘large’ watercraft only. In other words, all ships are vessels but not all vessels are ships.

The terminology used in UNCLOS can also be examined in the context of ship registration, where the Convention uses the word ‘ship’. Since ship registration is mainly used for watercraft that engage on ‘international’ voyages, it is generally meaningful for watercraft which are large enough to go to sea. This could be why Article 91 of UNCLOS requires States to fix the conditions for granting their nationality to ‘ships’ not vessels. A ‘vessel’ may be a small rowing boat that is not capable of going to sea and thus, UNCLOS does not oblige States to keep the names and particulars of such small vessels on their register of ships,[177] though some States may choose to do so. The argument that the term ‘ship’ only covers larger watercraft which are capable of going to sea, is also supported by Article 2 of the United Nation Convention on Conditions for Registration of Ships that states a ship is ‘any self-propelled sea-going vessel used in international seaborne trade for the transport of goods, passengers, or both *with the exception of vessels less than 500 gross registered tons*.’[178] Article 1(b) of the International Convention on Salvage also supports this interpretation by stating that ‘[v]essel means any ship or craft, or any structure capable of navigation.’

The distinction between the two terms, though, is to some extent obscured by some international conventions and domestic laws that reverse the above-mentioned relationship between the two concepts. For example, Article I(1) of the CLC Convention gives the wide meaning to the term ‘ship’ as the mother term that encompasses vessels and seaborne craft: ‘“[s]hip” means any sea-going vessel and sea-borne craft of any type whatsoever’. Similarly, Section 313(1) of the UK Merchant Shipping Act recognises ‘ship’ as the wider term: ‘“ship” includes every description of vessel used in navigation’. Nonetheless, it is submitted that ‘vessel’ is the broader term for the simple fact that no one would disagree that a small empty container floating on water can be called a ‘vessel’ (container) but definitely not a ‘ship’. Based on this notion, in the China/US incident the US contended that its UUV was a ’vessel’ rather than a ‘ship’.

Returning to the question posed earlier, it appears that there is no legal difference between the terms ‘vessel’ and ‘ship’ under UNCLOS and the drafters of the Convention have preferred one term to another in different contexts. Thus, it may be said that the UNCLOS navigational rights which are granted to ‘ships’, may be enjoyed by ‘vessels’ too. This interpretation is supported by Article 211(4) where it empowers coastal State to adopt laws and regulations for prevention of pollution from ‘vessels exercising the right of

[177] UNCLOS, Article 94(2)(a).

[178] Emphasis added.

innocent passage'.[179] This means that the right of innocent passage is not only given to 'ships' but also to 'vessels'. Recourse may also be had to Article 32 of the VCLT where it states that in interpreting the meaning of an ambiguous or obscured term of a treaty, the 'preparatory work' of the treaty may be used as a supplementary means of interpretation. With this in mind, the explanation for the use of the two different terms in different contexts is that, in drafting UNCLOS different committees worked on different Articles of UNCLOS and consequently the Second Committee showed a preference for 'ship' in its articles and the Third Committee opted for 'vessel'.[180] As explained by the Chairman of the Third Committee, the reason behind selection of the term 'vessel' by the Third Committee was that, after consultation with the IMO and others 'it was understanding of the Third Committee that the broader term "vessel" was more appropriate, for it would cover not only ships but also other floating structures whose use or operation might cause pollution of the marine environment.'[181] Although it would be more appropriate if the expressions were harmonised, as the Drafting Committee of UNCLOS reported in its work to examine the matter:

> 'This problem affects only the English and Russian versions since one word is used in the other languages e.g. *buque* in Spanish and *navire* in French. The words "ship" and "vessel" are not interpreted as meaning different things in the text.'[182]

Furthermore, Article 33(1) of the VCLT states that when a treaty 'has been authenticated in two or more languages, the text is equally authoritative in each language, unless the treaty provides or the parties agree that, in case of divergence, a particular text shall prevail.' Since other (e.g. Spanish and French) versions of UNCLOS use only one term to mean ship or vessel, there is no meaningful difference between 'ship' and 'vessel' in the English version of UNCLOS.

2.5.2. Interpretation of the Crewing Requirements under UNCLOS

Ships and vessels are the same thing under UNCLOS. The difficult question, however, still remains: Can MASS be classified as 'ships' or 'vessels' within the meaning of UNCLOS? The answer to this question is not straightforward as neither of the two terms is defined in the Convention. To start untangling the issue, there are generally two principal differences between conventional crewed ships and MASS Degrees 3 and 4.

[179] Emphasis added.

[180] Satya N Nandan (ed) and Shabtai Rosenne, *United Nations Conventions on the Law of the Sea 1982: A Commentary*, Volume II (Martinus Nijhoff Publishers 1993) para 1.28.

[181] Ibid.

[182] Ibid.

The first difference is the crewing status i.e. there is no crew on board MASS Degrees 3 or 4.

The second difference is the carriage capacity i.e. some small MASS Degrees 3 or 4 are not capable of carrying goods or persons. UNCLOS contains some provisions only regarding the crewing status and not carriage capacity. According to Article 94(3)(b) of UNCLOS, every flag State must ensure safety at sea with regard to 'the manning of ships' flying its flag by taking into account the 'applicable international instruments'. Based on the 'manning' requirement in this Article, some may argue that MASS Degrees 3 or 4 do not constitute 'ships' under UNCLOS. This argument, however, is misleading. It may be easier to start with a structure such as a conventional oil tanker that all would agree *is* in fact a 'ship' under UNCLOS. If following a false fire alarm all persons on board the tanker (which is moored in a dock) leave the tanker, the tanker will still remain a 'ship' in a legal and literal sense. It is not the crew on board the tanker that makes it a 'ship'. Rather, it is the physical characteristics and the application of the tanker that makes it a 'ship' within the meaning of different conventions.

If the tanker faces equipment breakdown and develops a list while in transit passage through a strait and all persons on board abandon the tanker, the tanker with no human being on board is arguably still a 'ship' under UNCLOS. Article 43 of the UNCLOS requires the user States and the States bordering the strait to cooperate for the prevention, reduction and control of 'pollution from ships'. It would be absurd if the relevant States could deny their responsibilities to prevent pollution by arguing that the tanker is no longer a 'ship' within the meaning of UNCLOS. Now assume that salvors bring the tanker upright and tow it safely through the territorial waters of a coastal State and towards an appropriate port for repair. Again, it would be senseless if the coastal State could prevent the innocent passage of the tanker solely by arguing that there is no crew on board the tanker and she is not a 'ship' entitled to innocent passage.

When the tanker is repaired and ready to sail out to sea, she may still not be permitted to leave the port. Assume that the minimum safe manning requirement for the tanker is, for example, a master plus 15 officers and crew. If the shipowner intends to send the tanker to sea with a master and only 8 officers and crew, the port State will most probably detain the tanker; not because it is not yet a 'ship', but because it is 'unsafe' for the tanker to operate with fewer crew. Even if the tanker does leave the port with reduced crew, it may face difficulty exercising innocent passage through territorial waters of other states. Article 21(2) of UNCLOS provides that coastal States cannot impose laws and regulations in relation to 'manning' on foreign ships in innocent passage in their territorial waters, *unless* such laws and regulations are giving effect to 'generally acceptable international rules or standards'. On this ground, if the international and acceptable average crew size for the tanker in question is 15, then the coastal State may have relevant laws and regulations in place that will deny the right of innocent passage to the tanker especially if she is laden.

Again, this does not mean that the tanker is not considered to be a 'ship' due to its manning status. Rather, it is a 'ship' that does not comply with international manning standards. Thus, it may be said that the number of crew on board a ship does not, in itself, strip the tanker of its ship status. In fact, research in all maritime conventions that provide a definition for 'ship', fails to uncover even one convention in which manning is a prerequisite to ship status. Under-manning can negatively affect the navigational rights of the ship by making it an unseaworthy ship rather than a non-ship object.

With the above points in mind, it may now be less difficult to analyse the status of a MASS. Given the absence of a definition of ship or vessel in UNCLOS, there is nothing in the Convention to suggest that a MASS cannot be a ship or vessel especially if it has ship-like characteristics. However, being a 'ship' is not sufficient to enjoy the UNCLOS navigational rights. The flag State must discharge its UNCLOS duties in relation to such a ship and one of such duties, as prescribed by Article 94(3)(b), is ensuring safety at sea with regard to the 'manning' of the ship by taking into account the 'applicable international instruments'. It has been confirmed by the Secretariat of the IMO that the 'applicable international instrument' referred to in Article 94(3)(b) is in fact the International Convention for the Safety of Life at Sea (SOLAS) which contains the 'generally acceptable international rules or standards' regarding manning.[183] Accordingly, Regulation 14 in Chapter V of SOLAS provides that 'from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned'. This provision does not require that at least one crew member must be present on board but it states that in determining manning level the Administration (i.e. the flag State) should take into account the 'relevant guidance adopted by the Organization' i.e. the IMO's Principles of Minimum Safe Manning; Resolution A.1047(27).[184] This IMO Resolution does not specify a minimum number of crew to be present on board the ship but provides that in determining the minimum safe manning, the 'level of ship automation' and 'degree of shoreside support provided to the ship' should be taken into account.[185] It is clear that a high level of ship automation and shore-side support can significantly reduce the required number of crew on board. The average crew size for ocean-going cargo ships has reduced from

[183] 'Implications of the United Nations Convention on the Law of the Sea for the International Maritime Organization' (LEG/MISC.7) – available at <http://www.imo.org/en/OurWork/Legal/Documents/LEG%20MISC%208.pdf> accessed 07 February 2023.

[184] 'Principles of Minimum Safe Manning' (Resolution A 27/Res.1047(27)) – available at <http://www.imo.org/en/OurWork/HumanElement/VisionPrinciplesGoals/Documents/1047(27).pdf> accessed 07 February 2023.

[185] Annex 2, para 1.1.

250 crew members in 1860 to 16 crew members in 2000[186] and given the rapid development of ship automation, there is no reason to think it cannot practically reduce to 'zero' over the next few decades. Nothing in UNCLOS, SOLAS, or the IMO's Principles of Minimum Safe Manning suggests that the manning level for a watercraft that due to its high level of automation and shore-based support can safely operate with no crew on board cannot be 'zero'.

Support for the view that the manning level of a 'ship' may be zero, can be found in UNCLOS Article 91 that gives an almost unfettered authority to each State to determine the conditions for the grant of its nationality to 'ships'. If Article 94 implied an on-board presence of at least one crew member as a prerequisite to ship status under UNCLOS, Article 91 would expressly make it clear that states have full discretion to register a watercraft as a 'ship' only if the watercraft has at least one crew member on board. However, *the only condition* that Article 91 imposes on states in registering 'ships' is that there must be a 'genuine link' between the State and the ship – no condition on manning status. The matter may also be analysed from the standpoint of customary international law under which decisions of national courts are a form of state practice.[187] The courts of the UK have held some 'unmanned' barges to be 'ships'[188] and research in open sources fails to uncover any objection from any State regarding UNCLOS manning requirements. More importantly, as mentioned above, the UK registered its first ever MASS Degree 4 in 2017 without any objection raised by any other State. These lend support to the view that on-board presence of crew members is not a prerequisite to UNCLOS ship status.

Moreover, in order to best promote technological progress, the UNCLOS manning requirement should be interpreted in light of 'functional flexibility'.[189] This interpretation is supported by the following arguments. First, Article 94(3)(b) 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 the manning of ships. The proviso 'such measures … as are necessary to ensure safety at sea' indicates that the main objective of this UNCLOS provision is attaining safety at sea and that the measures to achieve this objective are

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186 Volker Bertram, 'Towards Unmanned Ships' <https://www.ntnu.edu/documents/20587845/1266707380/UnmannedShips.pdf> accessed 07 February 2023.

187 The International Law Commission, 'Draft Conclusions on Identification of Customary International Law, with Commentaries' <https://legal.un.org/ilc/texts/instruments/english/commentaries/1_13_2018.pdf> accessed 07 February 2023.

188 See *The Mac* (1882) 7 PD 126; *The Mudlark* [1911] P 116; and *The Harlow* [1922] P 175.

189 Alexandros Ntovas, 'Functionalism and Maritime Autonomous Surface Ships' in: James Kraska (ed) and Young Kil Park (ed), *Emerging Technology and the Law of the Sea* (Cambridge University Press 2022) 214.

within the regulatory discretion of each relevant flag State.[190] Second, the available *travaux préparatoires* of UNCLOS[191] show that the UNCLOS manning requirement is functionally established 'to ensure safety at sea' and on the basis of being 'adequate to the needs of the ship'.[192] Third, as observed above, generally accepted international regulations and guidelines base the manning requirements on the 'functional flexibility' and avoid any prescriptive constraint on the form or the number of humans on board the ship.[193] Further support is lent to the 'functional flexibility' approach by the emerging new regulatory philosophy that aims to set goal-based standards. For instance, the IMO's Interim Guidelines for MASS Trials envisage that MASS operations 'should be conducted in a manner that provides at least the same degree of safety, security and protection of the environment as provided by the relevant instruments'.[194] Based on goal-based standards, the interim guidelines, therefore, demonstrate a functional formulation which is to be safeguarded against safety and security risks by appropriate measures.[195]

It has been said that if there is no crew on board, then it may be argued that as a matter of logic the ship is not 'manned' at all and thus, necessarily falls foul of any regulation calling for manning adequacy.[196] To overcome this difficulty, an argument could be made that an 'unmanned' watercraft cannot be considered 'undermanned' because it was designed and built to safely operate without any crew on board in the first place. Put differently, such a watercraft is not meant to be 'manned' at all, and although there is no crew on board, the watercraft is considered to be seaworthy and safe to operate. The wording of Article 94(3) clarifies that the 'purpose' of the UNCLOS manning requirements is ensuring 'safety at sea'. From a purposive interpretation standpoint, if a State can reasonably ensure that the advanced technology of a watercraft can maintain the required 'safety at sea' without the presence of any crew on board the watercraft, the State has

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[190] Ibid 227.

[191] Particularly, Article 34(1) of the ILC Articles concerning the Law of the Sea. See UN Doc A/CN.4/104, 'Report of the International Law Commission on the Work of its Eighth Session, 23 4 July 1956, Official Records of the General Assembly, Eleventh Session, Supplement No. 9 (A/3159)' – available at <Report of the International Law Commission on the Work of its Eighth Session, 23 4 July 1956, Official Records of the General Assembly, Eleventh Session, Supplement No. 9 (A/3159) (un.org)> accessed 07 February 2023.

[192] Alexandros Ntovas, 'Functionalism and Maritime Autonomous Surface Ships' in: James Kraska (ed) and Young Kil Park (ed), *Emerging Technology and the Law of the Sea* (Cambridge University Press 2022) 227.

[193] Ibid.

[194] IMO Doc MSC.1/Circ.1604, para 2.

[195] Alexandros Ntovas, 'Functionalism and Maritime Autonomous Surface Ships' in: James Kraska (ed) and Young Kil Park (ed), *Emerging Technology and the Law of the Sea* (Cambridge University Press 2022) 231.

[196] Robert Veal, 'Unmanned Ships and their International Regulation' [2016] 9 Lloyd's Shipping & Trade Law 1, 2.

arguably fulfilled its obligation regarding the manning requirements. Furthermore, since UNCLOS is an umbrella convention, it leaves the details and standards of the manning requirements to be established through relevant conventions. Hence, Article 94(5) provides that in complying with the manning requirements States must conform to generally accepted international regulations. As mentioned above, the competent authority for such international regulations is the IMO and the apparent inconsistency between the UNCLOS manning requirement and the operation of MASS can be addressed through measures at the IMO without any need to amend the UNCLOS manning-related provisions. This is because UNCLOS is an 'umbrella' convention and 'most of its provisions are not self-executing and accordingly can only be implemented through other treaties, such as the treaties adopted by IMO.'[197] In fact, one of the questions in the CMI questionnaire reflected this particular aspect of UNCLOS. The question reads:

> 2.2. Paragraphs (3) and (4) of UNCLOS Article 94 include a number of obligations on flag states with respect to the manning of such ships. Do you think that it is possible to resolve potential inconsistencies between these provisions and the operation of unmanned ships without a crew on board through measures at IMO (under paragraph (5) of the same Article) or do you think other measures are necessary to ensure consistency with UNCLOS. If so, what measures?

Majority of the national Maritime Law Associations replied that any potential inconsistency can be resolved through measures at IMO level. For instance, the British Maritime Law Association stated that:

> [The UNCLOS manning requirement in Article 94] is not prescriptive and arguably permits unmanned operation if the relevant ship's autonomous navigation system is sufficiently safe. The absence of clarity in UNCLOS in this respect means that the particularities of this international requirement fall to be determined by specific and detailed IMO regulations.

Moreover, some States such as the US and Turkey are non-parties to UNCLOS and thus, they are not bound by UNCLOS manning requirements (or any UNCLOS requirements for that matter) unless the requirements reflect customary international law. Not only is there no customary international law regarding the number of crew on board different ships, but also (as will be observed below) a rule of customary international law that recognises MASS Degrees 3 and 4 as 'ships' is currently developing.

[197] 'The United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea (ICP), 10th Session' <https://www.un.org/Depts/los/consultative_process/documents/10_A.Blanco-Bazan.pdf> accessed 07 February 2023.

Two other issues have also been raised in relation to difficulties surrounding the manning requirements under UNCLOS. First, Article 94(4)(b) requires that 'each ship is in the charge of a master and officers who possess appropriate qualifications' and it has been argued that since the natural meaning of the terms master, officers and crew connotes persons working on board the ship, Article 94(4) seems to require the relevant master and officers to be on board the ship.[198] Second, Article 94(4)(a) of the Convention directs the flag State to ensure that each ship flying its flag 'has *on board* such charts, nautical publications and navigational equipment and instruments as are appropriate for the safe navigation of the ship'.[199] It has also been argued that since requiring such items to be 'on board' ships 'can only be for the benefit of those charged with the ship's navigation', Article 94 requires the relevant master, officers and crew to be on board the ship.[200] Interpretations, nonetheless, may be developed to resolve such undesirable results. First, although due to the long-standing 'manned' shipping practice the meaning of the master and crew of a ship is closely intertwined with an on-board presence, Article 94(4)(b) does not explicitly require the relevant masters, officers and crew to be 'on board' the ship. A MASS Degree 3 can be in the charge of a remote controller who can be regarded as the 'master' of the craft. When the watercraft is sailing in congested waters, a number of 'officers' may assist him/her with, for example, radar observations at the remote control-centre. In case of MASS Degree 4, a 'competent' algorithm (approved by the IMO) can be considered as the master of the craft that navigates it.

Furthermore, Article 94(4)(a) does not require carriage of 'paper' charts and publications on board the ship; they may be electronic. In fact, many ships nowadays use 'electronic chart display and information system' (ECDIS) which is the electronic version of paper charts and is displayed in a computer system which is installed 'on board' the ship. Further, Regulation 19 (2.1.4) in Chapter V of SOLAS permits replacing paper charts with ECDIS for all ships. Carrying such electronic charts in 'on-board' computers, does not, *per se*, necessitate an on-board presence of a crew to use such electronic charts; the electronic charts along with other navigational data obtained from the ship's equipment can be used by the algorithm of the ship (in case of a MASS Degree 4) or can be transmitted to a remote controller (in case of a MASS Degree 3). In sum, Article 94 does not necessitate on-board presence of crew members.

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[198] Robert Veal *et al*., 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 19.

[199] Emphasis added.

[200] Robert Veal *et al*., 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 19.

2.5.3. The Ambit of the Term ‘Ship’ or ‘Vessel’ under UNCLOS

When it is stated that a particular watercraft constitutes a ship (or vessel) under UNCLOS, it has to be determined whether the watercraft is a ship (or vessel) for the purposes of ‘all’ UNCLOS provisions related to ships and vessels. Put differently, if a watercraft is considered to be a ship or vessel, does this mean that the watercraft must comply with ‘all’ UNCLOS provisions that apply to ships and vessels? The following arguments suggest that a single ordinary meaning should not be given to the term ‘ship’ or ‘vessel’ under UNCLOS. The precise significance of these terms will ultimately depend on the context.

First, Article 111(3) of UNCLOS states that ‘the right of hot pursuit ceases as soon as the ship pursued enters the territorial sea of its own State or of a third State’. In this sense, a ‘ship’ is a self-propelled object that can navigate across water and therefore, considering a ‘fixed’ platform to be a ‘ship’ in this sense would be preposterous. On the other hand, however, Article 98(1)(a) of the Convention directs every State to require the ‘master’ of a ‘ship’ flying its flag to ‘render assistance to any person found at sea in danger of being lost’. Safety of human life is the highest priority and if the crew of a fixed oil platform can rescue a person in distress at sea, there is no compelling reason to think the platform should not be considered to be a ‘ship’ and the person in charge of the platform, its ‘master’. The phrase ‘flying its flag’ may be construed as being of ‘registry’ of the relevant State because UNCLOS contains references to ‘the State of registry’ of installations or equipment[201] and frequent references to obligation of States in relation to vessels flying their flag or ‘of their [or its] registry’.[202] The lack of an express definition of ‘ship’ in UNCLOS, therefore, provides the flexibility to interpret a fixed platform as a ‘ship’ in one context but not in another.

Second, Article 91(1) that states: ‘Every State shall fix the conditions for the grant of its nationality to ships.’ Under this provision, small yachts can be considered as ‘ships’ because a State can grant its nationality to small yachts that meet the State’s requirements for registration. Article 91(2) provides: ‘Every State shall issue to ships to which it has granted the right to fly its flag documents to that effect’. However, some States do not issue ‘documents’ to small yachts entitled to fly their flag.[203] Is it correct then to presume such states fail to comply with their obligations under Article 91(2)? As has been suggested, rather than presuming that such States violate Article 91(2), it is more reasonable to interpret small yachts as not being ‘ships’ for the purposes of Article

[201] Articles 109(3)(b) and 262.

[202] E.g. Articles 209(2), 211(2)-(3), 212(1), 216(1)(b), 217(1)-(3), and 222.

[203] George K Walker(ed), *Definitions for the Law of the Sea: Terms Not Defined by the 1982 Convention* (Martinus Nijhoff Publishers 2012) 58.

91(2).[204] Thus, small yachts may be considered as 'ships' under one UNCLOS provision but not another.

Third, the term 'ship' under UNCLOS may even refer to individuals. For instance, Article 94(1) provides that '[e]very State shall effectively exercise its jurisdiction and control in administrative, technical and *social matters* over ships flying its flag.'[205] Reference to exercise of jurisdiction and control in 'social matters' over ships implies that in this context the term ship not only refers to the physical ship itself but also to its master, officers and crew members. The obligations set out in the subsequent paragraphs in Article 94 lend support to this notion[206] as these obligations apply both to the physical ship (e.g. the flag State must maintain a register of ships flying its flag) and to the master, officers and crew (e.g. the flag State must take measures with regard to training of the crew). It follows that the term 'ship' does not have a single meaning under different UNCLOS provisions.

Fourth, Article 99 prohibits the transport of slaves in 'ships' and Article 110 gives warships the right of visit and empowers them to board a 'ship' which is suspected to be engaged in slave trade. In this context, it would be absurd if one could argue that the right of visit does not apply to, for example, a particular structure simply because the structure is not a 'ship'. For the purposes of provisions regarding prohibition of slavery, each and every single structure that may be found in the marine environment, fixed or floating, must be construed as a 'ship'. Similarly, Articles 109(4) and 110(1) empower certain warships to board a 'ship' if it is suspected that the 'ship' is engaged in unauthorised broadcasting on the high seas, to arrest any person or ship engaged in unauthorised broadcasting, and to seize the broadcasting apparatus. Again, if the unauthorised broadcasting has been done from a fixed installation on the high seas, then the context necessitates interpreting the fixed installation as a 'ship' so that warships can board the installation for investigation.

As noted above, any artificial object found in the marine environment may or may not be construed as a 'ship' depending on the circumstances. In fact, historical sources suggest that in drafting UNCLOS I, the parties did not give a single 'ordinary meaning' to the term 'ship' or 'vessel'.[207] An attempt to draft a general definition of 'vessel' by the International Law Commission was unsuccessful particularly because it could not reach agreement with regard to non-self-propelled 'barges'.[208] The Special Rapporteur said that he had

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[204] Ibid.

[205] Emphasis added.

[206] George K Walker(ed), *Definitions for the Law of the Sea: Terms Not Defined by the 1982 Convention* (Martinus Nijhoff Publishers 2012) 59.

[207] Allen H Craig, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism vs Functionalism' (2018) 49 Journal of Maritime Law and Commerce 477, 500.

[208] Ibid, see footnote 68.

‘doubts as to the necessity of the definition of a ship’ and the International Law Commission unanimously agreed to delete a suggested definition of ship from the Convention.[209] Since UNCLOS covers a wide variety of subjects and applies to many different waterborne objects, formulating a fixed definition of ‘ship’ that captures all various human-made objects operating in the marine environment, would not only be troublesome but also unwise. Professor O’Connell said about four decades ago that the variegated definitions of ship in different international conventions indicate that the International Law Commission was wise when it abandoned the attempt to define ‘ship’.[210]

Since no single ‘ordinary meaning’ is attached to the concept of ‘ship’ under UNCLOS, there is no reason to exclude MASS from the concept. In other words, being regarded as a ‘ship’ does not mean that a MASS must now comply with all UNCLOS provisions (e.g. manning requirements) that apply to ‘ships’. Just because a fixed platform may be construed to be a ‘ship’ under provisions related to prohibition of slavery, it does not mean that all other UNCLOS provisions applicable to ‘ships’ will automatically apply to that fixed platform. For example, Article 94(4)(b) requires the flag State to ensure that the crew of the ‘ship’ are qualified in terms of ‘seamanship’. Manifestly, applying the requirement of ‘seamanship’ to persons on a ‘fixed’ platform that has nothing to do with navigation would be absurd. Thus, recognising a given structure as a ‘ship’ for the purposes of certain provisions does not mean that the structure must necessarily comply with all other UNCLOS provisions applicable to ships. Each case should be judged according to its own circumstances. In the same vein, it would be preposterous to apply the UNCLOS manning requirements to a watercraft which was in the first place designed and built with no crew accommodation and is meant to be operated with no human on board. Of course, in order to ensure safety at sea, the flag State will still be under other applicable obligations with regard, *inter alia*, to the construction, equipment and seaworthiness of the watercraft. In summary, the concept of ‘ship’ may, depending on the circumstances, take on different meanings under different UNCLOS provisions.

2.5.4. Interpretation of MASS as ‘Devices’ under UNCLOS

In addition to ships and vessels, UNCLOS uses a large number of different terms to refer to other human-made objects that may be present in the marine environment: devices, equipment, machinery, platforms, installations, structures and artificial islands. Veal *et al*. argue that if MASS do not constitute ‘ships’, there is nothing in the ordinary English dictionary definition of ‘device’ or in the wording of UNCLOS which would prevent a MASS

[209] [1955] 1 YB Int’l Law Commission 1, para 28-9 (UN Doc A/CN.4/SER.A/1955) – available at <https://legal.un.org/ilc/publications/yearbooks/english/ilc_1955_v1.pdf> accessed 07 February 2023.

[210] DP O'Connell, *The International Law of the Sea*, Vol II (1st edn, Clarendon Press 1982) 750.

being classified as a 'device'.[211] They further argue that the terminology used in UNCLOS to describe the process of device use i.e. 'launching' and 'taking on board' suggests a connection between the 'device' and a mother ship.[212] However, as shown below, by adopting the established rules of treaty interpretation, it may be argued that MASS generally cannot and should not be so classified.

The authors argue that since Part XII of UNCLOS uses the term 'device' most often in conjunction with the term 'installation', the term device 'seems to contemplate (while not being limited to) *use* in conjunction with an installation.' They argue that:

> Article 209 UNCLOS contemplates "devices" flying the flag of a State but unlike "ships" does not prescribe any rights which are conditional on such registration. This apparent contradiction might further demonstrate that "devices" are contemplated as being part of the anatomy of a "ship" and having the benefit of the latter's registration.

The relevant part of Article 209(2) reads:

> States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from activities in the Area undertaken by vessels, installations, structures and other devices flying their flag or of their registry or operating under their authority, as the case may be.

First, in accordance with Article 31(1) of the Vienna Convention on the Law of Treaties, 'the ordinary meaning' must be given to the term 'device' in its 'context' and in light of the 'object and purpose' of the provision in question. Thus, the ordinary meaning of 'device' must be interpreted in the context of the title of Article 209 i.e. 'pollution from activities in the Area'. Area means the 'seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction'[213] and activities in the Area means 'all activities of exploration for, and exploitation of, the resources of the Area'.[214] Such activities contemplate drilling the seabed, extracting, processing, storing and/or carrying natural resources of the seabed such as petroleum. In this context, interpreting the term 'device' as a small watercraft that navigates on the surface and is part of the anatomy of a ship, will accord more than the 'ordinary meaning' of the term 'device' to it and the interpretation does not seem to put the device into its 'context' i.e. seabed activities.

Second, the 'purpose' of the provision is prevention, reduction and controlling pollution of the marine environment. Arguably, a small 'device' which is launched and recovered as

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[211] Robert Veal *et al*., 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 21.

[212] Ibid.

[213] UNCLOS, Article 1(1)(1).

[214] UNCLOS, Article 1(1)(3).

part of the anatomy of a ship, cannot be considered as a serious source of pollution calling for regulation. The first concerned source of pollution which is mentioned in Article 209(2) is the activity of vessels that engage in storing and/or carrying harmful substances such as petroleum products. The second source of pollution is the activity of installations, structures 'and other devices'. In this context, the principle of *ejusdem generis* should be adopted to interpret the words 'and other devices'. The rule *ejusdem generis* means that when a list of specific items belonging to the same kind is followed by general words, the general words should be interpreted to include only things of the same kind.[215] Thus, the words 'and other devices' in the phrase 'installations, structures and other devices' can only include items that are in their nature similar to installations and structures. The whole phrase as a unit, therefore, contemplates stationary installations such as oil platforms. The principle of *ejusdem generis* has been codified in Article 31.4.A of the Vienna Convention on the Law of Treaties that states a 'special meaning' may be given to a term only if it is established that the parties so intended. There is no evidence to suggest that the parties to UNCLOS intended to give a 'special meaning' to the term 'device'. In fact, the *travaux préparatoires* of UNCLOS indicates that the Drafting Committee once considered a possible need for harmonisation of the various kindred terms such as 'installations', 'installations and devices', 'installations and structures' and 'installations or equipment' and even considered inserting a new subparagraph in the very first article of UNCLOS reading: '"installations" includes artificial islands and structures'.[216] In light of this, the term 'device' seems to contemplate something more of an 'installation' than a small vessel (device) that navigates on the water as part of a mother ship.

Furthermore, Article 209 does not necessarily contemplate 'devices flying the flag of a State'. Under UNCLOS, flying the flag of a State is a concept that is considered for ships and vessels only. Article 90 of UNCLOS provides that every State has the right to sail 'ships flying its flag' on the high seas. The initial draft of this Article used the words 'ships under its flag' but on the recommendation of the Drafting Committee it later was changed to 'ships flying its flag'.[217] However, this change applied only to the English version of the provision and the Drafting Committee in its harmonisation work had recommended an addition to the first article of UNCLOS which would read: 'a ship or vessel "flying the flag" of a State means a ship or vessel authorized to fly the flag of that State.'[218] This is reflected throughout the Convention where reference is made to the obligations of States in relation

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[215] Jonathan Law (ed), *Oxford Dictionary of Law* (9th edn, OUP 2018) 367.

[216] Myron H Nordquist (ed), Shabtai Rosenne (ed) *et al*., *United Nations Conventions on the Law of the Sea 1982: A Commentary*, Volume IV (Martinus Nijhoff Publishers 1991) para 194.10(m) and footnote 15.

[217] Satya N Nandan (ed), Shabtai Rosenne (ed) *et al*., *United Nations Conventions on the Law of the Sea 1982: A Commentary*, Volume III (Martinus Nijhoff Publishers 1995) para 90.7.

[218] Ibid, see footnote 3.

to vessels flying their flag or 'of their [or its] registry'.[219] For objects other than ships or vessels the Convention always uses a terminology other than 'flying the flag'. For example, Articles 109(3)(b) and 262 use the term 'the State of registry' for installations or equipment, and Articles 212(1), 216(1)(b) and 222 use the term 'aircraft of its [or their] registry'. Therefore, the appearance of the phrase 'devices flying their flag' in Article 209(2) seems to be more of a coincidental result of a poor drafting than a meaningful legal concept. The Article, it is submitted, should be read as follows:

States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from activities in the Area undertaken by:

(a) vessels flying their flag
(b) installations, structures and other devices of their registry or operating under their authority

Thus, the term 'device' under Article 209 does not connote a watercraft navigating on the water and 'flying the flag' of a State nor something which is part of the anatomy of a ship that enjoys the benefit of the ship's registration. The more accurate interpretation, it is submitted, is that a 'device' under UNCLOS is a piece of equipment of a more permanent character than something that 'navigates' on or under the water. Firstly, apart from Article 19(2)(f) that uses the phrase 'military device', the term 'device' is always used in conjunction with other terms such as pipelines[220], installations[221], structures[222] and machinery[223] which connote a piece of equipment that has been 'fitted' to the seabed. Secondly, the term 'device' in conjunction with such terms is mainly used in the context of exploration and exploitation of the sea-bed resources where the risk of pollution or damage to the marine environment is high; a context which is not related to shipping or freedom of navigation.

Article 19(2)(f) of UNCLOS prohibits the launching, landing or taking on board any 'military device' from ships in innocent passage. One may argue that under this Article some small MASS capable of being launched and recovered may be classified as a 'device' or a 'military device'. Be that as it may, the term 'military device' is not a term of art under international law[224] and it is used only once in a very specific context in UNCLOS. Thus,

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[219] For example, in Articles 209(2), 211(2)-(3), 212(1), 216(1)(b), 217(1)-(3), and 222.

[220] Article 145(a).

[221] Article 194(3).

[222] Article 209(2).

[223] Article 274(b).

[224] Daniel AG Vallejo, 'Electric Currents: Programming Legal Status into Autonomous Unmanned Maritime Vehicles' (2015) 47 Case Western Reserve Journal of International Law 405, 414.

while the term ‘device’ may cover certain small MASS like the American UUV in the China/US incident, it definitely cannot cover ‘all’ MASS. To demonstrate with an example, a large MASS which is used to carry cargo may not be considered as a ‘device’ which is launched and recovered by another ship. Consequently, MASS cannot and should not (in general) be categorised as ‘devices’. However, this does not mean that all MASS may be classified as ‘ships’ for all purposes under UNCLOS; some MASS can and should indeed be regarded as a ‘device’. As observed, the ambit of the term ‘ship’ depends on the context and circumstances. For example, Article 98 of UNCLOS obliges every State to require the ‘master’ of a ‘ship’ flying its flag to render assistance to persons in distress at sea. However, a minute MASS Degree 4 which is used only for gathering ocean temperature data and is not capable of carrying anything or anyone, cannot be expected to render any kind of assistance to persons in distress at sea. As a result, such a watercraft cannot be a ‘ship’ within the meaning of Article 98. This interpretation is in line with Article 98 that obliges the master of a ‘ship’ to render assistance ‘in so far as he can do so without serious danger to the ship, the crew or the passengers’. In this case, the watercraft may be seen as a ‘device’ rather than a ‘ship’. On the other hand, if a MASS Degree 3 is capable of taking and carrying persons on board, the watercraft may be a ‘ship’ and its remote controller the ‘master’ of the ‘ship’ who is obliged to rescue persons in distress under Article 98. Even if a MASS Degree 4 that does not have carriage capacity but it is equipped with cameras and GPS, non-existence of an individual as the ‘master’ of the watercraft should not, in itself, relieve the watercraft of the obligation to assist persons in distress at sea. If the algorithm of the watercraft is so intelligent to assess various situations at sea and decide independently of human beings, it is difficult to see why the same algorithm should not help save lives at sea, for example, by stopping and remaining close to the location of the incident and thereby helping rescuers to locate the persons in distress more quickly. Additionally, the watercraft can provide vital information through live camera pictures about the nature of the distress, the weather condition and the situation of the persons in distress.

To sum up, the term ‘device’ is mainly used in UNCLOS provisions related to prevention of pollution and it is usually used in conjunction with installations and structures i.e. equipment that is usually used for oil exploration and exploitation. Thus, MASS cannot collectively be categorised as ‘devices’ under UNCLOS. Most present and future MASS would constitute a ‘ship’ (or ‘vessel’) for the purpose of at least one UNCLOS provision. Nevertheless, a very small MASS Degree 3 or 4 may be considered as a ‘device’ rather than a ‘ship’ under certain UNCLOS provisions, and it may have an independent existence without a mother ship.

2.6. Evolutionary Interpretation Approach

Some may argue that since the concept of 'ship' at the time of UNCLOS negotiations did not encompass MASS, the term 'ship' under UNCLOS does not cover MASS. However, as it has been pointed out,[225] there is some evidence of an 'evolutionary approach' to treaty interpretation adopted by the courts. For example, in the recent case of *Costa Rica v Nicaragua*,[226] Article VI of the Cañas–Jerez Treaty of 1858 granted Costa Rica a perpetual right of free navigation 'for the purpose of commerce' on certain sections of the San Juan River between the two countries. Because the notion of 'commerce' in the mid-nineteenth century did not quite encompass tourism, Nicaragua argued that the term 'commerce' could be interpreted to cover only the purchase and sale of physical goods to the exclusion of all services such as passenger transport.[227] Costa Rica, however, contended that the modern meaning of the term covers not only transport of goods, but also transport of passengers, including tourists.[228] The International Court of Justice concluded that the terms of the Treaty, including the term 'commerce' must be understood 'to have the meaning they bear on each occasion on which the Treaty is to be applied, and *not necessarily their original meaning*' and 'it is the *present meaning* [of the term] which must be accepted for purposes of applying the Treaty'.[229] The Court, therefore, found that the meaning of the term 'commerce' could be extended to encompass 'tourism' because 'the activity of transporting persons can be commercial in nature nowadays.'[230]

Based on this evolutionary approach, it may be argued that although the notion of 'ship' at the time of UNCLOS negotiations did not encompass MASS or if the parties to the Convention did not so intend, the emergence of new watercraft with no crew on board and the fact that some States have registered and are using such watercraft as 'ships', suggest that the meaning of 'ship' under UNCLOS may be extended to cover MASS too. Support for this evolutionary approach to UNCLOS can be found in the text of UNCLOS itself too. As the new ocean technology is constantly developing, the list of freedoms of the high seas cannot be exhaustive;[231] hence, the term '*inter alia'* in Article 87. The term '*inter alia*' arguably provides the flexibility to accommodate the use of new technologies in the high seas.

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[225] Robert Veal, Michael Tsimplis and Andrew Serdy, 'The Legal Status and Operation of Unmanned Maritime Vehicles (2019) 50(1) Ocean Development & International Law 23, 27.

[226] *Dispute Regarding Navigational and Related Rights* [2009] ICJ 213.

[227] Ibid [58].

[228] Ibid [45].

[229] Ibid [70].

[230] Ibid [71].

[231] RR Churchill and AV Lowe, *The Law of the Sea* (3rd edn, Juris Publishing 1999) 205.

Where completely new usage of the high seas may be 'added' to the non-exhaustive list of the freedoms of the high seas, it is certainly possible to argue that those freedoms of the high seas that are already and expressly listed in Article 87(1), can undergo some sort of evolution in terms of the technologies involved. One of such listed freedoms is the 'freedom of navigation' which is of particular importance as it has been (and remains) a prerequisite for international trade and commerce[232] and given its historical importance, its listing as the first freedom of the high seas is iconic.[233] Since States cannot in principle control what other States do in the high seas, apart from a few restrictive rules, the sea users remain at liberty as to their activities in the high seas.[234] In relation to the 'freedom of navigation', among such restrictive rules are the obligations of the flag State to ensure safety at sea; to observe the rules regarding protection of the marine environment; to use the high seas for peaceful purposes;[235] and to have due regards to the rights and duties of other States in the high seas.[236] If a State can observe all such rules in its exercise of the freedom of navigation, then it should not matter whether the state uses conventional ships or MASS as both situations fall under the principle of the 'freedom of navigation'.

Article 2 of the 1958 Convention on the High Seas (UNCLOS I) that listed the freedoms of the high seas, also contained the term '*inter alia*' and made reference to 'other rights'. At the second session of the UNCLOS Conference (1974), a working paper by El Salvador proposed to remove the term '*inter alia*' and the reference to 'other rights' from Article 2 'so as to avoid too wide interpretations'.[237] At a later meeting the representative of El Salvador proposed that the terms '*inter alia*' and 'other rights' that imply an open-ended list of freedoms of the high seas 'should be replaced with specific provisions enumerating all the freedoms allowable under international law'.[238] While the reference to 'other rights' was replaced by two specific rights i.e. 'freedom to construct artificial islands' and 'freedom of scientific research', the proposal to remove the term '*inter alia*' was not approved and the term found its way to the final version of UNCLOS. Thus, although not expressly included in the list of the freedoms of the high seas, or not within the contemplation of the State parties to UNCLOS at the time of negotiations, States can

[232] Donald R Rothwell (ed), Alex G Oude Elferink (ed), Karen N Scott (ed) and Tim Stephens (ed), *The Oxford Handbook of the Law of the Sea* (OUP 2015) 536.

[233] Donald R Rothwell and Tim Stephens, *The International Law of the Sea* (2nd edn, Hart Publishing 2016) 164.

[234] RR Churchill and AV Lowe, *The Law of the Sea* (3rd edn, Juris Publishing 1999) 205.

[235] Article 88.

[236] Article 87(2).

[237] Satya N Nandan (ed), Shabtai Rosenne (ed) *et al*., *United Nations Conventions on the Law of the Sea 1982: A Commentary*, Volume III (Martinus Nijhoff Publishers 1995) para 87.4.

[238] Ibid.

and actually do use the high seas to launch satellites into space nowadays; thanks to the phrase '*inter alia*' in Article 87.

It is therefore apparent from the preparatory work and the wording of UNCLOS Article 87 that this Article does not and UNCLOS negotiations did not intend to restrict the freedoms of the high seas to the marine technologies that existed at the time of negotiations. Thanks to new technologies, the conventional ships are evolving into intelligent MASS which will bring about several benefits. In light of this evolutionary interpretation approach, although the concept of 'ship' at the time of UNCLOS negotiations did not possibly cover MASS, there is no compelling reason to think that the parties intended to 'restrict' the concept of 'ship' solely to crewed watercraft. Quite the contrary, the *travaux préparatoires* and the wording of UNCLOS provisions regarding the freedoms of the high seas suggest that the drafters of the Convention intended to give an evolutionary and self-updating nature to the Convention so as to accommodate the use of new technologies in the high seas in the future. The self-updating nature of the Convention allows the emerging MASS equipped with new technologies to enjoy the freedom of navigation. The fact that some States such as the UK and China have registered and are using MASS as 'ships' indicates that the meaning of 'ship' under UNCLOS is evolving and it now covers MASS too.

2.7. Comparison with the Aviation Industry

Investigating the legal status of unmanned aerial vehicles (UAVs) in international aviation law may help shed some light on the legal status of MASS under international maritime regulations. This is because the law in relation to autonomous systems is more flexible and responsive and has moved much quicker in aviation than in the shipping industry. Today, UAVs are regarded as 'aircraft' in both civil and military aviation law with navigational rights in the international airspace. Therefore, the way in which the aviation regulatory framework applies to UAVs can show the way forward for integration of MASS into the maritime regulatory framework. To this end, the development and the legal status of UAVs in the aviation industry will be investigated below.

2.7.1. Development of International Civil Aviation Law

The development of the legal framework for international civil aviation started with the 1919 Paris Convention[239] which was later replaced by the 1944 Chicago Convention on International Civil Aviation. In 1928, the International Commission for Air Navigation had adopted a glossary of terms which defined 'aircraft' as 'any machine which can derive

[239] 'Manual on Remotely Piloted Aircraft Systems (RPAS)', ICAO Doc 10019 (2015) para 1.2.1.

support in the atmosphere from reactions of the air'.[240] In 1967, the International Civil Aviation Organization (ICAO) amended the definition and re-defined aircraft as 'any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface'. The second part of this new definition was added to exclude from the definition of 'aircraft' all air cushion type vehicles (e.g. hovercraft) that derive support from the reactions of the air with the *earth* surface. The ICAO then included this definition in Annex 7 to the Chicago Convention. Since the definition is found in an annex developed by the ICAO pursuant to the Chicago Convention and not within the text of a treaty, it has been argued that the legal status of the definition is open to debate.[241]

A quibble about the amended definition is that the definition is silent on machines that derive support from the reactions of the air against *water* surface; is a wing-in ground (WIG) craft flying in close proximity to the water surface a watercraft or an aircraft? Addressing the issue, the IMO and the ICAO recently agreed that any WIG craft capable of sustained flight outside the influence of ground effect at an altitude of more than 150 metres should be subject to the rules and regulations of ICAO and other craft, including those with limited 'fly-over' capability, should be covered only by the maritime regulatory regime.[242]

2.7.2. The Legal Status of UAVs in Civil Aviation

In light of the continuing development of 'unmanned aircraft' in the civil aviation industry, a question regarding the amended definition of aircraft is whether a machine that derives support from reactions of the air but has no operator/pilot on board, may be an 'aircraft' within the meaning of and therefore subject to the Chicago Convention. In 2015, the Legal Committee of the ICAO held its 36th Session to discuss, *inter alia*, legal issues relating to 'remotely piloted aircraft'. The Secretariat of the ICAO presented the Legal Committee with a Paper[243] which offered, *inter alia*, an interpretation of the term 'aircraft'. The Paper sufficed to state that Annex 7 to the Chicago Convention 'makes it clear that remotely piloted aircraft (RPA) are simply one type of unmanned aircraft'. The UK doctrine has also

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[240] Benjamyn I Scott and Andrea Trimarchi, *Fundamentals of International Aviation Law and Policy* (Routledge 2020) para 3.2.2.1.

[241] Ibid.

[242] 'Guidelines for Wing-in-ground Craft' (MSC.1/Circ.1592) – available at <http://www.imo.org/en/OurWork/Safety/Regulations/Documents/MSC.1-CIRC.1592.pdf> accessed 07 February 2023.

[243] 'Study of Legal Issues Relating to Remotely Piloted Aircraft' LC/36-WP/2-4 (2015) – available at <https://www.icao.int/Meetings/LC36/Working%20Papers/LC%2036%20-%20WP%202-4.en.pdf> accessed 07 February 2023.

reached the same conclusion as it refers to UAVs as 'unmanned aircraft' and defines them as '[a]n aircraft that does not carry a human operator, is operated remotely using varying levels of automated functions, is normally recoverable, and can carry a lethal or non-lethal payload'.[244] The US Department of Defense's position is also the same.[245]

Another issue relating to UAVs is the scope of Article 8 of the Chicago Convention entitled 'Pilotless aircraft' which reads:

> 'No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.'

This Article implies that 'pilotless aircraft' have the right to fly in any airspace other than over the territory of a contracting State without the authorisation of that State. However, it obliges the State of registry of pilotless aircraft to ensure that the flight of such pilotless aircraft does not pose a danger to civil aircraft. The Paper of the ICAO Secretariat stated that 'pilotless aircraft' includes all unmanned aircraft 'whether remotely piloted, fully autonomous, or combinations thereof' and thus they are all subject to Article 8. *Ergo*, in the context of 'civil' aviation, the issues regarding the legal status of UAVs and their navigational rights in the international airspace is deemed (at least by the ICAO) to have been resolved – the main challenges ahead are regulating their safe operation.

2.7.3. The Legal Status of UAVs in Military Aviation

When it comes to 'military' aviation, the law is unclear and this is important because, for instance, 'military aircraft' is a term of art in international law which is associated with certain rights and responsibilities. While modern air and missile warfare have been rapidly developing ever since the end of World War Two, the international regulatory responses to this development have been limited to a number of international treaties such as the 1949 Geneva Conventions for the Protection of War Victims that did not cover many important aspects of air and missile operations. Therefore, in 2003, the Program on Humanitarian Policy and Conflict Research (HPCR) at Harvard University created a project that took six years and an international group of scholars and governmental

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244 The UK Ministry of Defence, 'Unmanned Aircraft Systems, Joint Doctrine Publication 0-30.2' (August 2017) – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/673940/doctrine_uk_uas_jdp_0_30_2.pdf> accessed 07 February 2023.

245 The US Department of Defense, 'Use of International Airspace by U.S. Military Aircraft and for Missile and Projectile Firings', DoD Directive 4540.01 (2015) – available at <https://www.hsdl.org/?abstract&did=801464> accessed 07 February 2023.

experts to complete. The outcome of the project was the *HPCR Manual on International Law Applicable to Air and Missile Warfare* which is a restatement of the existing treaty and customary international laws on air and missile warfare.

Although the term 'aircraft' is not defined in the law of armed conflict,[246] the *HPCR Manual*, interprets it as meaning 'any vehicle, *whether manned or unmanned*, that can derive support in the atmosphere from the reactions of the air (other than the reactions of the air against the earth's surface), including vehicles with either fixed or rotary wings.'[247] This interpretation of 'aircraft' in a military context is clearly derived from Annex 7 to the Chicago Convention and is so broad that it covers fixed-wing aeroplanes, helicopters, UAVs, gliders, dirigibles, blimps and even balloons regardless of their size (e.g. huge transport aircraft or small drones), function (e.g. combat or transport), status (e.g. military or civilian), or mode of operation (e.g. manned, remotely piloted or operating autonomously).[248] Missiles, however, do not qualify as unmanned aircraft because they do not derive their support in the atmosphere from reaction with the air.[249] The explicit reference to 'whether manned or unmanned' in the definition seems to be rooted in customary international law; decades of usage of various UAVs for military purposes in the international airspace has established their status as 'aircraft' with the right of flight in the international airspace. Thus, it is considered that under military aviation law, the term 'aircraft' also covers UAVs. Whether or not UAVs may further qualify as 'military aircraft' in the law of armed conflict will be analysed in the next sections.

In sum, there is some recent precedent in international civil and military aviation laws to interpret UAVs as 'aircraft' and to integrate them into the international aviation regulatory framework. Recourse, therefore, may be sought to this precedent in order to provide the way forward in resolving the issue of the legal status of MASS under international maritime laws. With this in mind, the success in the aviation sector may be considered to be owed to the inclusive definition of 'aircraft' and also to the long-standing operations of various UAVs under the rules of customary international law. Each of these alternative approaches shall be analysed below.

2.7.4. Extrapolation of the Concept of Aircraft to the Concept of Watercraft

The essential element in the definition of 'aircraft' is deriving support from 'reactions of the air' which has enabled the definition to capture virtually any type of artificial flying object including UAVs. The lack of a definition for 'ship' in UNCLOS, therefore, allows

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[246] William H Boothby, *The Law of Targeting* (OUP 2012) 333.

[247] Rule 1(d) (emphasis added).

[248] Ibid Commentary 1.

[249] Ibid Commentary 4.

liberal interpretations and one may envisage adopting a similar concept in order to define ‘ship’ and resolve the legal status of MASS. This approach would define ship or vessel as ‘any machine that can derive support from and/or move on or under the water through reactions of the water or reactions of the air against the water surface’. This definition is surely broad enough to cover all crewed and crewless surface and underwater vehicles including WIG craft regardless of their manning status, size, shape, purpose or carriage capabilities. This is because all surface vessels floating or moving on the water and all underwater vehicles stabilising or moving under the water do so through the reaction (pressure) of the water regardless of whether the vessel is propelled by propeller, oar or hydro-jet. Even sailing vessels that derive their propulsion from the wind, they still derive ‘support’ from the reaction (pressure) of the water to stay afloat. It should be noted that although such interpretation can help ‘include’ MASS as being ships, adopting the interpretation as a ‘definition’ in the text of UNCLOS would be problematic in the context of such an all-embracing convention as it would ‘exclude’ some other maritime objects from being ships. This is because not all artificial objects found in the marine environment derive support from reactions of the water to remain or move on or under the water. Take for example a marine installation on the high seas that is rigidly fixed to the seabed. Such an object does not utilise any reaction of the water to remain in position and would not therefore be a ‘ship’ within the meaning of the proposed definition. However, as observed earlier, such an installation may constitute a ‘ship’ in the context of, for example, unauthorised broadcasting or rendering assistance to persons in distress at sea under UNCLOS.

In fact, adopting ‘any’ definition of ship in the context of UNCLOS, it is submitted, would probably do more harm than good. For instance, one may define ‘ship’ in a very inclusive way as *any* artificial object found in the high seas which is linked to a State through registration. While in a sense this sounds reasonable because any ship in the high seas ‘must’ have a national character, adopting such a definition would mean that any human-made object in the high seas that has no nationality would not constitute a ship and this would cause a whole host of issues. As an example, warships are entitled to seize a ‘ship’ which has no nationality on the high seas and it would be absurd if one could argue that warships are not entitled to seize a stateless ship merely because the ship has no nationality and therefore does meet the definition of ‘ship’. This would defeat the purpose. The better approach therefore is to require that ships (without defining them) must have a national character. In other words, nationality must not be a ‘prerequisite’ to ship status but it must be a requirement as a ‘consequence’ of being a ship.

Given that the regulatory contexts in which the terms ‘ship’ and ‘vessel’ appear in UNCLOS and the variety of watercraft and their purposes are very wide, no ‘prerequisite’ such as nationality or manning should be attached to ship status under UNCLOS. Rather, these should be ‘consequences’ for an object that qualifies as a ship. That is to say, every ‘ship’ operating in the high seas must have a nationality and must have sufficient crew on board (if it is necessary for safe operation of the ship in question at all). The definition of ‘aircraft’ in Annex 7 to the Chicago Convention basically covers ‘any’ human-made object that operates in the air. Using that definition as a paradigm, the only ‘prerequisite’ for a ship under UNCLOS, it is submitted, is that it must be a human-made object that operates in the marine environment i.e. under, on, or in close proximity to the water surface. This is the most expansive interpretation of the term ‘ship’ which is possible under UNCLOS. As a result, ‘any’ artificial object at sea may qualify as a ‘ship’; the context and the circumstances will determine whether it will or not. For instance, a very small MASS Degree 4 without any carriage capacity which has no camera and which is exclusively used for recording the salinity of the oceans cannot be considered a ‘ship’ for the purposes of UNCLOS provisions that require ‘ships’ to render assistance to persons in distress at sea. The same watercraft, nonetheless, does constitute a ‘ship’ for the purposes of UNCLOS provisions that relate to the freedom of navigation. Although the wide variety of UNCLOS provisions and also MASS in terms of function and capability mean that their ship status has to be examined on a case-by-case basis, it shall be observed in the next sections that one thing is clear: all MASS constitute ‘ships’ for the purpose of the freedom of navigation in the high seas. The way forward, therefore, is to regard MASS collectively as ‘ships’ with UNCLOS navigational rights, and then start to regulate their safe operations.

Moving to the second factor of success in the aviation industry, customary international law has played an important role in establishing the status of civilian UAVs as ‘aircraft’ and the status of military UAVs as ‘military aircraft’. This is so because remotely-controlled and autonomous aircraft have been in existence since World War One and have been operated by both civil and military entities.[250] Accordingly, despite the fact that the term ‘aircraft’ is not defined in the law of armed conflict, today UAVs may qualify as ‘military aircraft’. Thus, in addition to aforementioned approaches, customary international law may also provide the way forward in establishing the legal status of MASS as ‘ships’.

2.8. Customary International Law Approach

Whether or not MASS are ‘ships’ under UNCLOS and have any navigational rights may also be investigated from a customary international law standpoint. A new rule of customary international law may emerge if there is sufficient ‘state practice’ together with ‘*opinio juris*’ which are two constituent elements of customary international law.[251] In 1950, the International Law Commission (ILC) listed ‘opinions of national legal advisors’

[250] ‘Manual on Remotely Piloted Aircraft Systems (RPAS)’, ICAO Doc 10019 (2015) para 1.2.4.

[251] Christopher Greenwood, ‘Sources of International Law: An Introduction’ <https://legal.un.org/avl/pdf/ls/greenwood_outline.pdf> accessed 07 February 2023.

and ‘practice of international organizations’ as evidence of customary international law too.[252] It was not entirely clear how and to what extent these different elements could contribute to the formation or expression of rules of customary international law. Hence, in 2012, the ILC began to identify the way in which the existence and content of rules of customary international law are to be determined. The ILC included in its agenda the topic ‘[f]ormation and evidence of customary international law’ which was changed to ‘Identification of customary international law’ in 2013.[253] In December 2018, after the fifth (and also the final) report prepared by the Special Rapporteur,[254] the Commission concluded its work by adopting the ‘Draft Conclusions on Identification of Customary International Law’[255] (hereinafter, the Draft Conclusions) through Resolution A/RES/73/203[256] and recommended that the General Assembly should ensure their widest dissemination.[257] It is important to note that ‘State practice’ (also known as the ‘objective’ element) and *opinio juris* (otherwise known as the ‘subjective’ element) are both essential elements and one without the other will not give rise to any rule of customary international law. The relationship between the two elements is best explained by the ILC in Commentary 4 on Conclusion 2:

> Practice without acceptance as law (*opinio juris*), even if widespread and consistent, can be no more than a non-binding usage, while a belief that something is (or ought to be) the law unsupported by practice is mere aspiration; it is the two together that establish the existence of a rule of customary international law.[258]

In the following sections, in light of the ILC’s Draft Conclusions, these two elements together with other factors will be considered to determine the legal status of MASS from the perspective of customary international law.

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[252] [1950] 2 YB Int’l Law Commission (UN Doc A/CN. 4/SER.A/1950/Add. 1) – available at <https://legal.un.org/ilc/publications/yearbooks/english/ilc_1950_v2.pdf> accessed 07 February 2023.

[253] ‘Summaries of the Work of the International Law Commission’ (*International Law Commission*, 07 March 2019) <https://legal.un.org/ilc/summaries/1_13.shtml> accessed 07 February 2023.

[254] Available at <https://legal.un.org/docs/?symbol=A/CN.4/717> accessed 07 February 2023.

[255] Available at <https://legal.un.org/docs/?path=../ilc/texts/instruments/english/draft_articles/1_13_2018.pdf&lang=EF> accessed 07 February 2023.

[256] Available at <https://legal.un.org/docs/?symbol=A/RES/73/203> accessed 07 February 2023.

[257] ‘Analytical Guide to the Work of the International Law Commission’ <https://legal.un.org/ilc/guide/1_13.shtml> accessed 07 February 2023.

[258] ‘Draft Conclusions on Identification of Customary International Law, with Commentaries’ <https://legal.un.org/ilc/texts/instruments/english/commentaries/1_13_2018.pdf> 126 accessed 07 February 2023.

2.8.1. State Practice and *Opinio Juris*

Conclusion 5 provides that 'State practice consists of conduct *of the State*, whether in the exercise of its executive, legislative, judicial *or other functions*.'[259] Thus, to be regarded as 'State practice', the conduct in question must be 'of the State'. Commentary 1 on Conclusion 5 also clarifies that the conduct of 'any State organ' is considered as conduct of that State whether the organ exercises executive, legislative, judicial or 'other functions' such as 'commercial activities or the giving of administrative guidance to the private sector.'

The following are examples of State practice pertaining to MASS. In 2017, the UK Ship Register signed its first ever MASS Degree 4, C-Worker 7, to the flag.[260] The UK Ship Register is part of the Maritime and Coastguard Agency (MCA) which is an executive agency of the UK Government's Department for Transport.[261] Therefore, the conduct of the UK Ship Register is 'of the State (UK)' and shows that the UK regards MASS as 'ships' under Article 91(1) of UNCLOS. In May 2019, the first ever international, commercial and autonomous voyage was made by *SEA-KIT Maxlimer* that carried a small box of oysters from the UK to Belgium and a consignment of Belgian beer back to the UK.[262] Since the watercraft engaged in an international voyage between British and Belgian ports and it was welcomed by Belgian 'customs officers' who took delivery of the oysters, the British and Belgian port authorities believe (*opinio juris*) that MASS are 'ships' with navigational rights in different maritime zones. Another MASS Degree 4, *The Mayflower*, was also scheduled to set off from Plymouth (UK) to Plymouth (Massachusetts, USA) in September 2020[263] to cross the Atlantic Ocean autonomously in order to carry out oceanographic research and provide an active test platform for machine-learning algorithms for collision avoidance.[264] Again, the project being proposed and supervised by the Plymouth (UK) 'City Council'[265] (which is a State organ) and the voyage being an international voyage between British and American ports are both indications of State practice and *opinio juris*.

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[259] Emphasis added.

[260] 'UK Ship Register Signs its First Unmanned Vessel' <https://www.ukshipregister.co.uk/news/uk-ship-register-signs-its-first-unmanned-vessel/> accessed 07 February 2023.

[261] 'The UK Ship Register' <https://www.ukshipregister.co.uk/about-us/> accessed 07 February 2023.

[262] 'Autonomous Boat Makes Oyster Run' (*BBC News*, 09 May 2019) <https://www.bbc.co.uk/news/science-environment-48216966> accessed 07 February 2023.

[263] The journey took place at a later time (June 2022) due to the Covid-19 pandemic.

[264] 'Unmanned Ship to Go on 400-year-old Journey Across the Atlantic' (*BBC News*, 16 October 2019) <https://www.bbc.co.uk/news/technology-50047449> accessed 07 February 2023.

[265] 'Plymouth City Council' <http://democracy.plymouth.gov.uk/mgConvert2PDF.aspx?ID=89364> accessed 07 February 2023.

It should be noted that it is not necessary to show that the practice is universal and all States have participated in it. It is enough to demonstrate that the practice is 'sufficiently widespread'[266] and that the participating States 'include those that had an opportunity or possibility of applying the alleged rule'.[267] Obviously, less advanced States that do not yet have the MASS technology, do not have the 'opportunity or possibility' of participating in the practice. However, more MASS are currently under construction in different States in order to be used in international voyages. For example, Japanese shipping companies are working to launch self-navigating cargo ships by 2025.[268] Rolls-Royce also has planned and is working to launch MASS Degree 3 ocean-going ships by 2030, and MASS Degree 4 ocean-going ships by 2035.[269] Some States have only participated in the practice in their own territorial waters but may extend the practice to the high seas. For instance, in December 2019 China also entered the scene and launched its first autonomous cargo ship that completed her trial voyage in China's territorial waters and the Wanshan Marine Test Field in China will become the largest autonomous ship test area in the world.[270] In some states, even national guidelines have been established for the operation of MASS within their jurisdiction. For example, Maritime UK published the second version of its 'UK Code of Practice' in November 2018.[271] The latest (sixth) version was published in November 2022.[272] Conclusion 10 considers 'public statements made on behalf of States' as evidence of *opinio juris*. In relation to the above-mentioned State practices, since they are accompanied by public statements made on behalf of the relevant States (e.g. announcement of registration of C-Worker 7 by the UK Ship Register), it may be argued that both elements of customary international law are present.

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[266] Draft Conclusion 8.

[267] Commentary 3 on Draft Conclusion 8.

[268] 'Japan to launch self-navigating cargo ships 'by 2025'' (*BBC News*, 09 June 2017) <https://www.bbc.co.uk/news/technology-40219682> accessed 07 February 2023.

[269] Paul Dean, Tom Walters and Jonathan Goulding, 'Autonomous Vessels – Are Regulations Keeping up with Innovation? November 2017' (*HFW*) <http://www.hfw.com/Autonomous-vessels-are-regulations-keeping-up-with-innovation-November-2017> accessed 07 February 2023.

[270] 'China's First Autonomous Cargo Ship Completes Trial Voyage' <https://splash247.com/chinas-first-autonomous-cargo-ship-completes-trial-voyage/> accessed 07 February 2023.

[271] 'Maritime Autonomous Surface Ships: UK Code of Practice' (Version 2, November 2018) – available at <https://www.maritimeuk.org/media-centre/publications/maritime-autonomous-surface-ships-uk-code-practice/> accessed 07 February 2023.

[272] 'Maritime Autonomous Ship Systems (MASS): UK Industry Conduct Principles and Code of Practice' <https://www.maritimeuk.org/priorities/innovation/maritime-uk-autonomous-systems-regulatory-working-group/mass-uk-industry-conduct-principles-and-code-practice-2022-v6/> accessed 07 February 2023.

Furthermore, State practice is not limited to 'physical' practice; it may also be 'verbal' for example through government statements that purport to interpret UNCLOS.[273] In 2007, the US Navy, the US Coast Guard, and the US Marine Corps promulgated an update to the 'Commander's Handbook on the Law of Naval Operations' in which it was asserted that unmanned watercraft enjoy the same innocent, transit and archipelagic passage as 'vessels'.[274] It was also asserted that unmanned watercraft engaged exclusively in government, non-commercial services are 'sovereign immune craft' and this status 'is not dependent on the status of its launch platform'. The Commander's Handbook used the term 'unmanned surface vehicle' and categorised them as 'other naval craft'. The 2017 update[275] to the document also repeats the same assertions. Commentary 5 on Conclusion 10 identifies 'official publications' such as 'military manuals' as evidence of *opinio juris*. The Commander's Handbook therefore serves as evidence of both State practice and *opinio juris*.

Conclusion 10(3) states that '[f]ailure to react over time to a practice may serve as evidence of acceptance as law (*opinio juris*), provided that States were in a position to react and the circumstances called for some reaction'. The US has consistently maintained the same position regarding MASS for more than a decade and research in the available data does not reveal any objection by other States to such assertions. While the US and other States' similar practices are known to other States, no single State has officially protested against such practices that treat MASS as ships. Conclusion 8(2) provides that if the practice is sufficiently widespread, 'no particular duration is required'. Nevertheless, as Commentary 9 clarifies, 'some period of time' must elapse for a practice to become sufficiently widespread simply because there is no such thing as 'instant custom'.

It is apparent from the above that MASS have operated and will continue to operate in national and international waters and the practice of treating MASS as ships that enjoy freedom of navigation is not only accompanied by *opinio juris* but also will soon be 'sufficiently widespread' which will ultimately give rise to a new rule of customary international law: MASS are ships that enjoy UNCLOS navigational rights.

2.8.2. Practice of International Organisations

Conclusion 4(2) of the ILC's Draft Conclusions provides that '[i]n certain cases, the practice of international organizations also contributes to the formation, or expression, of

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[273] Michael N Schmitt and David S Goddard, 'International Law and the Military Use of Unmanned Maritime Systems' (2016) 98(902) International Review of the Red Cross 567, 577.

[274] Para 2.5.2.5.

[275] US Department of the Navy, 'Commander's Handbook on the Law of Naval Operations (2017 edition)' – available at <https://www.hsdl.org/?abstract&did=806860> accessed 07 February 2023.

rules of customary international law.' The practice of international organisations counts only 'in certain cases' for the following reasons. First, the practice must be 'attributed to international organizations themselves, not practice of States acting within or in relation to them.'[276] This is because while international organisations 'often serve as arenas or catalysts for the practice of States', they are not States but they are entities established and empowered by States and/or other international organisations to 'carry out certain functions, and to that end have international legal personality, that is, they have their own rights and obligations under international law.'[277] Second, practice of international organisations may give rise only to those rules of customary international law whose subject matter falls within the mandate of the organisations and/or those rules that are addressed specifically to them.[278]

Based on Article 2 of the Convention on the International Maritime Organization, the purposes of the IMO, *inter alia*, are:

> To provide machinery for co-operation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting *shipping* engaged in *international trade*, and to encourage the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from *ships*; and to deal with administrative and legal matters related to the purposes set out in this Article.[279]

Thus, regulation of ships engaged in 'international trade' is within the competence of the IMO. Accordingly, it may be argued that regulation of MASS (at least those that are intended to be used in international shipping) falls within the mandate of the IMO.

Although the IMO is explicitly mentioned only in Article 2 of Annex VIII of UNCLOS, several provisions in the Convention require States to 'take into account'[280] and 'ensure compliance'[281] with applicable international rules established by 'the competent international organization'. It has been confirmed that the expression 'competent international organization' when used in the singular and in connection with the adoption

[276] The International Law Commission, 'Draft Conclusions on Identification of Customary International Law, with Commentaries' <https://legal.un.org/ilc/texts/instruments/english/commentaries/1_13_2018.pdf> (page 130ff) accessed 07 February 2023.

[277] Ibid.

[278] Ibid.

[279] Emphasis added.

[280] Article 22(3).

[281] Article 217(1).

of international shipping rules, applies ‘exclusively’ to the IMO.[282] Bearing in mind the global mandate of the IMO to adopt international shipping rules, in February 2017, nine countries including Denmark, the UK and the US jointly submitted a paper[283] to the MSC at the IMO inviting it to undertake a regulatory scoping exercise to ensure the safe, secure and environmentally sound operation of MASS within the existing IMO instruments. The paper warned that ‘as the number, type and size of MASS increase, these arrangements may become unsustainable and potentially unsafe … [and] the existence of different national regulatory frameworks may render the construction and operation of MASS unmanageable, and may hamper innovation and technological developments’.[284] At its 100th session in December 2018, the MSC agreed to undertake a regulatory scoping exercise which was completed in June 2021.[285] The IMO intends to address the issue of MASS in the context of international maritime law conventions such as COLREGs, SOLAS, MARPOL and the STCW Convention. With that goal, the IMO has adopted the term ‘Maritime Autonomous Surface Ships’ (MASS) that covers different watercraft with different levels of autonomy. For the purpose of its regulatory scoping exercise, the IMO has provisionally defined MASS as ‘a ship which, to a varying degree, can operate independently of human interaction’ and it has categorised MASS into four groups based on their level of autonomy.[286]

Thus, the authority to determine whether MASS are ships under ‘IMO conventions’ and therefore the power to regulate them, is within the competence of the IMO. Some may argue that because the regulatory scoping exercise was proposed by nine Member ‘States’ of the IMO and is currently being carried out by delegations from certain ‘States’, the scoping exercise is the practice of those ‘States’ and not the practice of the ‘IMO’ itself. However, the scoping exercise was approved by and is being conducted under the supervision of the ‘MSC’ which is the most senior technical body of the IMO. Moreover, the outcome of the scoping exercise that was published in June 2021, is surely be

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282 ‘The United Nations Convention on the Law of the Sea (UNCLOS) and the International Maritime Organization’ (*IMO*, 18 March 2014) <http://www.imo.org/en/MediaCentre/SecretaryGeneral/SpeechesByTheSecretaryGeneral/Pages/itlos.aspx> accessed 07 February 2023.

283 ‘Maritime Autonomous Surface Ships Proposal for a Regulatory Scoping Exercise’ (MSC 98/20/2) – available at <https://www.transportstyrelsen.se/contentassets/e8f7935abb704e25875c8fa7e289db4f/98-20-2.pdf> accessed 07 February 2023.

284 Ibid para 8-11.

285 ‘Autonomous Shipping’ <http://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx> accessed 07 February 2023.

286 ‘IMO Takes First Steps to Address Autonomous Ships’ (*IMO*, 25 May 2018) <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx> accessed 07 February 2023.

attributed to the 'IMO' itself, and not to the practice of those States that proposed or conducted the scoping exercise within the IMO.

The fact that the application of IMO conventions like COLREGs and SOLAS to MASS is being studied under the regulatory scoping exercise shows that the IMO believes MASS are ships or vessels (as the case may be) for the purposes of these conventions. Also, employing the word 'ship' in the title of the scoping exercise (Maritime Autonomous Surface <u>Ships</u>) and also in the definition of MASS (as a <u>ship</u> which, to a varying degree, can operate …) indicates that the IMO believes (*opinio juris*) that MASS are 'ships' at least for the purposes of some IMO conventions. These could be considered as the practice of a competent international organisation accompanied by *opinio juris* giving rise to a new rule of customary international law: MASS are collectively 'ships' under the IMO's conventions and because IMO conventions primarily apply to ships engaged in 'international' shipping, the emerging rule of customary international law means that MASS will be able to navigate in the high seas. It must be noted that although the scoping exercise may imply that the IMO believes MASS are considered ships under UNCLOS, the IMO's opinion or its regulatory scoping exercise cannot be taken as evidence that MASS are ships under 'UNCLOS'. This is simply because there is nothing to suggest that it is within the competence of the IMO to determine the legal status of MASS under 'UNCLOS'. Nevertheless, the IMO's opinion and its practice contribute to the formation and/or expression of the emerging rule that MASS are ships under 'customary international law'. Whether under UNCLOS or customary international law, the result is the same: When it comes to the right to engage in international navigation, MASS are ships and are entitled to engage in international voyages.

2.8.3. Conduct of Other Actors

In its 1950 report to the General Assembly, the ILC observed that it was impracticable 'to list all of the numerous types of materials which reveal States' practices on each of the many problems arising in international relations.' Instead, it listed and analysed '"[w]ithout any intended exclusion, certain rubrics' of evidence of customary international law such as 'practice of international organizations' and 'opinions of national legal advisers'. The ILC in its recent reports on 'Identification of customary international law' adopts a more general approach and does not mention 'opinions of national legal advisers'. Instead, it concludes that '[c]onduct of other actors is not practice that contributes to the formation, or expression, of rules of customary international law, but may be relevant when assessing the practice [of States and of international organisations]'.[287] Such conduct, however, may have:

[287] 'Draft Conclusions on Identification of Customary International Law, with Commentaries', Draft Conclusion 4(3) – available at

> '[A]n indirect role in the identification of customary international law, by stimulating or recording the practice and acceptance as law (*opinio juris*) of States and international organizations. For example, the acts of private individuals may sometimes be relevant to the formation or expression of rules of customary international law, but only to the extent that States have endorsed or reacted to them.'[288]

Thus, although activities or statements of transnational corporations and non-governmental organisations (NGOs) do not count as 'practice' of States, they may nonetheless 'shape' the practice of States reacting to such activities or statements and therefore may contribute to the development and determination of customary international law. As an example, since 2013, the classification society DNV which is a non-governmental organisation based in Norway, has been working to develop a concept for an autonomous, fully battery-powered and zero-emission ship called *The Revolt*.[289] It also produced and published design criteria and guidelines for MASS Degrees 3 and 4 in 2018.[290] These technical activities of DNV have shaped and supported Norway's practice regarding autonomous shipping and have placed Norway at the forefront of autonomous ships technology. For example, In September 2017, the Norwegian Government gave a grant of about a third of the total cost of the construction of *Yara Birkeland*[291] which will be the world's first all-electric, zero-emission and autonomous container ship scheduled to be launched within the next few years in Norway.[292] *Yara Birkeland* is a multi-partner project between Norwegian maritime authorities and non-governmental bodies including DNV, Yara and Kongsberg[293] and the DNV guidelines are to be trialled on the vessel.[294]

<https://legal.un.org/ilc/texts/instruments/english/commentaries/1_13_2018.pdf> accessed 07 February 2023.

288 Ibid, see Conclusion 4, Commentary 8.

289 Hans Anton Tvete, 'The ReVolt: A new inspirational ship concept' <https://www.dnvgl.com/technology-innovation/revolt/index.html> accessed 07 February 2023.

290 'Autonomous and Remotely Operated Ships' <http://rules.dnvgl.com/docs/pdf/dnvgl/cg/2018-09/dnvgl-cg-0264.pdf> accessed 07 February 2023.

291 'MV *Yara Birkeland*' <https://en.wikipedia.org/wiki/MV_Yara_Birkeland> accessed 07 February 2023.

292 'The First Ever Zero Emission, Autonomous ship' (*Yara*, 14 March 2018) <https://www.yara.com/knowledge-grows/game-changer-for-the-environment/> accessed 07 February 2023.

293 'Final Design of Yara Birkeland Revealed – Model Commences Testing at Sintef Ocean' <https://www.kongsberg.com/news-and-media/news-archive/2017/final-design-of-yara-birkeland-revealed--model-commences-testing-at-sintef/> accessed 07 February 2023.

294 'New DNV GL Autonomous Guidelines to be Trialled on Yara Birkeland' <https://www.rivieramm.com/news-content-hub/new-dnv-gl-autonomous-guidelines-to-be-trialled-on-iyara-birkelandi-23489> accessed 07 February 2023.

Additionally, together with industry bodies, the Norwegian government established the Norwegian Forum for Autonomous Ships (NFAS) to promote the concept of autonomous shipping and turned the Trondheim Fjord into a test area for autonomous ship trials.[295] Norway together with the Baltic and International Maritime Council (BIMCO) also took the initiative to prepare the draft interim guidelines for MASS trials that was submitted to the MSC of the IMO in September 2018.[296] It is therefore not surprising that, in 2015, Lars Alvestad, director of the Department of Vessels and Crew in the Norwegian Maritime Directorate said: 'Norway is a flag state, and we ought to be the first to put unmanned vessels on the market. When Norway starts to do this, the rest of the world will follow.'[297]

Maritime UK and Lloyd's Register (another classification society which is headquartered in the UK) are other examples of how non-governmental associations may affect practice of a State. For example, by providing a Code of Practice for design and operation of autonomous surface vessels less than 24 metres in length, Maritime UK has played a significant role in influencing the UK's position and practice regarding MASS. In the words of the UK's Department for Transport, 'Maritime UK is able to engage government at the highest levels by demonstrating its global success, and setting out what it needs for the future to enhance our attractiveness to the international maritime community.'[298] The UK is planning to develop proposals for a new Merchant Shipping Act and to map the seabed of the UK exclusive economic zone (EEZ) by autonomous vessel.[299] Some classification societies such as DNV[300] and Lloyd's Register[301] have already published certain design criteria and guidelines for MASS. BIMCO which is the largest international association representing shipowners also supports the initiatives by the IMO and is planning to

[295] 'Autonomous and Remotely-operated Ships' <https://www.dnvgl.com/maritime/autonomous-remotely-operated-ships/index.html> accessed 07 February 2023.

[296] IMO Doc MSC 100/5/2, 'Interim Guidelines for MASS Trials (Submitted by Norway and BIMCO)' (28 September 2018) – available at <http://www.autonomous-ship.org/testarea/MSC100-norway.pdf> accessed 07 February 2023.

[297] 'Norway Should Lead the Way on Unmanned Vessels' <https://www.sintef.no/en/latest-news/norway-should-lead-the-way-on-unmanned-vessels/> accessed 07 February 2023.

[298] 'Maritime 2050: Navigating the Future' (*Department for Transport*, January 2019) page 30 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773178/maritime-2050.pdf> accessed 07 February 2023.

[299] Ibid 81.

[300] 'Autonomous and Remotely Operated Ships' <http://rules.dnvgl.com/docs/pdf/dnvgl/cg/2018-09/dnvgl-cg-0264.pdf> accessed 07 February 2023.

[301] 'New Code to Certify Unmanned Vessels Announced' <https://www.lr.org/en-gb/latest-news/new-code-to-certify-unmanned-vessels-announced/> accessed 07 February 2023.

facilitate the use of autonomous ships in international trade.[302] The International Association of Classification Societies (IACS) has initiated a review of IACS rules currently in force to address the requirements that may impede technical development of MASS Degrees 3 and 4.[303] Such professional activities and statements by non-governmental bodies can influence States' practice and therefore contribute to the development of customary international law.

The responses of the Maritime Law Associations to the formal survey of the CMI may also be considered as 'conduct of other actors'. In relation to UNCLOS, one of the questions in the CMI questionnaire was:

> 2.1. Do you foresee any problems in treating unmanned ships as "vessels" or "ships" under the Law of the Sea in your jurisdiction (i.e. that such ships would be subject to the same rights and duties such as freedom of navigation, rights of passage, rights of coastal and port states to intervene and duties of flag states) in the same way as corresponding manned ships are treated?

Only Maltese and Italian Maritime Law Associations (MLA) expressed some concern about treating MASS as 'vessels' or 'ships' under UNCLOS. The Maltese MLA stated that it foresees problems in the treatment of MASS as ships because of the absence of national and international legislation and that it is a moot point whether Malta will acknowledge and accept that the rights and obligations of crewed ships under UNCLOS extend to MASS. It also stated that the uncertainty will persist until MASS are regulated at national and international level. The Italian MLA stated that foreseeable problems in treating MASS as 'vessels' or 'ships' under UNCLOS will depend on the inherent (in)adequacy of UNCLOS to deal with the matter and possible inconsistencies with the definition of 'ship' to be found in Italian law. Since Maritime Law Associations are non-governmental bodies, these statements are not 'of the State' and they do not mean that the 'States' have officially 'objected' to treatment of MASS as 'ships' by other States. The Maritime Law Associations simply 'opine' that their 'national' law definition of ship may exclude treatment of MASS as ships and this should not affect the status of MASS under 'international' law. Further, they believe that UNCLOS may have inherent inadequacies to deal with the matter. To the contrary, as observed earlier the absence of definition of 'ship' in UNCLOS provides the required flexibility to adapt the Convention to new situations. The vast majority of different Maritime Law Associations from around the world believe that MASS can be treated as 'ships' under UNCLOS and the practice of their relevant States in the future will most probably reflect these statements. The IMO's

[302] 'Autonomous Ships' <https://www.bimco.org/about-us-and-our-members/bimco-statements/12-autonomous-ships> accessed 07 February 2023.

[303] International Association of Classification Societies, 'Annual Review (2017)' page 24 – available at <http://www.iacs.org.uk/media/5992/iacs-annual-review-2017.pdf> accessed 07 February 2023.

Regulatory Scoping Exercise is an indication that possible issues will also be addressed at international level.

All in all, it seems that a new rule of customary international law is developing to the effect that MASS will be recognised as 'ships' that enjoy the UNCLOS navigational rights. This emerging rule of customary international law, can subsequently establish the UNCLOS ship status of MASS from a treaty interpretation perspective too. This is because according to Article 31(b)(3)(b) of the Vienna Convention on the Law of Treaties, in interpreting a treaty any 'subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation' must also be taken into account.

The previous sections aimed to answer the question of whether a MASS may generally qualify as a 'ship' in the 'unrestricted sense' of the word and nothing was found to suggest a negative answer. However, the conclusion that MASS can collectively be regarded as ships, does not necessarily mean that they can qualify as 'any' type of ship under UNCLOS. For instance, can a MASS qualify as a 'warship'? Nor does it mean that MASS are automatically entitled to operate in 'all' maritime zones and engage in 'all' types of activities. The following sections, therefore, will analyse the potential issues regarding operations and activities of MASS in various maritime zones and their classification as specific types of ships under UNCLOS.

2.9. Different Activities of MASS in Different Maritime Zones

The conclusion of the previous sections is that the legal status of MASS under UNCLOS is determined as 'ships' or 'vessels'. However, as alluded to previously, being 'generally' classified as ships or vessels does not necessarily mean that MASS constitute ships for 'all' UNCLOS provisions. A given MASS may be a 'ship' for one provision but not for another. One of the most (if not *the* most) important questions, in this regard, is whether MASS are ships for the purposes of the 'freedom of navigation' and if so, whether they can engage in all activities in all maritime zones. It has been argued that the consequence of a MASS being classified as a 'device' rather than a 'ship' would be that 'as a device it may not exercise the navigational rights and freedoms in the various maritime zone[s] which are granted to "ships".'[304] Hence, the next questions are: In what maritime zones and under what conditions may MASS operate and what 'activities' can they engage in? The passage and activities of a MASS will be analysed in all maritime zones in the following order:

i) the internal/territorial waters or the EEZ of the flag State

[304] Robert Veal *et al.*, 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 21ff.

ii) the high seas
iii) the EEZ of a foreign coastal State
iv) the territorial waters of a foreign coastal State
v) the archipelagic waters of a foreign coastal State
vi) the internal waters and ports of a foreign coastal State

It will be observed that as the vessel goes beyond the territorial waters of its flag State and towards the high seas, its freedoms start to shrink and as it approaches the coastal waters of a foreign State and enters its EEZ and territorial waters, the foreign State starts to gain jurisdiction over the vessel in relation to certain matters. In general, the closer the vessel to the coast of the foreign State, the stronger jurisdiction the coastal State has over it.

2.9.1. Operation of MASS in Internal/Territorial Waters or EEZ of the Flag State

Article 2 of UNCLOS extends the coastal State's sovereignty beyond its land territory to the territorial sea which is an adjacent belt of sea up to a limit not exceeding 12 nautical miles measured from the baseline.[305] This territorial sovereignty denotes complete and exclusive jurisdiction over all matters and all people unless international law provides otherwise.[306] Thus, the flag State has full and exclusive power to establish requirements for operation of the MASS in its territorial waters. This means that even if a particular MASS does not constitute a 'ship' or 'vessel' under UNCLOS or under the national laws of other States, the flag State my still classify that craft as a 'ship' or 'vessel' and permit the watercraft to operate in its territorial waters. The MASS, therefore, will have to comply only with the domestic laws of its flag State as long as it operates in the territorial waters of its flag State. As such, even though MASS have not yet been regulated by the IMO, they can nevertheless operate in the territorial and internal waters of their flag State under national laws. Thus, the domestic operation of MASS is the best opportunity for the new technology to demonstrate its safety credentials to national administrations who can then play an important role in the compliance of the new technology with the current international requirements.[307]

In addition to pure 'navigation' which is what cargo ships do in transporting goods from one place to another, the MASS in the territorial waters of its flag State may enjoy a wide variety of other activities such as fishing, mapping the seabed, conducting scientific

[305] UNCLOS, Article 3.

[306] Yoshifumi Tanaka, *The International Law of the Sea* (2nd edn, Cambridge University Press 2015) 6.

[307] 'CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework' page 21 – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 07 February 2023.

research, exploring natural resources of the seabed and so on. Under UNCLOS Article 56, the same activities are permitted also in the EEZ of the flag State. Depending on the domestic laws of the flag State, the MASS may even operate in the territorial waters of the launching state without prior registration. For example, if a MASS is too small and does not go beyond the territorial waters of the launching state, the State may not require the watercraft to be registered as this exemption is permitted under Article 94(2)(a) of UNCLOS. The situation, though, will be different if the MASS goes beyond the territorial waters of its flag State and enters the high seas.

2.9.2. Operation of MASS in the High Seas

UNCLOS Article 90 (Right of navigation) provides that: 'Every State, whether coastal or land-locked, has the right to sail *ships* flying its flag on the high seas.'[308] However, the argument that freedom of navigation on the high seas is exclusively granted to 'ships' and not devices or other maritime objects, is not plausible for the following reasons. Firstly, Article 90 should not be construed in a literal way otherwise it would result in absurdity. The Article apparently entitles State to sail ships 'on' the high seas and thus, a literal reading may suggest that the right does not extend to submarines navigating 'under' the water. However, under customary international law, submarines have always enjoyed this fundamental right both 'on' and 'under' the water in the high seas. Moreover, the whole point of a submarine is navigating 'under' the water. For the sake of clarity, hereinafter the phrase 'in the high seas' will be used in lieu of 'on the high seas' when referring to both surface and sub-surface navigation.

Secondly, one may think that a very small scientific Unmanned Underwater Vehicle (UUV) which is not capable of carrying anything, cannot enjoy freedom of navigation in the high seas because it seems to be more of a 'device' than a 'ship'. However, Article 20 indirectly extends the right of innocent passage in the 'territorial sea' not only to submarines but also to 'other underwater vehicles' which arguably cover all types of unmanned underwater vehicles. If submarines and all unmanned underwater vehicles can operate in the 'territorial waters' of a foreign State where the State has 'sovereignty', they can surely operate in the 'high seas' where no State has sovereignty. And if unmanned 'underwater' vehicles can enjoy freedom of navigation 'under' the high seas, their surface counterparts can surely enjoy the same freedom 'on' the high seas. Put differently, if 'all' types of underwater vehicles that operate 'under' the water, regardless of their name, size, crewing or application, constitute 'ships' for the purposes of the freedom of navigation in the high seas, so can all types of MASS that operate 'on' water. Given the fact that for thousands of years 'ships' (in the traditional sense of the word) have navigated only 'on' water, regarding miniscule watercraft that chiefly navigate 'under' the water as

[308] Emphasis added.

ships but excluding those MASS that navigate 'on' the water (just because they may look like 'devices' rather than ships) would be nothing but absurdity.

Thirdly, it was noted that a marine platform while attached to the seabed and engaged in seabed activities may still be considered to be a 'ship' under certain UNCLOS provisions. Of course, speaking of freedom of 'navigation' in relation to a 'fixed' platform would be senseless. However, a fixed oil platform may be made afloat to navigate under its own propulsion or to be towed to other locations for oil exploration and/or exploitation. The argument that freedom of navigation is only given to 'ships' and not devices or installations like oil platforms, would prevent the navigation and movement of such structures in the high seas. However, customary international law shows that oil platforms while afloat can and actually do enjoy the freedom of navigation otherwise no single oil project could have been done in the high seas.

Fourthly, as noted earlier, the term '*inter alia*' that comes immediately before introducing the list of the freedom of the high seas in Article 87 of UNCLOS, indicates that the list is, in fact, open-ended and can, for example, include launching satellites into space. Thus, a narrow interpretation of UNCLOS that excludes MASS from the freedom of navigation, would be at odds with the spirit of Article 87 that permits States to use the high seas for an inclusive range of (peaceful) purposes. In other words, where Article 87 allows States to use the high seas for all sorts of (peaceful) activities from fishing, operating ships and aircraft and laying submarine pipelines to constructing artificial islands and conducting scientific research, an argument to deprive MASS of the freedom of navigation merely because there is no human on them would be in direct contradiction to the text and spirit of Article 87. This view would also be against public policy as it would prevent States from using MASS on the high seas in life-threatening operations such as firefighting or mine clearance.

Above all, the freedom of navigation on the high seas is a right which is granted to 'States' rather than 'ships'. Article 87(1) provides that the high seas are open to all 'States' and Article 90 makes it clear that every 'State' has the right to sail ships on the high seas. Accordingly, ships are one of the various 'means' by which States may exercise freedom of 'navigation'. Thus, apart from conventional ships, states may generally use any other watercraft that can be used for navigation such as submarines and MASS to exercise freedom of navigation.

It is, therefore, submitted that focusing on the traditional meaning of the term 'ship' in Article 90 is misleading and the term should be construed in an unrestricted sense of the word. This conclusion is also supported by the language used in the regime of innocent passage. In Subsection A of Part II of UNCLOS which is entitled 'Rules applicable to <u>all</u>

ships'[309] and which encompasses the provisions regarding the right of innocent passage, Article 20 requires 'submarines and other underwater vehicles' to navigate on the surface and to show their flag while in innocent passage. This means that submarines and all other underwater vehicles are considered as ships for the purposes of innocent passage. In fact, the preparatory work of UNCLOS shows that the requirement concerning submarines was extended to cover 'all other types of underwater vehicles, whatever their designation' and the requirement is equally applicable to both military and commercial submarines.[310] Thus, for the purposes of innocent passage, 'all' types of underwater vehicles are subcategories of 'ships' irrespective of their construction, size, crewing level, application or designation. Similarly, the term 'ship' in Article 90 also can and should be interpreted inclusively. Given the rationale behind the freedom of navigation, it seems reasonable to argue that the ambit of the term 'ship' in Article 90 is wide enough to capture almost all maritime objects that can navigate under or upon the high seas regardless of their 'name' or 'type'. The nomenclature, shape, size or crewing status of a maritime object by which a state exercises the 'freedom of navigation' on the high seas are immaterial and potentially misleading.

The upshot is that, even if a particular MASS is (for whatever reason) named as 'device' rather than ship or vessel, it will still enjoy the UNCLOS navigational rights on and under the high seas provided that the watercraft complies with relevant international regulations, in particular, ship registration. This is because ship registration is a fundamental international rule whereby the jurisdiction over each vessel on the high seas rests exclusively with the State to which the vessel belongs. The corollary of this rule is that all vessels using the high seas must have a national character.[311] A vessel without nationality enjoys no protection in international law; she cannot engage in lawful trade as ports will deny entry to her and she is liable to seizure on the high seas.[312] With this in mind, it is still difficult to comment on the legality of the Chinese seizure of the American UUV as there is no indication as to whether or not the UUV was flying any flag or at least had some registration information on its body. On the one hand, regardless of whether the UUV was a 'vessel' or 'device', the UUV had the right to enjoy the freedom of navigation in the high seas. On the other hand, though, the fact that China considered and announced the UUV to be an 'unidentifiable device' implies that the UUV was not in fact flying any flag to indicate its nationality nor did it bear any registration information to that

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[309] Emphasis added.

[310] Satya N Nandan (ed) and Shabtai Rosenne, *United Nations Conventions on the Law of the Sea 1982: A Commentary*, Volume II (Martinus Nijhoff Publishers 1993) para 20.7(a) (emphasis added).

[311] Richard Coles and Edward Watt, *Ship Registration: Law and Practice* (2nd edn, Informa Law 2009) para 1.3.

[312] Ibid para 1.4.

effect. If this is the case, even though the UUV could be considered as a 'vessel' for the purposes of the freedom of navigation in the high seas, it was nevertheless a vessel without nationality and therefore liable to seizure in the high seas. To add to the uncertainty, the Pentagon press operations director said after the incident that: '[the UUV] is ours. *It is clearly marked*; we'd like to have it back and [would] like this to never happen again'.[313] It is true that relatively small MASS may not be able to fly the conventional flag of a State, some minimum information can, nonetheless, be displayed on their hull or main body. In the interest of peace and order in the high seas and to ensure that every watercraft in the high seas will remain under jurisdiction of an identifiable State, it is submitted that every watercraft irrespective of its size, construction or purpose is entitled to navigate on the high seas provided that it is registered by a State, and its registration details are permanently displayed on the watercraft where they can best be seen.

Different States have established different requirements such as vessel's type, size or age for ship registration. For instance, while a vessel must be more than six metres in length to be eligible for registration under Maltese flag[314] and it must be under 20 years old for initial registration under Liberian flag[315], it may join the UK Ship Register without meeting those criteria. In fact, the variation between flag States' requirements for ship registration is as varied as the differences in culture, language and national character.[316] Thus, MASS can enjoy the freedom of navigation in the high seas provided that they are registered as a ship or vessel by a State and fly the flag of that State or at least bear some registration information to that effect. Apart from 'navigation', (un)manned vessels can also engage in fishing, scientific research and laying submarine cables and pipelines in the high seas.[317] However, such activities are not generally as extensive as they would be in the territorial waters of the vessel's flag State. UNCLOS Article 87(2) directs States to have 'due regard for the interests of other States' while exercising their freedoms of the high seas. Hence, (un)manned vessels may not be involved in any activity in an area which is right in the way of ships following an established and busy international shipping route. The following section indicates that as the MASS enters the EEZ of a foreign State, the range of lawful activities for the vessel becomes even more restricted.

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[313] 'Chinese Seize U.S. Navy Underwater Drone in South China Sea' (US Department of Defense, 16 December 2016) <https://www.defense.gov/Explore/News/Article/Article/1032823/chinese-seize-us-navy-underwater-drone-in-south-china-sea/> accessed 07 February 2023 (emphasis added).

[314] Richard Coles and Edward Watt, *Ship Registration: Law and Practice* (2nd edn, Informa Law 2009) para 18.4.

[315] Ibid para 17.5.

[316] Alexander Severance and Martin Sandgren, 'Flagging the Floating Turbine Unit: Navigating Towards a Registerable, First-Ranking Security Interest in Floating Wind Turbines' (2014) 39(1) Tulane Maritime Law Journal 1, 75.

[317] Article 87(1).

2.9.3. Operation of MASS in the EEZ of a Foreign State

The EEZ of a coastal State is an area beyond and adjacent to its territorial sea[318] and may extend up to a maximum of 200 nautical miles from the baseline.[319] In accordance with UNCLOS Article 58(1), the freedom of navigation enjoyed by States in the high seas applies also in the EEZ of a coastal State. Based on the conclusion from the previous section, it follows that MASS are entitled to the freedom of navigation in the EEZ too. However, unlike with the high seas, this does not mean that they can also engage in all other activities in the EEZ. As the vessel enters the EEZ of a foreign State, it comes under the jurisdiction of that State in relation to certain matters. Article 58(1) reads:

> In the exclusive economic zone, all States, whether coastal or land-locked, enjoy, *subject to the relevant provisions of this Convention*, the freedoms referred to in article 87 of navigation and overflight and of the laying of submarine cables and pipelines, and *other internationally lawful uses of the sea* related to these freedoms, such as those associated with the operation of ships, aircraft and submarine cables and pipelines, and compatible with the other provisions of this Convention.[320]

Thus, the freedom of navigation and 'other internationally lawful uses of the sea' in the EEZ are not absolute but are 'subject to the relevant provisions' of UNCLOS. Among such restrictive provisions are:

(i) The coastal State may adopt laws and regulations relating to the protection of the marine environment in its EEZ[321] and may interfere in passage of a vessel navigating in its EEZ to undertake physical inspection of the vessel if there are clear grounds for believing that the vessel has violated such laws and regulations.[322]

(ii) The coastal State has jurisdiction with regard to 'marine scientific research'[323] and 'economic' activities such as exploitation and exploration of natural resources in its EEZ.[324]

(iii) Foreign ships must not be involved in activities that constitute 'threat or use of force' against the 'territorial integrity or political independence' of the coastal

[318] Article 55.

[319] Article 57.

[320] Emphasis added.

[321] Article 211(5).

[322] Article 220(5).

[323] Articles 56(1)(b)(ii) and 246(1).

[324] Article 56(1)(a).

> State or in any other manner inconsistent with the Charter of the United Nations.[325]

Thus, as long as (un)manned vessels observe the above regulations, they can navigate in the EEZ of foreign States. Nevertheless, unlike crewed cargo ships that mainly use the EEZ only to 'navigate' to and from different places, MASS have a high potential to engage in other activities such as military exercises and gathering intelligence data in the EEZ. The question is then whether such activities fall under 'other internationally lawful uses of the sea' which are permitted in UNCLOS. Since the EEZ is a *sui generis* zone, i.e. because it is neither part of the high seas nor the territorial sea, the topic of non-navigational uses of this zone by foreign ships is highly controversial. In this regard, activities of foreign ships which are expressly prohibited in the EEZ may be divided into three groups: activities of 'economic' nature, those that constitute 'marine scientific research' and activities that amount to 'threat or use of force'. These will be analysed below.

2.9.3.1. Activities of 'Economic' Nature in the EEZ of a Foreign State

The wording of the term 'Exclusive Economic Zone' together with Article 56(1)(a) leave no doubt that purely 'economic' activities such as exploration or exploitation of the living or non-living resources of the EEZ are exclusively granted to the coastal State. Nevertheless, this does not mean that foreign vessels cannot carry out any activities in the EEZ which may also have subsequent economic benefits. This is because certain activities such as hydrographic surveys may benefit the international community as a whole. The British Admiralty charts produced by the United Kingdom Hydrographic Office (UKHO) can illustrate the point. Today, due to their high accuracy and reliability, over 90% of the world's ships trading internationally use the British Admiralty charts[326] and part of this commercial success is, of course, owed to the hydrographic surveys that the UKHO does in the EEZ of other States. Article 59 of UNCLOS emphasises that any conflict arising out of the use of the EEZ should be resolved 'in the light of *all the relevant circumstances*, taking into account the respective importance of the interests involved to the parties as well as to the *international community as a whole*.'[327] Since the UKHO has been charting the world's oceans for over 200 years with the primary aim (or at least the eventual effect) of saving and protecting lives at sea,[328] such hydrographic surveys

[325] Article 301.

[326] 'Admiralty chart' <https://en.wikipedia.org/wiki/Admiralty_chart> accessed 07 February 2023.

[327] Emphasis added.

[328] 'UKHO Warns of Dangers Posed by Counterfeit Admiralty Products' <https://www.admiralty.co.uk/AdmiraltyPressReleasesLibrary/010416%20-%20UKHO%20Press%20Release%20-

benefit the 'international community as a whole'. It therefore seems safe to argue that such surveys carried out by (un)manned vessels in the EEZ of foreign States are permitted under both UNCLOS or customary international law as the case may be. Other hydrographic surveys that promote purely economic activities such as fishing and tourism are not permitted as they affect economic interests of the coastal State.

2.9.3.2. Activities that Constitute 'Marine Scientific Research' in the EEZ of a Foreign State

Although not defined in UNCLOS, the term 'marine scientific research' is generally understood to be 'any scientific study or related experimental work having *the marine environment as its object* which is designed to increase knowledge of the oceans.'[329] Conducting marine scientific research in the EEZ is under jurisdiction of[330] and is regulated by[331] the coastal State. Thus, (un)manned vessels may conduct marine scientific research in the EEZ only with the consent of the coastal State. Nevertheless, in 'normal circumstances' coastal States must grant their consent for marine scientific research projects in their EEZ 'exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all [hu]mankind.'[332] Article 246(4) makes it explicit that even if there are no diplomatic relations between the coastal State and the researching State, 'normal circumstances' may still exist. In light of this, it seems safe to assume that circumstances would be 'normal' unless there is an imminent danger of armed conflict.[333] In short, (un)manned vessels may conduct marine scientific research in the EEZ only with prior authorisation of the coastal State who in normal circumstances 'must' grant its consent if the proposed research is exclusively for peaceful purposes and for increasing scientific knowledge of the marine environment that will benefit all humanity.

%20UKHO%20warns%20of%20dangers%20posed%20by%20counterfeit%20ADMIRALTY%20products.pdf> accessed 07 February 2023.

[329] Yoshifumi Tanaka, *The International Law of the Sea* (2nd edn, CUP 2012) 360.

[330] Article 56(1)(b)(2).

[331] Article 21(1)(g).

[332] Article 246(3).

[333] Marko Pavliha and Norman A Martinez Guiterrez, 'Marine Scientific Research and the 1982 United Nations Convention on the Law of the Sea' (2010) 16 Ocean & Coastal LJ 115, 121ff.

2.9.3.3. Activities that Constitute 'Threat or Use of Force' in the EEZ of a Foreign State

Since the EEZ has essentially an 'economic' nature, UNCLOS has unequivocally attributed rights and duties of the coastal States and other States in the EEZ in respect of 'economic' activities such as exploration/exploitation of the natural resources, construction and use of artificial islands and the like. However, there are some other uses of the EEZ that are not directly addressed by UNCLOS and thus it is unclear whether such uses of the EEZ fall within the rights of the coastal State or other States. For instance, 'military activities' of foreign ships in the EEZ is a vexed issue that is not specifically addressed by UNCLOS and it is not entirely clear whether the costal State enjoys any jurisdiction over such activities. UNCLOS Article 59 provides a general answer to the question of unspecified uses of the EEZ:

> In cases where this Convention does not attribute rights or jurisdiction to the coastal State or to other States within the exclusive economic zone, and a conflict arises between the interests of the coastal State and any other State or States, the conflict should be resolved on the basis of equity and in the light of all the relevant circumstances, taking into account the respective importance of the interests involved to the parties as well as to the international community as a whole.[334]

It is clear that Article 59 contains no presumption in favour of either the costal State or other States, and this neutrality would suggest that disputes concerning unspecified uses of the EEZ should to be decided on a case-by-case basis.[335] In fact, the general reference to 'all the relevant circumstances' that potentially covers many different factors and the lack of specificity as to what factors might be more important than others, means that Article 59 does not have any normative nature and its intended purpose can only be attained through application of the mandatory procedures of dispute settlement in Part XV of UNCLOS.[336] However, because the US is not a State party to UNCLOS and because some other naval powers such as Canada, France and Russia have excluded (through Article 298(1)(b)) 'disputes concerning military activities' from the mandatory procedure,[337] it seems rather unlikely that the issue will be clarified through a judicial decision in the foreseeable future.

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[334] Emphasis added.

[335] RR Churchill and AV Lowe, *The Law of the Sea* (3rd edn, Juris Publishing 1999) 176.

[336] Natalie Klein, *Dispute Settlement in the UN Convention on the Law of the Sea* (CUP 2005) 140.

[337] UN Doc No. 31363, 'Declarations and Reservations' (16 November 1994) <https://treaties.un.org/doc/Publication/MTDSG/Volume%20II/Chapter%20XXI/XXI-6.en.pdf> accessed 07 February 2023.

Some light may, nevertheless, be shed on the issue by recourse to Article 32 of the Vienna Convention on the Law of Treaties which states the preparatory work of a treaty may be used to determine the meaning of an ambiguous provision in the treaty. The preparatory work of UNCLOS demonstrates that UNCLOS generally does not grant the coastal State the power to regulate military activities of other States in its EEZ.[338] Thus, it appears that although as a matter of fact the costal State is indeed more interested in what happens in its EEZ, as a matter of law the security interests of the costal State in its EEZ cannot be higher than that of the international community as a whole.[339] In sum, while (un)manned ships enjoy the freedom of navigation in the EEZ of foreign States, whether or not they may also have the right to engage in military activities in the EEZ, is not entirely clear and will depend on the circumstances especially the security interests of the coastal State vis-à-vis the security interests of the international community as a whole.

2.9.4. Operation of MASS in Territorial Waters of a Foreign State (Innocent Passage)

Given that the 'sovereignty' of a coastal State extends to its territorial sea,[340] can a coastal State prevent entrance of foreign vessels into its territorial waters? There is one exception to the otherwise unfettered sovereignty of the coastal State over its territorial sea: innocent passage. UNCLOS makes it clear that 'ships' of all States enjoy the right of innocent passage through the territorial waters of a coastal State[341] unless the passage is 'prejudicial to the peace, good order or security of the coastal State'.[342] Article 20 of UNCLOS also provides that: 'In the territorial sea, submarines and other underwater vehicles are required to navigate on the surface and to show their flag.' Article 20, therefore, indirectly recognises the right of innocent passage for submarines and 'other underwater vehicles'. In addition, Subsection A of Part II of UNCLOS which encompasses the provisions regarding the right of innocent passage, is entitled 'Rules applicable to <u>all ships</u>'[343] and thus, it may be said that all types of underwater vehicles are subcategories of 'ships' irrespective of their construction, size, crewing status, or application. It follows that even a small scientific Unmanned Underwater Vehicle (UUV) is entitled to the right of innocent passage. And where such a small UUV is entitled to innocent passage, surely

[338] Ali Movaghar, 'Unravelling the Strands of the South China Sea Conundrum: A Critical Analysis of China's Actions and Statements' (2020) 34(1) Australian & New Zealand Maritime Law Journal 31, 46.

[339] Ibid.

[340] UNCLOS, Article 2(1).

[341] Article 17.

[342] Article 19(2).

[343] Emphasis added.

an unmanned surface vehicle should also enjoy the right of innocent passage. However, some States may interpret the entitlement of ‘ships’ (or vessels) to the right of innocent passage too restrictively. For example, in the case of *Passage through the Great Belt*,[344] Denmark argued that Finland’s mobile offshore drilling unit was not a ‘vessel’ within the meaning of UNCLOS and thus had no right of transit through the Danish Strait. However, only one week before the oral hearings were to open before the International Court of Justice (ICJ), the two parties agreed to settle the dispute and the question therefore remains open.[345]

Thus, the question essentially is whether a coastal State can adopt national laws and regulations to prevent passage of MASS through its territorial sea. The coastal State may adopt laws and regulations relating to innocent passage of ships through its territorial waters in respect of certain matters.[346] The coastal State, though, cannot prevent the innocent passage of a ship solely on account of its ‘manning’ status unless such prevention is supported by ‘generally accepted international rules or standards’.[347] The principal difference between a MASS Degree 3 or 4 that is used to carry cargo and its conventional (crewed) counterpart is the manning status. As observed earlier, generally accepted international standards do not prescribe a fixed number of crew for safe manning of each type of ship. Thus, depending on the ship’s level of automation and shore-side support, the number can technically be zero. Furthermore, UNCLOS Article 19(2) provides a list of ‘activities’ such as fishing activities and military activities that are considered to be prejudicial to the peace, good order or security of the coastal State and will therefore render the passage non-innocent. The list, therefore, focuses on ‘activities’ of ships rather than their manning.[348] The corollary of these arguments is that the manning status of a ship will not, *per se*, render its passage non-innocent under UNCLOS.

Putting the manning status aside, the issue should therefore be analysed with special attention to ‘activities’ of MASS. The situation regarding MASS engaged in ‘commercial’ activities seems to be less challenging. If a MASS is designed and built to operate only in the marine environment and if it is operated only for ‘commercial’ purposes such as carriage of cargo or passengers, then in ordinary circumstances activities of such a watercraft will not be prejudicial to the peace, good order or security of the coastal State.

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344 *Finland v Denmark* (1991) ICJ 12.

345 Yoshifumi Tanaka, *The International Law of the Sea* (2nd edn, Cambridge University Press 2015) para 4.9.

346 UNCLOS, Article 21(1).

347 UNCLOS, Article 21(2).

348 Robert Veal and Henrik Ringbom, ‘Unmanned Ships and the International Regulatory Framework’ [2017] 23(2) JIML 100, 103.

However, if a MASS carries out survey, research or data collecting activities while in a passage in the territorial sea, then such activities are considered to be prejudicial to the coastal State and will therefore render the passage non-innocent.[349] The difficulty is that it may be challenging for the coastal State to find out whether a MASS Degree 4 is actually engaged in collecting data while in passage. In case of crewed ships, clarifying doubts and ambiguities is relatively easy. For example, if the coastal State is in any doubt as to the innocence of the passage of a crewed ship in its territorial sea, it can contact the ship and ask the ship to clarify its intentions or correct its conduct. This practice is reflected in paragraph 4 of the USA-USSR Joint Statement on Uniform Acceptance of Rules of International Law Governing Innocent Passage (1989). However, it is currently unclear 'how' a coastal State may contact a MASS Degree 4 and 'who' can clarify the intentions of the vessel or correct its behaviour while in passage. Moreover, in the case of a MASS Degree 4 (which is equipped with all sorts of cameras and other detection equipment), ascertaining the exact intentions and/or activities of the vessel will be extremely difficult or impossible for the coastal State. China has banned Tesla cars from its military bases and key agencies due to concerns about the vehicles' cameras that could record sensitive information,[350] and it is not inconceivable that some States may also ban passage of autonomous vessels in their territorial sea.

To sum up, although in theory all MASS are generally entitled to the right of innocent passage, there are in practice certain challenges as to how the coastal State can ensure the passage of a MASS Degree 4 in its territorial waters is innocent. As a result, under Article 19(2)(c) of UNCLOS, some State may ban operation of MASS Degree 4 (and especially non-commercial vessels) in their territorial sea at least in certain sensitive areas. The position of some maritime powers like the US as to the right of innocent passage for MASS is that all unmanned surface and underwater vehicles enjoy the right of innocent passage in the territorial sea.[351] However, less developed countries or countries who are protective of their territorial sea may well adopt an opposing view especially with regard to MASS Degree 4 that are used for non-commercial purposes.

[349] UNCLOS, Article 19(2).

[350] Andrew Court, 'Tesla cars are 'banned from China's military bases and key agencies amid fears that the vehicles' cameras could be recording sensitive information'' (*DailyMail*, 19 March 2021) <https://www.dailymail.co.uk/news/article-9380567/Chinese-military-bans-Tesla-cars-complexes-camera-concerns-Bloomberg-News.html> accessed 07 February 2023.

[351] US Department of the Navy, 'Commander's Handbook on the Law of Naval Operations' (2017 edition) para 2.5.2.5.

2.9.5. Operation of MASS in Territorial Waters of a Foreign State (Transit Passage)

Transit passage means the exercise of the 'freedom of navigation'[352] through straits which are used for international navigation between one part of the high seas or EEZ and another part of the high seas or EEZ.[353] There are three important differences between innocent passage and transit passage. First, while the regime of innocent passage does not allow foreign 'aircraft' to fly over the territorial waters of a coastal State because it only applies to 'ships', the regime of transit passage guarantees navigation and overflight of all 'ships and aircraft'.[354] Thus, since the legal status of UAVs has been resolved as 'aircraft' in international law, UAVs enjoy the right of transit passage but not innocent passage. Second, while the regime of innocent passage does not allow submarines and other underwater vehicles to pass submerged, the regime of transit passage does not expressly require submarines and other underwater vehicles to 'navigate on the surface and to show their flag'. Instead, it allows all ships and aircraft in transit passage to operate in their 'normal modes' of operation[355] which means that transit passage includes the right of 'submerged passage'.[356] Third, while a coastal State may temporarily suspend the innocent passage of foreign ships for security or safety reasons such as weapons exercises,[357] the States bordering a strait cannot suspend transit passage of ships.[358] It can be observed, therefore, that in comparison with innocent passage, the bordering States have less power to interfere with transit passage of ships through the strait and no power to suspend the regime of transit passage. It follows that the right of transit passage extends to MASS too. Since 'transit passage' is a more inclusive regime where States have less authority to interfere with operation of ships and aircraft and no authority to suspend the regime, MASS that are generally entitled to innocent passage, enjoy transit passage too. Moreover, because unmanned aerial vehicles are considered as 'aircraft' under international law, they enjoy the right of transit passage as 'aircraft' and it would be absurd if the maritime counterparts of such vehicles didn't have such a right just because they operate on the water rather than over it. Under US doctrine, unmanned underwater

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[352] UNCLOS, Article 38(2).

[353] UNCLOS, Article 37.

[354] UNCLOS, Article 38(1).

[355] UNCLOS, Article 39(1)(c).

[356] United Kingdom Hydrographic Office, *The Mariner's Handbook* (9th edn, UKHO 2009) para 9.5.

[357] UNCLOS, Article 25(3).

[358] UNCLOS, Article 44.

vehicles (UUVs), unmanned surface vehicles (USVs) and unmanned aerial vehicles (UAVs) all enjoy the right of transit passage.[359]

Of course, the bordering States may adopt laws and regulations in respect of safety of navigation, prevention of pollution, fishing and loading or unloading of goods or persons.[360] However, given the importance of transit passage in international shipping, such laws and regulations must not have 'the practical effect of denying, hampering or impairing the right of transit passage'[361] and the bordering States cannot even temporarily suspend transit passage of ships.[362] As a hypothetical example in order to illustrate the international importance of transit passage, if Spain or Morocco denied the right of transit passage for MASS Degree 3 and/or 4, having to sail around Africa and then through the Suez Canal in order to enter the Mediterranean Sea, would make autonomous shipping between North European ports and Mediterranean or Black Sea ports economically unfeasible. Article 39(1), nevertheless, requires foreign ships in transit passage to 'refrain from any threat or use of force' against the States bordering the strait and to 'refrain from any activities other than those incident to their normal modes of continuous and expeditious transit'. So long as MASS refrain from prohibited activities, they enjoy the right of transit passage.

2.9.6. Operation of MASS in the Archipelagic Waters of a Foreign State

An archipelagic State is a State like the Philippines which is constituted wholly by one or more groups of islands.[363] Provided that certain conditions are met, archipelagic States may draw straight baselines connecting the outermost points of their outermost islands[364] in which case, the waters so enclosed are called archipelagic waters.[365] There are two types of navigational right for foreign ships in archipelagic waters. The first is a 'right of archipelagic sea lanes passage'. An archipelagic State should designate 'sea lanes' suitable for the continuous and expeditious passage of foreign ships through its archipelagic waters and the adjacent territorial sea[366] where all ships enjoy the right of

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359 US Department of the Navy, 'Commander's Handbook on the Law of Naval Operations' (2017 edition) para 2.5.3.2.

360 UNCLOS, Article 42(1).

361 UNCLOS, Article 42(2).

362 UNCLOS, Article 44.

363 UNCLOS, Article 46.

364 UNCLOS, Article 47(1).

365 UNCLOS, Article 49(1).

366 UNCLOS, Article 53(1).

archipelagic sea lanes passage.[367] And if an archipelagic State does not designate such sea lanes, all ships are nonetheless entitled to exercise the right of archipelagic sea lanes passage through the routes normally used for international navigation.[368] The provisions of UNCLOS Article 53 which govern the right of archipelagic sea lanes passage in archipelagic waters are identical to those governing the right of transit passage in international straits. The second is a 'right of innocent passage' which applies to waters outside of archipelagic sea lanes. This is a more limited right which is granted to ships of all States and which is regulated by the same provisions applicable to the regime of innocent passage elsewhere.[369] It follows that the same arguments in the foregoing sections in relation to the rights of innocent and transit passage of MASS in non-archipelagic waters, hold true in archipelagic waters too.

2.9.7. Operation of MASS in the Internal Waters/Ports of a Foreign State

Because this is the closest point to the land of a foreign State that a ship may reach, the coastal State exercises its maximum power in relation to interference with the operation of foreign ships. The coastal State is empowered by Article 25(2) of UNCLOS to refuse a MASS access to its ports if the vessel does not meet the required conditions laid down by the coastal State provided that such refusal is not an abuse of rights under Article 300 of UNCLOS. For example, whether or not the coastal State recognises MASS as ships or vessels, it may require all foreign ships calling at its port to be 'manned' and thus preclude MASS from using its ports. As noted earlier, under the domestic laws of some States, MASS are considered to be unseaworthy and accordingly those States may prevent such ships from using their ports for safety concerns. Thus, MASS designed to carry cargo may have to operate (at least initially) only between the ports of States that have a positive attitude towards such ships. China, the Philippines, Indonesia, Russia and Ukraine which are the five largest supply countries for seafarers,[370] may decide to ban MASS from entering their ports in order to support their seafarers. For example, being the crewing capital of the world, the Philippines has shown that it is not very keen on MASS as these ships would create 'a big impact on the country's economy as a seafarer nation'.[371] However, the proposal for a regulatory scoping exercise at the IMO faced no opposition

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367 UNCLOS, Article 53(2).

368 UNCLOS, Article 53(12).

369 UNCLOS, Article 52(1).

370 'Global Supply and Demand for Seafarers' <http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade/global-supply-and-demand-for-seafarers> accessed 07 February 2023.

371 'Philippines not Keen on Unmanned ships – Stakeholders' <https://www.manilatimes.net/2018/05/01/business/maritime-business/philippines-not-keen-on-unmanned-ships-stakeholders/396045/396045/> accessed 07 February 2023.

by any of those countries.[372] It therefore seems that even seafaring countries are likely to open their ports to MASS due to their safety and economic benefits in the long term.

2.9.8. Operation of MASS Degree 4 in All Maritime Zones

There are two particular issues that seem to cast doubt on 'legitimacy' of the operations of MASS Degree 4 in certain maritime zones and on 'safety' of such operations in all maritime zones. First, navigating a large ship in shallow coastal waters or docking/undocking it in most ports can be a challenging task for master mariners who are often unfamiliar with the local tidal currents and other local factors. For this reason, most coastal States have made 'pilotage' compulsory for certain vessels that intend to dock/undock or navigate in some of their coastal waters. In other words, local 'pilots' who are well-experienced and familiar with the area, will board ships to navigate and/or berth/unberth them in that area. For instance, Article 7(1) of the UK Pilotage Act 1987 empowers and obliges the harbour authority to make pilotage compulsory in any area that he or she considers the pilotage to be necessary for securing the safety of navigation. The question then is how a MASS may be navigated by a pilot in local waters. Even where pilotage is not a legal requirement, it may still be 'unsafe' to operate crewless ships in certain coastal waters. While the remote control of a MASS Degree 3 may possibly be handed over to a local pilot ashore, the situation is less clear regarding MASS Degree 4. This issue can be resolved by requiring the control mode of such vessels to be switched over from MASS Degree 4 to MASS Degree 3 in pilotage waters, or by changing the national laws as a result of advanced technology that will allow such vessels to navigate and dock/undock autonomously and without a pilot.

Second, under UNCLOS Article 220, where there are clear grounds for believing that a vessel navigating in the territorial waters or the EEZ of a foreign State has violated laws and regulations of that State or has breached the applicable international pollution-related rules, that State may undertake 'physical inspection' of that vessel. In case of a MASS Degree 3, such 'physical inspection' would be possible through communication and co-operation with the remote controller. However, in case of a MASS Degree 4 which is navigating autonomously on the water, it is currently unclear how the relevant authorities may communicate with the vessel to stop and board it in order to do the 'physical inspection'. Similarly, there is also a question mark over the successful exercise of the right of 'hot pursuit' which is given to coastal States by UNCLOS Article 111. The same uncertainty exists in case of a MASS Degree 4 which is navigating autonomously on the high seas and is suspected to be engaged in carrying unlawful goods like narcotic drugs or is suspected to have no nationality in which case warships are empowered by UNCLOS

[372] Allen H Craig, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism vs Functionalism' (2018) 49 Journal of Maritime Law and Commerce 477, 501 (footnote 73).

Article 110(1)(d) to board the vessel for investigation. If a MASS Degree 4 cannot understand and react to radio communications, then exercising the 'right of hot pursuit' (by coastal States) and the 'right of visit' (by warships) on such a vessel may be challenging. Again, the issue can be addressed by requiring such vessels to be operated by a remote operator in coastal waters. In the high seas, warships may exercise reasonable force to stop and board a MASS Degree 4 in the interests of the international community or protection of the marine environment so long as such exercise of power does not endanger the safety of navigation or otherwise create any hazard to a vessel, or expose the marine environment to an unreasonable risk.[373]

In summary, all types of MASS enjoy the freedom of navigation in the high seas. They also enjoy the same right in the EEZ and territorial waters of foreign States provided that they comply with the relevant international regulations and national laws of the coastal State. A costal State who finds a MASS in violation of international or its national regulations, or a coastal State who does not recognise any navigational rights for such a vessel may decide to seize it in its own territorial waters. The next question, therefore, is how legitimate such a seizure may be and whether such vessels enjoy any immunity.

2.10. Immunity of Different Types of 'Ship' under UNCLOS

An important classification of ships is when they are looked at from the angle of the 'purpose of operation' of the ship and 'sovereign immunity'. This is of particular importance in the context of collisions because ship arrest is a powerful weapon for a potential claimant to secure their claim after a collision has occurred. However, if a MASS enjoys sovereign immunity, then it cannot be arrested following a collision. In this regard, Subsection A of Section 3 in Part II of UNCLOS applies to 'all ships' which, as observed above, includes submarines and other underwater vehicles regardless of their purpose of operation. Apart from this overarching category of 'all ships', Section 3 introduces two specific categories of ships:

(i) Subsection B applies to 'merchant ships and government ships operated for commercial purposes'.
(ii) Subsection C applies to 'warships and other government ships operated for non-commercial purposes'.

The question here arises as to whether any given ship will fall into one of these two categories and whether there is any overlap between the two. Put another way, do these two categories encompass any imaginable type of ship? An initial analysis suggests that any given ship at any given time may be operated for either commercial or non-commercial purposes; there cannot be a third category. This view is further supported by

[373] UNCLOS, Article 225.

the rationale behind the categorisation which is itself a principle of international law on sovereign immunity under which any given ship (or entity for that matter) is either immune or not immune from foreign jurisdiction depending on the circumstances. There is no third possibility.

Article 31 of UNCLOS provides that 'warships and other government ships operated for non-commercial purposes' enjoy sovereign immunity which itself implies that 'merchant ships and government ships operated for commercial purposes' do not enjoy such immunity. Articles 16(1) and (2) of the United Nations Convention on Jurisdictional Immunities of States and Their Property (JISP) also state the same principle. Based on this approach, any given MASS will fall into one (and only one) of the following categories:

(i) warships
(ii) government ships operated for 'non-commercial' purposes
(iii) merchant ships or government ships operated for 'commercial' purposes

The key term that makes the difference is '(non-)commercial purposes'. Ships in the first and second category are immune; ships in the third categories are not. The sum of these three categories covers 'all ships' under UNCLOS. Below, each type of these categories shall be analysed in the context of MASS.

2.10.1. Warships

Being recognised as a 'warship' will have several significant consequences for a watercraft. First, it entitles the watercraft to 'complete immunity' from the jurisdiction of any State other than the flag State.[374] Second, the provisions of UNCLOS regarding the protection and preservation of the marine environment will not apply to the watercraft.[375] Third, the watercraft will be entitled to exercise the 'right of hot pursuit'.[376] Fourth, the watercraft can exercise the 'right of visit'.[377] Fifth, the watercraft will be entitled to seize pirate ships.[378] Lastly, the watercraft can exercise belligerent rights.[379]

Thus, it is vital to determine whether or not MASS can generally constitute 'warships'. Definition of 'warship' is given in UNCLOS Article 29 as follows:

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[374] UNCLOS, Articles 32 and 95.

[375] UNCLOS, Article 236.

[376] UNCLOS, Article 111(5).

[377] UNCLOS, Article 110(1).

[378] UNCLOS, Article 107.

[379] Louise Doswald-Beck (ed), *San Remo Manual on International Law Applicable to Armed Conflicts at Sea* (CUP 1995) 90.

> [A] ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list or its equivalent, and manned by a crew which is under regular armed forces discipline.

Based on this definition, in order for any given MASS to qualify as a 'warship', it must first and foremost be a 'ship' and then meet all the following conditions:

(i) The ship must 'belong to the armed forces' of a State;
(ii) The ship must 'bear the external marks' indicating its nationality and military purpose;
(iii) The ship must be 'under the command of an officer' duly commissioned by the government of the State; and
(iv) The ship must be 'manned by a crew' which is under regular armed forces discipline.

As to being a 'ship', as observed above, as long as the structure operates in the 'marine environment' it can generally be considered as a 'ship' for various UNCLOS provisions. But the question here is whether this MASS can further qualify as a 'warship'. A plain reading of the definition would exclude MASS from being warships for a warship must be 'manned by a crew' and 'under the command of an officer'. However, in the era of increasing military use of maritime drones, the manning requirement in the definition makes it out-dated and thus, a liberal interpretation to manning may be adopted so as to include remote control.[380] Such interpretation will keep UNCLOS effective and updated without having to amend the text of the Convention which would be extremely difficult given the high number of the State parties with various interests.

The counterpart of 'warship' in the aviation realm is 'military aircraft'. It is therefore useful to investigate whether a UAV may qualify as a 'military aircraft'. Although the concept of 'military aircraft' is not entirely clear in international law as UNCLOS does not provide a definition, Rule (x) in Section A of the HPCR Manual on International Law Applicable to Air and Missile Warfare defines 'military aircraft' as any aircraft:

(i) operated by the armed forces of a State;
(ii) bearing the military markings of that State;
(iii) commanded by a member of the armed forces; and
(iv) controlled, manned or pre-programmed by a crew subject to regular armed forces discipline.

[380] Robert Veal, Michael Tsimplis and Andrew Serdy, 'The Legal Status and Operation of Unmanned Maritime Vehicles' (2019) 50 Ocean Development & International Law 23, 30.

This definition is based on Articles 3 and 14 of The Hague Rules of Air Warfare[381] which themselves are considered as reflecting customary international law.[382] The surprising similarity between the HPCR Manual definition of 'military aircraft' and the UNCLOS definition of 'warship' may justify recourse to any authoritative interpretation of the definition of 'military aircraft' in order to shed some light on the definition of 'warship'. In this regard, it is worthy of note that a group of experts who were selected from the original international Group of Experts that drafted the Manual further examined the rules of the Manual and produced a *Commentary* on the rules.

The group concluded that the term 'command' refers to the individual aboard the aircraft 'or controlling it remotely'.[383] This means that as long as the aircraft is commanded by 'a member of the armed forces', it does not matter whether that person is commanding the aircraft from within the aircraft or elsewhere. The experts also opined that the requirement that the aircraft must be controlled, manned or pre-programmed by a crew under military discipline does not mean that all military aircraft must necessarily be manned by a crew.[384] Nowadays, unmanned aerial vehicles, whether armed or unarmed, qualify as military aircraft 'if the persons remotely controlling them are subject to regular armed forces discipline'.[385] In fact, as Captain Norris points out,[386] the requirement that a military aircraft must be controlled, manned, or pre-programmed by a crew under military discipline is a modern version of the original rules which required that the crew be 'exclusively military'[387] and wear a 'fixed distinctive emblem'[388] to make them recognizable at a distance if they were separated from their aircraft. Based on this interpretation, if a military aircraft does have a crew, then that crew must be subject to regular armed forces discipline.

Applying these interpretations to 'warships', if a MASS belongs to the armed forces of a State; bears the external markings; is commanded by an officer commissioned by the State and is remotely controlled by a crew which is subject to regular armed forces discipline, then that watercraft is a 'warship' within the meaning of UNCLOS. It would be

[381] A convention which was never adopted.

[382] The Program on Humanitarian Policy and Conflict Research at Harvard University, *HPCR Manual on International Law Applicable to Air and Missile Warfare* (CUP 2013) 37.

[383] Ibid 38.

[384] Ibid.

[385] Ibid.

[386] Andrew Norris, *Legal Issues Relating to Unmanned Maritime Systems: Monograph* (US Naval War College 2013) 29.

[387] Rules concerning the Control of Wireless Telegraphy in Time of War and Air Warfare, Article 14.

[388] Ibid Article 15.

absurd to designate such a watercraft anything else other than a 'warship'. Nevertheless, some have argued that MASS cannot qualify as 'warships'[389] in which case, the only available possibility would be considering them as 'government ships operated for non-commercial purposes'. This may, at first glance, seem sensible because every right granted by UNCLOS to 'warships' is equally granted to these government ships that are 'clearly marked and identifiable as being on government service and authorized to that effect':[390] Firstly, these ships also enjoy State immunity.[391] Secondly, they are also exempted from complying with UNCLOS provisions regarding the protection and preservation of the marine environment.[392] Thirdly, they can also exercise the 'right of hot pursuit'.[393] Fourthly, they can, like warships, exercise the right of visit if they are duly authorised ships 'clearly marked and identifiable as being on government service'.[394] Finally, they are also entitled to seize pirate ships.[395]

Such classification would not be problematic during peacetime. However, it is noteworthy to observe that the classification would nonetheless cause serious issues during periods of international armed conflicts as it will result in two paradoxical absurdities. First, under international law, only 'warships' can exercise belligerent rights[396] and it would be absurd if a military MASS Degree 3 that is equipped with armaments and is remotely controlled by armed forces would not be able to engage in armed conflicts merely because it is categorised as a 'government ship operated for non-commercial purposes' rather than a 'warship'. Second, under international law, military attacks must be limited strictly to 'military objectives'[397] which are defined as 'objects which by their nature, location, purpose or use make an effective contribution to military action and whose total or partial destruction, capture or neutralisation, in the circumstances ruling at the time, offers a

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[389] Michael N Schmitt and David S Goddard, 'International Law and the Military Use of Unmanned Maritime Systems' (2016) 98(902) International Review of the Red Cross 567, 579.

[390] There is one exception though: Under Article 30, the coastal State may require a warship in innocent passage to leave the territorial sea immediately if the warship does not comply with the laws and regulations of the coastal State whereas under Article 25(1) the coastal may prevent passage of other types of ship if the passage is not innocent.

[391] UNCLOS, Articles 32, 107, 111(5) and 224.

[392] UNCLOS, Article 236.

[393] UNCLOS, Article 111(5).

[394] UNCLOS, Article 110(5).

[395] UNCLOS, Article 107.

[396] Louise Doswald-Beck (ed), *San Remo Manual on International Law Applicable to Armed Conflicts at Sea* (CUP 1995) 90.

[397] Ibid Article 41.

definite military advantage.'[398] Even 'merchant ships' that engage in belligerent acts on behalf of the enemy such as laying mines, carrying troops, replenishing warships intelligence gathering or carrying out reconnaissance or surveillance may be rendered a 'military objective'.[399] In light of these rules, a MASS that belongs to the enemy and is equipped with armaments, intelligence gathering or surveillance systems, whether classified as a 'warship' or a 'government ship operated for non-commercial purposes' will obviously be a lawful 'military objective'. This is the second absurdity. To contrast the two preposterous outcomes with each other, if a military MASS Degree 3 is classified as a 'government ship operated for non-commercial purposes' rather than a 'warship', then the watercraft will not be able to initiate an attack on the enemy because it is not a 'warship' but it can nevertheless be attacked by the enemy because it is a 'military objective'. It is true that under the principle of 'self-defence' established by customary international law and re-affirmed by the International Court of Justice[400] the MASS can attack back to defend itself, but with today's advanced and powerful weapons, the first military attack on a vessel will usually mean the last attack too. It should also be borne in mind that the principles of sovereign immunity cease to apply during international armed conflicts.[401] It is, therefore, submitted that such MASS Degree 3 should be classified as 'warships'. In order to overcome the literal difficulties, it may be argued that if the technology gives the remote controller(s) a real-time picture of the watercraft and its surroundings and also real-time control over the watercraft, then the watercraft is (remotely) manned and if the remote controllers are under the command of an officer who is duly commissioned by the government of the State, then the watercraft will also be under the command of that officer.

Some commentators while supporting the possibility of warship status for MASS Degree 3, argue that the warship status cannot be supported with regard to MASS Degree 4 or 'pre-programmed autonomous' vessels.[402] This is because firstly, pre-programmed autonomous watercraft cannot be considered to be manned by a crew in any sense. Secondly, the watercraft would not be under the contemporaneous command of an officer who is commissioned by the State because performance of the watercraft has been pre-determined by the programmer in the past. Put differently, there is no real-time command by an officer over the watercraft. However, it is submitted that if a MASS Degree 4 with

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398 Ibid Article 40.

399 Ibid Article 60.

400 *Nicaragua v United States of America* (1986) ICJ 14, [194].

401 Michael N Schmitt (ed), *Tallinn Manual on the International Law Applicable to Cyber Warfare* (CUP 2013) 25.

402 Robert Veal *et al.*, 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 16.

naval warfare capabilities belongs to the armed forces of a State and has the relevant external markings, then for the same foregoing reasons it should be classified as a 'warship' in order to avoid the said issues during international armed conflicts. Interpretation therefore should be developed to overcome the literal barriers. For example, as previously mentioned in regard to 'military aircraft', the requirement that a warship must be 'manned by a crew which is under regular armed forces discipline' may be construed as 'if' a warship is to be manned by a crew 'at all', then that crew must be under regular armed forces discipline. The emphasis is on the military nature of the crew i.e. members of armed forces as distinct from civilian members and therefore it should be immaterial whether the crew (if there is a crew at all) operate the warship from a location aboard the watercraft or elsewhere. Similarly, the requirement that a warship must be 'under the command of an officer duly commissioned by the government of the State' may be interpreted to mean that if a MASS Degree 4 is pre-programmed, then in order to qualify as a 'warship', the programming of the watercraft must have been done by an individual 'duly commissioned by the government of the State'. To interpret otherwise in an emerging era of autonomous watercraft and aircraft, would not only render the relevant UNCLOS provisions out-dated and ineffective, but also would engender a whole host of issues during international armed conflicts. Military MASS Degree 3 or 4 that meet the mentioned criteria, can and should be classified as 'warships'. Based on this doctrine, even if a coastal State does not recognise the right of innocent or transit passage for MASS and finds in its territorial waters a MASS that qualifies as a 'warship', will not be able to stop, board, arrest or seize it as warships enjoy 'complete immunity' under UNCLOS. Instead, the coastal State can only require the watercraft to leave its territorial sea immediately.[403]

2.10.2. Government Ships Operated for 'Non-commercial' Purposes

The term 'government ship' is not defined in UNCLOS. However, Articles 16(1) & (2) of the JISP, Article 236 of UNCLOS, and Article 9 of the 1958 Geneva Convention indicate that a government ship is a ship which is 'owned or operated by a State'. Thus, any type of MASS that is owned or operated by a State (as distinct from an individual or a company), may qualify as a 'government ship'. Further, if such a government ship is operated for 'non-commercial purposes' such as firefighting, then it enjoys almost all of the rights, including sovereign immunity, that warships enjoy during peacetime. The chief difference is that, during international armed conflicts, such ships may not exercise belligerent rights nor can they be attacked by the enemy as a 'military objective' unless they engage in belligerent acts on behalf of the enemy.

[403] UNCLOS, Article 30.

Any ship that does not fall into one of the two previous categories will inevitably fall into the third category which includes any type of ship, State owned or privately owned, which is operated for ‘commercial purposes’. Being a merchant ship operated for commercial purposes will expose MASS found in the territorial waters of a coastal State to the risk of being seized if the coastal State does not recognise the right of innocent or transit passage for such vessels. Possible subsequent disputes then have to be settled in accordance with the resolution procedures prescribed in Part XV of UNCLOS.

2.11. Policy Grounds

The above legal arguments to establish the legal status of MASS as ‘ships’ are additionally supported on policy grounds. That is to say that interpreting MASS as ‘ships’ with UNCLOS navigational rights will benefit the international community as a whole. First, to interpret otherwise, would render UNCLOS ineffective and out-dated in the emerging era of maritime autonomous watercraft. For example, MASS can be used in maritime life-threatening operations such as firefighting and mine-clearance; they can reduce maritime accidents and subsequent damage to the marine environment; and they can also reduce the cost of cargo transportation. It is, therefore, desirable to construe them as ‘ships’ with the same navigational rights that conventional ships enjoy under UNCLOS. Second, given that the high seas are not under jurisdiction of any State and are open to all States, MASS registered in certain States will sooner or later start navigating on the high seas. If MASS are not considered as ‘ships’ entitled to navigational rights in the high seas, then what mechanism is there to prevent such MASS from using the high seas? Can a warship flying the flag of State A seize a MASS registered in State B on the high seas? If yes, ‘who’ decides that the MASS is not a ship and has no navigational rights? Since there is no judicial judgment concerning the legal status of MASS, interpretation of State B may well be different from that of State A. This uncertainty can open the way to abuse and can jeopardise the security of international shipping.

2.12. Conclusions

As highlighted in the China/US incident, the national law approach seems to be problematic because under the national laws of some States a MASS may not constitute a ‘ship’. Because this approach may cause inconsistency and conflict, the interpretation that the legal status of MASS can be decided by each individual States is untenable.

Based on treaty interpretation rules, the terms ‘ship’ and ‘vessel’ have the same meaning under UNCLOS. The ‘general’ meaning of ship under UNCLOS is so broad that it covers any human-made object which is found under, on, or in close proximity to the sea surface. The ‘specific’ meaning of ship i.e. whether or not a given MASS is a ‘ship’ for the purposes of a specific UNCLOS provision will depend on the context, in particular, the provision in question. These findings are important for two reasons. Firstly, under all other maritime conventions in which the term ‘ship’ is defined, the term covers only certain types of marine structures whereas under UNCLOS the term potentially covers ‘all’ marine structures no matter how peculiar or non-ship-like in appearance. Secondly, if a given maritime structure constitutes a ‘ship’ under other conventions, it will remain a ‘ship’ throughout the convention and for the purposes of all provisions of the convention. Under UNCLOS, however, a given MASS may constitute a ‘ship’ for the purposes of one article but not another.

All MASS even small underwater gliders that do not have the appearance of conventional ships fully enjoy the UNCLOS navigational rights in the high seas and the EEZs as a ‘ship’. An evolutionary interpretation approach also results in the same findings. In the territorial and archipelagic waters, although coastal States cannot deny the rights of innocent or transit passage of MASS solely on the grounds of their manning status, there are practical issues as to how a coastal State may verify the real intentions and/or actual activities of certain MASS Degree 4 in its waters. In the internal waters, the uncertainty is even more pronounced as coastal States exercise the strongest degree of jurisdiction in their internal waters and harbours. Thus, MASS at least initially may have to operate only in the high seas, in the EEZs and in sovereign waters of States which recognise the right of the freedom of navigation for such vessels in all maritime zones. Once the right of freedom of navigation for MASS in different maritime zones is recognised by most States, preventing innocent passage of a MASS in a State’s territorial waters may constitute an abuse of rights under Article 300 of UNCLOS which will pave the way for universal operation of MASS.

Even if the above-mentioned legal arguments do not quite establish the legal status of MASS as ‘ships’ for the purposes of the freedom of navigation in various maritime zones, such watercraft are, nonetheless, gradually gaining their legal status as ‘ships’ under customary international law. One may argue that currently there is not sufficient State practice and *opinio juris* to establish such ship status, but it must be borne in mind that rules of customary international law develop by States asserting rights that did not previously exist.[404]

[404] Michael N Schmitt and David S Goddard, ‘International Law and the Military Use of Unmanned Maritime Systems’ (2016) 98(902) International Review of the Red Cross 567, 578.

Chapter 3: Integration of MASS into a Collision Avoidance Regime: An Analysis of COLREGs at Convention Level and Framework Level

3.1. Scope and Objectives

The next step after addressing navigation of MASS in the interim period, is integrating them into a collision avoidance regime and the first step towards this goal is identifying possible ways in which such integration may be done. The first objective of this chapter, therefore, is to explore all possible routes in order to determine the most appropriate route to an integrated collision avoidance regime. To this end, a top-bottom approach will be adopted i.e. the analysis will start from convention level and then it will zoom in on the framework and lastly on the rules and provisions. The structure of this chapter is based on a hypothesis that despite the opinion of some maritime organisations, there is no compelling need to develop a totally new convention to address navigation of MASS and that the current Convention should be preserved as a whole. In other words, any changes to the current Convention should be evolutionary as opposed to revolutionary. Once the analysis at convention level is completed and the tenability of the hypothesis has been established, Chapter 3 will then take the first step towards integration of MASS into the current collision regulations which is the second objective. The present version of COLREGs were formulated about five decades ago without the concept of unmanned vessels in mind and as a result, some of the terms used in the Convention have a limited scope which may not cover unmanned watercraft. Since COLREGs apply to 'vessels',[405] the term 'vessel' will be the first port of call in the journey of identification and clarification of potential gaps or issues in COLREGs.

Zooming in from convention level to framework level, this chapter will then scrutinise the suggestion of some IMO Member States that the framework of COLREGs should be fundamentally changed. There are currently two regimes of collision avoidance under the existing COLREGs. The first regime applies to vessels that navigate in good visibility when they are 'in sight of one another' and the second regime governs conduct of vessels when they navigate in 'restricted visibility' e.g. in dense fog. The last objective of this chapter, thus, is to assess whether integration of unmanned vessels into COLREGs necessitates a change to the main structure of COLREGs. The objective of this chapter is therefore threefold.

This chapter will not consider clarification of key terms or the principles of collision avoidance in different collision situations at rule level as these will be dealt with in the next

[405] COLREGs, Rule 1(a).

chapter. Unless expressly provided otherwise, the word 'Rule' throughout this research refers to a specific Rule in COLREGs.

3.2. A Short History of Collision Regulations

For several hundred years, there have been collision avoidance rules in place without any rules of statutory force until the last century.[406] Many years before navigation of ships was regulated, the practice of seamen (which were established by custom) had created collision avoidance rules and those rules are now the foundation of the existing COLREGs in force today.[407] With the appearance of steamships in the 19th century, came a need to regulate navigation of both sailing and steam-powered ships as the steamships had a much higher manoeuvrability than the sailing ships. In 1840, the London Trinity House published the first official regulations which recited three recognised rules for sailing vessels and promulgated two new rules for steamships.[408] The two new rules were included in the Steam Navigation Act of 1846 and regulations concerning navigation lights were added to the Act two years later.[409]

In 1863, another set of regulations, several of which are still in force, were drawn up by the British Board of Trade, in consultation with the French Government and by the end of 1864, the regulations had been adopted by more than thirty maritime nations including the US and Germany.[410] In 1889, the first International maritime conference on collision regulations was held in Washington DC and the resulting regulations were brought into force by several countries including the UK and the US in 1897.[411] During the 1910 Brussels Maritime Conference, another international agreement was reached though it had only minor differences from the Washington agreement.[412] The Brussels agreement was further revised during the 1948 International Conference on Safety of Life at Sea and the revised regulations came into force in 1954.[413] Because ships were

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[406] AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules* (7th edn, Butterworth Heinemann 2012) xi.

[407] Simon Gault (ed), Steven Hazlewood (ed), Andrew Tettenborn (ed), Stephen D Girvin (ed), Edward Cole (ed), Thomas Macey-Dare (ed) and Maureen O'Brien (ed), *Marsden and Gault on Collisions at Sea* (14th edn, Sweet & Maxwell 2016) para 5-007.

[408] Richard HB Sturt, *The Collision Regulations* (3rd edn, LLP 1991) 2.

[409] AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules* (7th edn, Butterworth Heinemann 2012) xi.

[410] Ibid.

[411] Ibid xii.

[412] Ibid.

[413] Ibid.

increasingly fitted with radar during the following years, at a Conference on Safety of Life at Sea held by the Inter-Governmental Maritime Consultative Organization (IMCO)[414] in 1960, regulations regarding the use of radar and the conduct of vessels in restricted visibility were updated and came into force in 1965.[415]

In 1960, the first Traffic Separation Scheme (TSS) was devised in the Strait of Dover by a working group from the UK, France and Germany[416] and was operated on a voluntary basis which was followed in other areas of the world in the following years. The Collision Regulations of 1960 were then updated (particularly with regard to Traffic Separation Schemes) and were replaced by the International Regulations for Preventing Collisions at Sea (COLREGs) which were adopted by IMCO in 1972 and entered into force in 1977.

3.3. Evolution vis-à-vis Revolution

Articles V and VI of COLREGs contain provisions for revising and amending the Convention. Since 1972, COLREGs have not undergone any radical changes and have been amended a number of times[417] to clarify certain provisions and/or to cope with new technologies. The latest amendment came about in 2016 when the IMO added to the Convention a new Part (F) that includes three new Rules.[418] As observed above, the history of collision regulations indicates that, for centuries, the practice of seamen has always remained the foundation of such regulations. For instance, after the advent of a revolutionary type of vessels i.e. the steamships, the previous regulations concerning sailing vessels were preserved and new provisions were added to the regulations to integrate the steamships into the regime. Similarly, after the introduction of a revolutionary navigational technology such as radar, the regulations were updated to cope with the new technology. Thus, collision regulations have always undergone some form of *evolution* rather than revolution. That is to say, the regulations have always been *supplemented*

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[414] It is now called the International Maritime Organisation (IMO).

[415] AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules* (7th edn, Butterworth Heinemann 2012) xii.

[416] Ibid xii ff.

[417] In 1981, 1987, 1989, 1993, 2001 and 2007: IMO, 'Status of Multilateral Conventions and Instruments in Respect of which the International Maritime Organization or its Secretary-General Performs Depositary or other Functions' (31 July 2013) – available at <https://wayback.archive-it.org/all/20130827232026/http://www.imo.org/About/Conventions/StatusOfConventions/Documents/Status%20-%202013.pdf> accessed 07 February 2023.

[418] IMO Resolution A.1085(28) – available at <http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Assembly/Documents/A.1085(28).pdf> accessed 07 February 2023.

with new provisions to accommodate a new technology or have been *amended* to clarify potential ambiguities, but they have never been radically changed.

In light of the emergence of another revolutionary type of vessels i.e. unmanned vessels which are on the not-so-distant horizon, the question, once again, arises as to whether these new vessels can be integrated into the current collision avoidance regime in an evolutionary process. As shall be observed below, there are organisations and IMO Member States that argue that these new vessels are so revolutionary that their integration calls for a revolutionary change to the current regulations. There are potentially three conceivable ways in which the issue may be addressed. The first is through a revolutionary step of developing a completely new and different *qualitative* convention. The second is developing a set of *quantitative* regulations which would also be a revolutionary approach. The third is amending the current qualitative COLREGs in a piecemeal fashion i.e. an evolutionary approach. Each of these shall be analysed below.

3.4. A New Qualitative Convention

Some may argue that the fourth category of MASS are currently incapable of complying with the subjective and human-oriented provisions of COLREGs and therefore a completely new set of qualitative collision regulations should be developed to address their collision avoidance. For instance, Denmark has suggested that, rather than seeking to develop fully COLREGs-compliant algorithms, a new set of regulations should be developed for MASS Degree 4.[419] However, it is submitted that developing a completely new convention would do more harm than good for the following reasons. First, developing a new and different qualitative convention in early stages in order to integrate unmanned vessels into a collision regulation regime would stifle the autonomous collision avoidance technology that would otherwise have to find a way to develop a COLREGs-compliant autonomous system. While developing and enforcing untested new collision regulations may bring about dangerous consequences, there is no harm in requiring MASS Degree 4 to fully comply with the current or an amended version of the current regulations. Quite the contrary, it will lead to development of a sophisticated, intelligent and safe collision avoidance technology. Necessity is the mother of invention. Second, the current collision regulations have withstood the test of time. Creating a novel set of regulations that are not tested on a large scale over a long time, may ironically cause unexpected disruptions, confusions and collisions. For new individuals who join the world of marine navigation for the first time, learning a totally new set of collision regulations may not be difficult or confusing. However, it would be practically difficult or even impossible for millions of ordinary and professional individuals who have complied with

[419] IMO Doc MSC 99/INF.3, para 3.4.1.2 – available at <https://www.transportstyrelsen.se/contentassets/814ad4d3513a461db47cfe377cd1d892/99-inf3.pdf> accessed 07 February 2023.

and accustomed to the existing COLREGs for years, to suddenly (from the date of the entry into force of a new convention) start complying with radically different rules. Not only would it be impossible but it would be dangerous as it would defeat the purpose of any collision avoidance regime. This is particularly so for ordinary individuals who lack professional maritime qualifications. Although COLREGs apply to all vessels[420] registered in any of the 163 Contracting States,[421] not all seafarers who work on such vessels are required to have the same training and knowledge of collision regulations. As will be demonstrated below, a large number of individuals on certain vessels may not even have any maritime qualifications at all.

Currently, the international standards of education and training for seafarers is set out by the STCW Convention which applies only to seafarers who serve on board 'seagoing ships'.[422] The Convention defines a seagoing ship as 'a ship other than those which navigate exclusively in inland waters or in waters within, or closely adjacent to, sheltered waters or areas where port regulations apply.'[423] The Convention, therefore, does not apply to many individuals who operate vessels exclusively in coastal or inland waters. Furthermore, the standards do not apply to seafarers who work on 'fishing vessels'.[424] Instead, a tailored convention that requires less navigational knowledge and training i.e. the STCW-F Convention applies to such seafarers. However, even though the requirements of the STCW-F Convention are less stringent, they apply only to seafarers who work on fishing vessels of 24 metres in length and over[425] but not to smaller fishing vessels. There are currently over 19,000 fishing vessels of less than 500 gross tonnage in the world fleet.[426] The mathematical relationship between gross tonnage and overall length for vessels is a complicated one. However, a study has found that about one-half of the vessels of 26 metres in length would be expected to be under 100 gross tonnage.[427] This means there are several thousand fishing vessels of less than 24 metres in length that engage in fishing in busy coastal waters around the world but the crew members on

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[420] Rule 1(a).

[421] IMO, 'Status of Treaties' (14 June 2022) – available at <https://wwwcdn.imo.org/localresources/en/About/Conventions/StatusOfConventions/StatusOfTreaties.pdf> accessed 07 February 2023.

[422] Article III.

[423] Article II(g).

[424] Article III(b).

[425] STCW-F Convention, Chapter II, Regulations 1 to 4.

[426] Equasis, 'The World Merchant Fleet in 2020', Table 1 – available at <http://www.emsa.europa.eu/equasis-statistics/items.html?cid=95&id=472> accessed 07 February 2023.

[427] Victor Restrepo, 'Relationship between Gross Tonnage and Overall Length for Vessels on the ICCAT Record' (2013) ISSF Technical Report 1, 6.

these vessels are not required to have the COLREGs-related knowledge laid down by the STCW-F Convention. Moreover, not all countries are a Contracting State to the Convention. In fact, at present there are only 32 Contracting States to the STCW-F Convention.[428] Thus, the vast majority of countries are not a Party to the Convention and the crew members who work on any fishing vessel (whether less or more than 24 metres in length) registered in any of the many non-contracting States are not required to hold the qualifications set out by the STCW-F Convention.

There is also another group of individuals who are not covered by the STCW Convention. The standards set out by the Convention do not apply to individuals who serve on board 'pleasure yachts not engaged in trade'.[429] To demonstrate the global scale of the impact of this provision, suffice to say that, in 2018, there were about 12 million registered recreational boats in the United States alone.[430] Over 87 million American people participate in recreational boating, using a boat for sports activities[431] and about 95% of such boats are less than 26 feet (7.9 metres) in length.[432] Also, in European waters, there are over 6 million boats with some 36 million European citizens regularly participating in recreational boating activities.[433] The absence of mandatory international training standards applicable to individuals who work on above-mentioned fishing and pleasure vessels may explain the high number of accidents involving such vessels. Over the period of 2011 to 2018, fishing vessels remained the category of vessel with the highest number of ships lost[434] and collision was the second most frequent category of

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[428] STCW-F.1/Circ.26, 'International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel, 1995' (27 November 2019) – available at <http://shippingregs.org/Portals/2/SecuredDoc/Circulars/STCW-F.1-Circ.26.pdf?ver=2019-12-05-114613-747> accessed 07 February 2023.

[429] STCW Convention, Article III(c).

[430] 'U.S. Recreational Boating Industry Sees Seventh Consecutive Year of Growth in 2018, Expects Additional Increase in 2019' (*The US National Marine Manufacturers Association*, 01 October 2019) <https://www.nmma.org/press/article/22428> accessed 07 February 2023.

[431] 'Recreational Boating - Statistics & Facts' (*Statista*, 29 January 2019) <https://www.statista.com/topics/1138/recreational-boating/#:~:text=In%20total%2C%2011.87%20million%20recreational,inboard%20boats%20and%20outboard%20boats.> accessed 07 February 2023.

[432] Ibid.

[433] 'Facts and Figures' (*The European Boating Industry*) <https://www.europeanboatingindustry.eu/facts-and-figures> accessed 07 February 2023.

[434] EMAS, 'Annual Overview of Marine Casualties and Incidents 2019' (2019) page 8 – available at <http://www.emsa.europa.eu/news-a-press-centre/external-news/item/3734-annual-overview-of-marine-casualties-and-incidents-2019.html> accessed 07 February 2023.

casualty event per fishing vessel type.[435] In relation to high number of collisions involving fishing vessels, studies carried out by MAIB indicate that two explanations feature repeatedly: an unattended wheelhouse or the watchkeeper's lack of knowledge as there have been several instances where the watchkeeper was found to have only a rudimentary knowledge of COLREGs.[436] Statistics indicate that the number of maritime accidents involving recreational vessels are also high.[437] According to the US Coast Guard statistics, in 2018, 'collision with recreational vessel' was the top primary type of accident among all types of recreational vessels.[438] Although survey results suggest that the main reasons behind nautical accidents involving recreational vessels are human and technical failures, the vast majority of stakeholders have stated during interviews that in most cases it is the 'lack of skills and experience' that causes such accidents.[439]

The upshot is that there are millions of smaller vessels around the world that are navigated by millions of individuals to whom the training standards of the STCW or STCW-F Convention do not apply and thus, they may have very limited knowledge and understanding of COLREGs. A fundamentally different set of collision regulations, therefore, is likely to make the water murkier, confuse this huge category of non-professional individuals and pose a serious danger to the safety of navigation. A unique aspect of COLREGs is that they are public-facing regulations that are applied by individuals from a wide background who navigate all sorts of vessels. Ordinary individuals with little or no professional navigational knowledge who navigate small fishing or recreational vessels, and master mariners with the highest level of maritime qualifications who navigate super tankers, should all understand and apply the collision regulations in the same way. In favour of a new convention, some may argue that where there is a risk of collision, all navigators, regardless of the level of their knowledge of COLREGs, can

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435 Ibid Figure 4.7.

436 Jennifer M Lincoln (ed), Diana S Hudson (ed), George A Conway (ed) and Rachel Pescatore (ed), 'Proceedings of the International Fishing Industry Safety and Health Conference' (2000) The US National Institute for Occupational Safety and Health, page 70 – available at <https://www.cdc.gov/niosh/docs/2003-102/pdfs/2003-102.pdf?id=10.26616/NIOSHPUB2003102> accessed 07 February 2023.

437 J Torralbo and M Castells, 'Comparison of Survival and Safety Requirements in European Union for Recreational Craft Inspections: A Spanish Case Study' (2014) 8(1) International Journal on Marine Navigation and Safety of Sea Transportation 103, 103.

438 The US Coast Guard, '2018 Recreational Boating Statistics' (August 2019) Table 1 – available at <https://www.uscgboating.org/library/accident-statistics/Recreational-Boating-Statistics-2018.pdf> accessed 07 February 2023.

439 ECSIP Consortium, 'Study on the Competitiveness of the Recreational Boating Sector' (November 2015) Final Report, page 84.

always contact each other on radio communication equipment such as VHF[440] radio and clarify their intention and avoid collision. Be that as it may, small vessels may not always have an operational VHF radio set on board, and even if they do have the equipment, it may be difficult or even impossible for all navigators from different nationalities to speak in a common language effectively. Furthermore, the crucial time that should be used to take an evasive action, may be wasted by trying to contact the other vessel on the VHF. After all, it is currently impossible to confirm the identity of individuals in a VHF radio communication. These may explain why 'it has been emphasized many times that ships should be navigated by reference to the Collision Regulations and not by V.H.F.'.[441] It follows that, if the integration of MASS is to be through amendments to the present collision regulations, an amended version of COLREGs should be sufficiently clear and unequivocal to be comprehensible by all ordinary and professional individuals. The courts of different countries should also interpret collision regulations uniformly so that mariners of different countries and different languages can also understand and apply them uniformly. As the last argument against a drastically different collision regulation regime, it can be argued that a new qualitative convention, however much different from the existing COLREGs, would still be *qualitative* i.e. would still be open to interpretation and would still be difficult to comprehend by machines. There is, therefore, not much point in developing another (totally new) qualitative convention.

3.5. A New Quantitative Convention

The second way of addressing collision avoidance of MASS may be through developing *quantitative* rules and equipping vessels with collision avoidance software and mechanisms that follow such quantitative rules. For example, in the aviation industry, due to several serious mid-air collisions, the industry has developed quantitative collision prevention rules which are codified into the Traffic Collision Avoidance System (TCAS) of aircraft and take precedence over the pilot or the air traffic controllers.[442] The *Überlingen* mid-air collision (where 71 passengers and crew were killed) was a result of one of the pilots following the air traffic controller's order (i.e. a human agent) instead of the TCAS.[443] Because qualitative rules are open to interpretation, it has been suggested by the classification society DNV that the same approach should be adopted in the shipping

[440] Very High Frequency.

[441] *The Angelic Spirit and Y Mariner* [1994] 2 Lloyd's Rep 595, 605.

[442] Bjørn Johan Vartdal, Rolf Skjong and Asun Lera St Clair, 'Remote-controlled and Autonomous Ships in the Maritime Industry' (*DNV GL-Maritime*, 2018) <https://www.dnvgl.com/maritime/publications/remote-controlled-autonomous-ships-paper-download.html> accessed 07 February 2023.

[443] '2002 Überlingen mid-air collision' <https://en.wikipedia.org/wiki/2002_%C3%9Cberlingen_mid-air_collision> accessed 07 February 2023.

industry by developing and adopting *quantitative* collision avoidance rules for MASS Degree 4 and thereby leaving no room for interpretation.[444]

However, the following issues cast doubt on the success and effectiveness of such a system in the maritime world. First, one may argue that such quantitative rules should be executed by a collision avoidance system independently, without human intervention, and without navigators even knowing what such quantitative rules are. However, making such a system compulsory at all times and for all vessels would be unreasonable as many people take up recreational boating just because they enjoy navigating the vessel *themselves*. Likewise, making a quantitative-based system the only controller of the vessel would be unwise. It is conceivable that such a system, like any other autonomous system may malfunction occasionally and if the human being who is locally or remotely in charge of navigation of the vessel does not know what needs to be done in a collision situation, it can potentially lead to conflicting actions and collision.

Second, it could be argued that such rules should primarily be executed by the system, but mariners should also know the rules so that they can navigate the vessel in compliance with the rules in the event that the system fails. However, remembering, understanding and complying with a series of quantitative (numerical) rules in each collision situation would be a mentally demanding task particularly when risk of collision exists and especially for millions of individuals who are not professional mariners and are not covered by international training standards such as those set out by the STCW Convention. Such rules would also be difficult to introduce or enforce as many IMO Member States do not have mandatory recreational boating education or licensing arrangements.

Third, one may argue that such quantitative rules should only be used by MASS Degree 4, and all conventional and MASS Degree 3 should follow an amended version of the existing qualitative COLREGs. If a set of quantitative rules produce an action different from or in contradiction to COLREGs, then this would clearly be undesirable as it would create uncertainty and confusion. Conventional vessels and MASS are likely to co-exist and interact with each other in the same waters for a long period of time. Thus, in the long interim period, all vessels will have to follow one set of collision avoidance rules so that in multi-ship encounter situations involving autonomous and manned or remotely operated vessels, each vessel can reasonably foresee the action of other vessels and avoid conflicting actions. Seafarers on manned ships should be reassured that MASS follow the same rules so that they can predict and comprehend the behaviour of MASS in different situations. Moreover, unless all humans give up the pleasures of cruising,

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[444] Bjørn Johan Vartdal, Rolf Skjong and Asun Lera St Clair, 'Remote-controlled and Autonomous Ships in the Maritime Industry' (*DNV GL-Maritime*, 2018) <https://www.dnvgl.com/maritime/publications/remote-controlled-autonomous-ships-paper-download.html> accessed 07 February 2023.

yachting, boating and fishing, a full transition from manned to MASS Degree 4 will never happen. Even if such quantitative rules are in perfect harmony with COLREGs, then turning them into a set of legally binding regulations would still be redundant. Instead, the industry can use the current or an amended version of the current quantitative COLREGs as a point of reference from which such quantitative rules (which are more readily intelligible to machines) can be extracted without necessarily turning such rules into a new convention.

Fourth, there are certain navigation concepts that simply cannot be quantified. For example, as a general principle of navigation, a give-way vessel must take ‘early and substantial’ action to keep well clear.[445] The question is whether the variables ‘early’ and ‘substantial’ may be quantified in a sensible and safe way. In the open sea where there are only two vessels involved in a situation, ‘early’ may mean taking action five minutes before reaching the potential collision point, and an alteration of course of forty degrees can be considered as ‘substantial’. In busy and confined waters, however, taking action five minutes in advance may be too early and altering forty degrees may be too dangerous of an action given the traffic density in the area. In such a situation, ‘early’ may mean one minute away from the collision point, and a course alteration of ten degrees may be considered ‘substantial’. The value of the two variables ‘early’ and ‘substantial’, therefore, is dependent on the circumstances such as the traffic density and the course and speed of other vessels. In other words, the large number of vessels in a limited space, changes the value of the variables ‘early’ and ‘substantial’ and an evasive manoeuvre for one vessel may lead into a close-quarters situation with another vessel and so on, in a cascading interaction effect with unpredictable results.[446] The concept of ‘early and substantial,’ thus, cannot be codified in a quantitative way.

Above all, the IMO Resolution A.500(XII)[447] directs the Council and the Committees of the IMO to consider a proposal for a new convention only if the proposal demonstrates the compelling need for such a new convention and addresses the cost to the maritime industry and the relevant legislative and administrative burdens. The importance of these

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445 COLREGs, Rule 16.

446 Thomas Porathe, ‘Maritime Autonomous Surface Ships (MASS) and the COLREGS: Do We Need Quantified Rules or is “the Ordinary Practice of Seamen” Specific Enough?’ (2019) The International Journal on Marine Navigation and Safety of Sea Transportation 511, 514.

447 IMO Resolution A.500(XII), ‘Objectives of the Organization in the 1980s’ (20 November 1981) – available at <https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.500(12).pdf> accessed 07 February 2023.

requirements is also highlighted in other IMO Resolutions[448] and Guidelines.[449] There is currently no evidence or study to establish that maritime collisions between manned vessels re-occur and collisions involving MASS are likely to occur solely because the existing collision regulations are qualitative and not quantitative. Thus, it can be argued that there is, as such, no *compelling* need for replacing the current qualitative COLREGs with a set of quantitative rules. Furthermore, adopting a mandatory set of quantitative rules will have substantial cost implications for the commercial and recreational maritime users. Unlike the provisions of other IMO conventions such as SOLAS that apply only to certain types of vessels, the application of COLREGs is virtually all-embracing as the merchant ships to which the Convention applies represent over 99% of the gross tonnage of the world's merchant shipping.[450] COLREGs also apply to all non-merchant vessels registered in any of the Contracting States that operate in the high seas or in waters connected with the high seas[451] i.e. the territorial waters. New quantitative rules would require such a countless number of vessels to install quantitative collision avoidance systems on board which would be economically unfeasible for many, especially smaller and non-commercial vessels. The legislative burden associated with the development of such quantitative rules will also be enormous as it would require taking an unprecedented step of devising and developing a radically different set of rules. A proposal for a quantitative convention made by any Contracting State or organisation at the IMO, therefore, has currently no reasonable prospect of being considered by the IMO's Maritime Safety Committee. Even if the IMO does consider such a proposal and even if (in the unlikely event) the IMO does develop a quantitative convention, the chances of success in the ratification of such a convention and its effective implementation will remain extremely low due to the unpreparedness of the industry.

3.6. Amending the Existing COLREGs

Setting aside the first two potential approaches, the only remaining way of integrating MASS into a collision avoidance regime is identifying the potential gaps or deficiencies in the existing COLREGs and amending the Convention in an incremental manner in order to address the issues while also minimising the risk of confusion and unexpected outcomes. At any rate, coming to a conclusion that a new qualitative or quantitative

[448] E.g. IMO Resolution A.998(25), 'Need for Capacity-Building for the Development and Implementation of New, and Amendments to Existing, Instruments' (3 January 2008).

[449] E.g. IMO Doc MSC-MEPC.1/Circ.4/Rev.4, 'Guidelines on the Organization and Method of Work of the Maritime Safety Committee and the Marine Environment Protection Committee and Their Subsidiary Bodies' (10 June 2015).

[450] IMO Doc COLREG.1/Circ.161, 'Convention on the International Regulations for Preventing Collisions at Sea, 1972: Accession by Uganda' (03 April 2019).

[451] Rule 1(a).

convention needs to be developed, is in fact impossible without actually analysing the provisions of COLREGs first. This research, therefore, will attempt to scrutinise the framework and provisions of COLREGs in the context of MASS and the hypothesis that MASS should comply with the essence of the existing collision regulations will be the point of departure.

The current version of COLREGs consists of nine Articles, forty-one Rules and four Annexes. The Articles contain provisions regarding Parties to the Convention, its ratification, entry into force, revision and amendment. The Rules have been divided into six Parts. Part A covers general matters such as application of COLREGs to vessels, responsibility to comply with (or to depart from) COLREGs and the definition of the terms used in COLREGs. Part B, which is pivotal to collision avoidance manoeuvres, lays down the Steering and Sailing Rules. Part C lays down provisions for the use of navigation lights and shapes. Part D provides rules for the use of sound signals and light signals under certain circumstances. Part E contains exemptions from rules relating to lights and sound signals to allow a transitioning period for vessels the keel of which was laid before the entry into force of COLREGs to adapt themselves with the requirements of the new regulations. Lastly, Part F sets out the rules for compulsory periodic audit of Parties to the Convention. The Annexes deal with technical details for lights, shapes, sound signal appliances and distress signals. The structure of COLREGs, however, can generally be reduced to a *code of conduct* i.e. a script to follow when vessels meet, and a *code of signals* i.e. a special set of lights, day shapes and sound signals to exchange data essential to following that script.[452] Since the Rules lie at the heart of COLREGs in terms of collision avoidance, the main focus of this chapter will be on the most important Rules of COLREGs.

3.6.1. Integration of MASS into the Current Collision Regulations

The Rules apply to 'all *vessels* upon the high seas and in all waters connected therewith navigable by seagoing vessels.'[453] The question then arises as to whether a MASS is a 'vessel' for the purposes of COLREGs. Being adopted after the Vienna Convention of the Law of Treaties, COLREGs is an international convention that should be construed in accordance with the Vienna Convention. Article 31(1) of the Vienna Convention provides that a treaty must be interpreted 'in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' The 'ordinary' meaning of the term 'vessel' may exclude a small watercraft which is not vessel-like and does not have any carriage capability. However, particular attention should also be given to the 'object and purpose' of the convention in question.

[452] William P Crawford, *Mariner's Rules of the Road* (Norton & Co 1983) 1.

[453] Rule 1(a) (emphasis added).

The object of COLREGs, as the name of the convention suggests, is to prevent collisions at sea and in a wider sense, to 'maintain a high level of safety at sea'.[454] In order to achieve this object, a 'purposive' rather than a literal approach should be adopted to interpret the term 'vessel'. In other words, any watercraft that may pose a risk of causing collision or damage to other vessels or structures must be subject to COLREGs as a 'vessel'. There is some evidence that supports this purposive approach. For example, Rule 5 of COLREGs requires every vessel to maintain a proper lookout by sight and hearing at all times. Since 'sight and hearing' are human qualities, a literal interpretation of Rule 5 would require the officer of the watch (OOW) to keep an aural watch with his or her ears in order to hear outside sound signals around the vessel. However, the OOW may keep a navigational watch in an enclosed bridge or on a high-speed craft where sounds may not be heard very well due to the enclosed bridge or the high ambient noise. Alternative solutions were accepted first informally through class requirements and then formally through an amendment to SOLAS.[455] SOLAS now requires a ship with a totally enclosed bridge to have 'a sound reception system, or other means, to enable the officer in charge of the navigational watch to hear sound signals and determine their direction'.[456] The 'purpose' of the hearing requirement in Rule 5 i.e. receiving outside sound signals can be achieved through electronic hearing systems. A purposive approach, therefore, may be adopted in construing COLREGs.

The term 'vessel' is defined in Rules 3(a) as 'every description of water craft, including non-displacement craft, WIG [wing-in-ground] craft and seaplanes, used or capable of being used as a means of transportation on water.' It is, therefore, the 'transportation' capability and not the manning status that is crucial for a watercraft to be a vessel. It goes without saying that the first and second categories of MASS are certainly vessels since there are seafarers on board and the MASS can be considered as a means of transportation of the seafarers. Even for the third and fourth categories of MASS where there is no one on board, if the MASS is 'capable' of transporting goods or people, it is still a 'vessel' and must comply with COLREGs accordingly. For example, a MASS Degree 3 or 4 in ballast condition (light ship) with empty cargo holds bound for its loading port, is still a 'vessel' as it is 'capable' of transporting goods on water. The position, however, is less straightforward regarding a MASS which is incapable of transporting goods or people due to its purpose, size or construction.

The significance of this issue is not purely academic or theoretical. The issue of what constitutes a 'vessel' in a broader maritime law context, is not static because

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454 COLREGs, the Preamble.

455 Henrik Ringbom, 'Regulating Autonomous Ships—Concepts, Challenges and Precedents' (2019) Ocean Development & International Law 1, 13.

456 Regulation V/19.2.1.8.

technological progress regularly calls for newly focused and sometimes entirely new criteria.[457] It has been stated that the greatest challenge that Admiralty judges have ever faced is adapting principles of general maritime law to the changing technology in structures claimed to be vessels.[458] The fact that the Supreme Court of the United State re-considers vessels every few years,[459] attests to this statement. When it comes to collision regulations, addressing the issue is of paramount importance from a safety standpoint. In fact, the most crucial matter in integrating MASS into COLREGs is ensuring that all types of watercraft (regardless of their size, structure or purpose) are unequivocally covered by Rule 3(a) so that they are obliged to adhere to COLREGs in order to avoid collisions.

Bearing in mind that all collision cases have so far involved watercraft that were used or were capable of being used as a means of transportation on water, a case concerning interpretation of the term 'transportation' within the meaning of Rule 3(a) is yet to come before courts. There are, nevertheless, fairly similar definitions of 'vessel' in national legislation of certain States where authoritative interpretation *might* be helpful. In the US maritime law, the terms 'ships' and 'vessels' are used in a very broad sense to include all navigable structures intended for 'transportation'.[460] In fact, Section 3 of the US Rules of Construction Act provides a definition for 'vessel' which is, in effect, identical to that of Rule 3(a) of COLREGs: 'The word "vessel" includes every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water.'[461] The term 'transportation' in this definition has had its interpretive ups and downs in the US courts over the years. Focusing on a recent (2007) case, however, in *Stewart v Dutra Construction Co*,[462] the structure in question was a massive dredge that could navigate only by manipulating its anchors and cables or by being towed and when in operation, it moved over water about 10 to 15 metres every couple of hours. The US Supreme Court slightly narrowed the scope of the definition and introduced a new dimension to the term 'transportation' by stating that a watercraft is a 'vessel' only if it is

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457 David W Robertson and Michael F Sturley 'Vessel Status in Maritime Law: Does Lozman Set a New Course' (2013) 44(4) Journal of Maritime Law and Commerce 393, 395.

458 W Eugene Davis, 'The Role of Federal Courts in Admiralty: The Challenges Facing the Admiralty Judges of the Lower Federal Courts (2001) 75 Tulane Law Review 1355, 1375.

459 John AC Cartner, Richard P Fiske and Tara L Leiter, *The International Law of the Shipmaster* (Informa Law 2009) 84 (footnote 32).

460 Nigel Meeson and John A Kimbell, *Admiralty Jurisdiction and Practice* (5th edn, Informa Law 2017) para 2.23

461 Available at <https://www.law.cornell.edu/uscode/text/1/3> accessed 07 February 2023.

462 [2005] AMC 609.

‘*practically* capable of being used’ as a means of transportation on water.[463] Since the structure was regularly (although not primarily) used to transport workers and equipment on water, it was *practically* capable of transporting goods and people and it was, accordingly, held to be a ‘vessel’.

Although a ‘practical possibility’ is far more concrete than mere ‘theory’, it remains, to some extent, technically abstract[464] and experts believed that the decision solidified the proposition that the transportation requirement includes the transportation of machinery and equipment incorporated in or installed on the structure that enables it to carry out its special purpose.[465] The next case, however, disturbed that proposition. About eight years later, in *Lozman v City of Riviera Beach, Florida*,[466] a similar issue that concerned a ‘borderline’ case (i.e. a floating house-like plywood structure with non-watertight French doors) came before the US Supreme Court. The Court stressed that the term ‘capable’ must not be interpreted too broadly[467] i.e. it must be applied in a ‘practical’, not a ‘theoretical’ way.[468] The Court then introduced a new ‘reasonable observer’ test that may be used in ‘borderline’ cases i.e. where ‘capacity’ to transport on water is in doubt: a structure does not fall within the scope of the definition of ‘vessel’ unless a reasonable observer, looking to the structure’s physical characteristics and activities, ‘would consider it designed to a *practical degree* for carrying people or things over water.’[469] The Court, accordingly, concluded that the floating home did not amount to a ‘vessel’ because there was nothing that could lead a reasonable observer to consider it designed to a ‘practical degree’ for transportation on water, and in the actual fact, the structure did not do so. In other words, the home had no feature to suggest it had been designed to transport ‘anything other than its own furnishings and related personal effects’.[470] The Court interpreted the term ‘transportation’ in a literal way i.e. ‘conveyance (of things or persons) from one place to another’.[471]

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[463] Ibid 617 (emphasis added).

[464] J Neale deGravelles, ‘Uncertainty in Vessel Status after Lozman v. Riviera Beach, Florida-An Analysis and Review of Recent Developments’ (2014) 14(1) Loyola Maritime Law Journal 56, 65.

[465] David W Robertson and Michael F Sturley, ‘Vessel Status in Maritime Law: Does Lozman Set a New Course?’ (2013) 44(4) Journal of Maritime Law and Commerce 393, 485.

[466] [2013] 1 Lloyd’s Rep Plus 17.

[467] Ibid 21.

[468] Ibid 22.

[469] Ibid 22 (emphasis added).

[470] Ibid 23.

[471] Ibid 21ff.

The interpretations of the US Supreme Court are quite narrow and if applied to the definition of 'vessel' in Rule 3(a), they would exclude any MASS e.g. a research vessel which is 'practically' incapable of carrying goods or persons. An expansive interpretation may bring some of those potentially excluded vessels within the definition. For example, a MASS which is incapable of carrying anything, if powered by fuel, may be said to be 'transporting' i.e. carrying the fuel even though it is neither designed nor meant to be primarily used so. Nonetheless, even such liberal interpretation would still leave some watercraft out of the definition. It is conceivable that many of such MASS will be battery-powered or solar-powered in which case it would be difficult to argue that they will be carrying anything at all. This is because firstly, electricity is not tangible and secondly the increase in the mass of a battery or a solar panel when they become fully charged, is absurdly close to zero. Even for the world's largest all-electric ferry, *The E-Ferry Ellen*, which has an unprecedented battery capacity of 4.3 MWh,[472] the total mass of the batteries, when fully charged, will increase by a paltry 172 *micro* grams[473] which is virtually zero when compared to the mass of the ship or anything else in the maritime world for that matter. Applying the principles of *Lozman*, such a minuscule transportation capability would be a purely 'theoretical' rather than 'practical' capacity of transportation on water. Can then such a battery-powered MASS which is not capable of carrying anything beyond its own mass be considered to be 'transporting' a number of batteries, cables and sensors? An answer in the affirmative would be contrary to the view of the US Supreme Court in *Lozman* because such pieces of equipment are *permanent* and *integral* parts of the MASS. The MASS is not carrying or transporting anything *in addition* to its own machinery; such sensors and other equipment all together constitute the MASS and make it what it is meant to be.

The interpretations of the US Supreme Court, therefore, are of little assistance as they would exclude certain MASS. A watercraft left out of the scope of Rule 3(a) would mean a potential danger to safety of navigation. The issue of 'transportation' requirement in Rule 3(a), therefore, needs to be addressed unequivocally. One way of doing so, may be through more expansive interpretations. For example, under the UK Merchant Shipping Act 1995,[474] in order to be a 'ship', a watercraft has to be used in 'navigation' and it has been suggested that there is no significant difference between the 'navigation' and 'transportation' requirements as they both simply intimate 'capability of controlled

[472] James Ellsmoor, 'The World's Largest Electric Ferry Has Completed Its Maiden Voyage' (*Forbes*, 18 August 2019) <https://www.forbes.com/sites/jamesellsmoor/2019/08/18/the-worlds-largest-electric-ferry-has-completed-its-maiden-voyage/#383515e6556a> accessed 07 February 2023.

[473] The famous formula $E = mc^2$ has been used.

[474] Section 313(1).

movement'.[475] While covering the vast majority of watercraft, even this expansive interpretation is not all-inclusive and would still leave some potential vessels out of the definition. For instance, the interpretation would mean that a Rule 3(a) vessel which through a permanent engine breakdown starts to drift on the water would no longer be a vessel as it no longer has any 'capability of controlled movement' on the water. However, such a vessel will still remain a 'vessel' within the meaning of COLREGs: a 'vessel not under command'[476] who must display the appropriate lights or day shapes[477] to inform and warn other vessels in the area. Even if due to a further technical failure, the vessel experiences a complete and prolonged power outage at night and becomes unable to display any navigation light at all, it would still remain a 'vessel' and must still comply with COLREGs. It may seem odd and hard to find any specific provision in COLREGs that would apply to such a totally disabled watercraft requiring it to do anything. However, the overarching principle of the 'ordinary practice of seamen' (otherwise known as 'good seamanship') prescribed in Rule 2(a), covers all such unspecified situations. In order to prevent collision, therefore, such a vessel must do whatever she reasonably can under the circumstances. Using a battery-powered handheld VHF radio to warn the nearby traffic and/or flashing the Aldis lamp[478] or a torch at approaching vessels may be considered to be good seamanship in this scenario. An amended Rule 3(a) should make it clear that every conceivable watercraft is a 'vessel' who must at all times comply with specific Rules of COLREGs and/or the principles of good seamanship. It is particularly crucial for designers and programmers of MASS to bear this point in mind as such vessels may be more prone to protracted technical failures given the lack of on-board technicians. Hence, the foregoing arguments call for a clearer and more inclusive definition of 'vessel' and it seems that Rule 3(a) should be reformulated by eliminating the 'transportation' requirement and thereby covering all watercraft that do not have any practical capability to transport goods or persons.

Further, based on Rule 3(a), a watercraft is a 'vessel' only if it is used 'on' water. Strictly speaking, the preposition 'on' excludes submarines navigating *close* to the surface of water from the definition of 'vessel'. However, such submarines present invisible danger to surface vessels navigating in the area and must, therefore, be required to comply with COLREGs as 'vessels'. From a safety perspective, any craft operating close to the water surface may create a risk of collision with other craft in the vicinity and it is, therefore, imperative for COLREGs to apply to 'any' craft operating on or close to the water surface

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[475] Simon Gault (ed) *et al*., *Marsden and Gault on Collisions at Sea* (14th edn, Sweet & Maxwell 2016) 173, footnote 367 and the accompanying text.

[476] Rule 3(f).

[477] Rule 27(a).

[478] A portable handheld lamp primarily used to transmit Morse code.

regardless of its transportation capability. Just because a craft is navigating ‘below’ (but close to) the water surface, should not give the craft an excuse to exempt itself from complying with COLREGs as a non-vessel object. It is submitted that the following proposed definition would address the aforementioned issues caused by the word ‘transportation’ and the preposition ‘on’:

The term ‘vessel’ includes any craft including non-displacement craft, WIG craft, seaplanes and MASS, used or capable of being used on or in close proximity to water surface.

This definition would not only cover submarines operating ‘below’ (but close to) water surface, but also seaplanes, hovercraft and WIG craft that operate ‘above’ (but close to) water surface. It would, therefore, require only minimal updating in the future. During the past decades, COLREGs have been amended a number of times in order to, *inter alia*, catch up with technology. For instance, in 2003, the IMO adopted Resolution A.910(22)[479] in which it included a new craft called Wing-In-Ground (WIG) craft in the definition of ‘vessel’ in Rule 3(a). The proposed definition, however, would be self-updating as it would include any craft that may be invented in the future and which may be used on or in close proximity to water surface. Needless to say, the word ‘close’ in the definition cannot reasonably be quantified as it has a *relative* meaning and each craft operating below or above the water surface will have to determine the threshold for itself with due regard to the special circumstances of the case, including the size, the ‘draught’[480] and the ‘air draught’[481] of other craft present in the area. A definition should also be added to Rule 3 for the term MASS.

3.6.2. Assessment of COLREGs at Framework Level

Navigational conduct of vessels will depend, *inter alia*, on the state of the meteorological *visibility* in the area in which they are navigating at the time. COLREGs currently consist of two separate regimes of collision avoidance. Rules 11 to 18 in Section II apply to vessels ‘in sight of one another’[482] and Rule 19 in Section III applies to vessels in

[479] Resolution A.910(22), ‘Amendments to the Convention on International Regulations for Preventing Collisions at Sea, 1972’ (29 November 2001) – available at <http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Assembly/Documents/A.910(22).pdf> accessed 07 February 2023.

[480] The vertical distance between the lowest point of a floating ship and the waterline, usually expressed in metres.

[481] The vertical distance between the waterline and the highest point of a floating vessel, usually expressed in metres.

[482] Rule 11.

‘restricted visibility’.[483] Thus, in order for a MASS to keep its navigational behaviour in line with COLREGs, it first has to determine the state of visibility in which it is navigating. A MASS, therefore, must be capable of ascertaining whether it is ‘in sight of one another’ with another vessel or in ‘restricted visibility’. During the IMO Regulatory Scoping Exercise for the use of MASS, however, China proposed that since collision avoidance between two MASS Degree 4 will be radar-based rather than human vision-based, MASS Degree 4 do not need to follow two separate sets of rules as per the changing condition of visibility; instead, COLREGs should be amended for MASS degree four at the ‘framework level’ of Part B rather than at rule level.[484] That is to say, sections I, II and III may be merged into one set of manoeuvring rules that apply in all conditions of visibility regardless of whether or not vessels are in sight of one another.

One of the main differences between the rules applicable in normal visibility (Section II) and restricted visibility (Section III) is that, while under Section II the more manoeuvrable i.e. the give-way vessel is required to keep out of the way of the hampered i.e. the stand-on vessel, in restricted visibility there is no such thing as stand-on vessel; all vessels must take avoiding action irrespective of their manoeuvrability. There are two reasons as to why when there is a risk of collision between two vessels in sight of one another, the prime responsibility for keeping out of the way rests with the vessel which has the greater manoeuvrability. Firstly, obliging a vessel with low manoeuvrability to keep out of the way, would not only be impractical but would even increase the risk of collision. For instance, an aircraft carrier that is engaged in recovery of aircraft, is seriously restricted in her ability to manoeuvre and cannot easily keep out of the way of other vessels. Requiring such a vessel to take avoiding action would, therefore, be unreasonable which is why other vessels with higher manoeuvrability must keep out of her way. Similarly, a vessel that is engaged in a towing operation, may not be able to deviate from her course in order to avoid collision or a close-quarters situation. More manoeuvrable vessels, thus, are required to take avoiding action. Secondly, if no such distinction were made, the vessel with the higher manoeuvrability would be more likely to wait for the other vessel to keep out of the way[485] and this is dangerous. In other words, if *both* vessels were required to take avoiding action, firstly, the less manoeuvrable vessel may not be able to take an effective action and secondly, the more manoeuvrable vessel being reliant on her ability to manoeuvre quickly and effectively, may delay her action until it is too late to clear the

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483 Rule 19.

484 IMO Doc MSC 101/5/2, ‘The Initial Review of the Mandatory IMO Instruments Related to Maritime Safety and Security’ (2 April 2019) para 6 – available at <https://www.transportstyrelsen.se/contentassets/023c3729a76b4511b67cd5fefa2b884f/101-5-2.pdf> accessed 07 February 2023.

485 AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules* (7th edn, Butterworth Heinemann 2012) 64.

situation by her action alone. The only safe and practicable solution, therefore, is obliging the vessel with the greater ability to keep out of the way of the hampered vessel. One may argue that this principle can also be extended to vessels in restricted visibility i.e. to place the prime collision avoidance responsibility on the more manoeuvrable vessel and thereby merging the two regimes into one that applies to all vessels and in all situations regardless of the state of visibility. There are, however, three reasons that explain why such interfusion is impractical:

First, the principle of allocating responsibility to vessels based on their manoeuvrability, cannot effectively be employed when vessels are in restricted visibility. This is simply because when the visibility is restricted, it is currently impossible for vessels to determine the degree of manoeuvrability of other vessels in the area with certainty. Vessels show their navigational status and the degree of their manoeuvrability through displaying certain 'lights' (at night) or physical 'shapes' (at day) and these lights or shapes cannot be seen by other vessels when visibility is restricted due to, for example, dense fog. Thus, a second regime of manoeuvring rules has been formulated in Section III that applies to vessels in restricted visibility where no vessel has any special privilege or right of way i.e. all vessels are required to take avoiding action regardless of which vessel may be less able to manoeuvre. This is, however, not to say that vessels in restricted visibility cannot determine navigational status of other vessels at all. Most vessels nowadays are fitted with an Automatic Identification System (AIS) that along with other data, transmits the navigational status of the vessel to other vessels in the area. AIS, however, is not a reliable means of determining navigational status of other vessels due to the following reasons. Firstly, having an AIS is not compulsory for all vessels and vessels of less than 300 gross tonnage are not obliged to be equipped with an AIS.[486] Secondly, even if all vessels were fitted with an AIS, the transmitted data would still be rather unreliable. An AIS transmits two types of data: static and dynamic. The static data such as the name and length of the vessel are normally fixed and cannot be altered by the OOW. However, the dynamic data such as the navigational status of the vessel, the number of her crew members and the name of her destination can be updated by the OOW as appropriate. Because the navigational status is updated manually by the OOW, there is a possibility for mistakes and thus, transmission of inaccurate data.

Second, even if all vessels were equipped with a reliable new technology that could determine the navigational status of other vessels in restricted visibility with certainty, there should still exist a second regime of manoeuvring rules that applies to such vessels in restricted visibility. This is because not all vessels are obliged to have a *radar* on board. According to SOLAS, only ships of 3000 gross tonnage and upwards are required to be

[486] SOLAS, Chapter V, Regulation 19.2.4.

fitted with an S-band (3 GHz) radar[487] which is particularly useful when navigating in fog or heavy rainstorms. There are many vessels that are not required and thus do not have an S-band radar on board. Even for vessels that do have such a radar, their radar may not be operational when navigating in fog. For a vessel without an operational radar or AIS, the only indication of the existence of other vessels in her vicinity might be their *fog signal*. Thus, there should be a second regime of rules to guide such (metaphorically) blind vessels through restricted visibility safely. Section III of COLREGs currently serves this purpose.

Last but not least, even if, for the sake of argument, all vessels *were* required to have AIS and radar installed on board, heavy precipitation and dense fog will cause atmospheric attenuation[488] which in colder climates can significantly decrease the detection ranges of all targets[489] or even render targets with weaker radar signature such as small vessels completely undetectable.[490] Thus, in thick fog where visibility is restricted some vessels may not be detectable by radar in ample time, and this technological radar limitation calls for a strict and separate regime of collision avoidance rules that apply in restricted visibility. In fact, in the discussions which took place before the 1972 Conference, serious consideration was given to the possibility of merging the two regimes into one, but the Conference did not adopt this principle mainly because ‘it is usually possible for vessels to sight one another in sufficient time to recognise the lights or shapes being displayed so that the degree of responsibility can be based on the vessel’s ability to take effective avoiding action.’[491]

The foregoing arguments demonstrate that the current framework of the steering and sailing rules i.e. the two regimes of rules based on the state of visibility have to be generally retained in the interests of safety. However, the analyses in the following sections show that requiring MASS to follow two separate regimes of rules depending on the state of visibility would be impractical and would result in overcomplication of COLREGs. It will be argued that MASS should be required to generally keep out of the way of all other vessels irrespective of the state of visibility to address several issues at

[487] SOLAS, Chapter V, Regulation 19.2.7.1.

[488] John N. Briggs, *Target Detection by Marine Radar* (The Institution of Electrical Engineers 2004) para 5.9.4.

[489] Harry Subramaniam, *Shipborne Radar and ARPA* (3rd edn, Vijaya Publication 2001) 92.

[490] Alan Bole, Bill Dineley and Alan Wall, *Radar and ARPA Manual* (2nd edn, Elsevier Butterworth-Heinemann 2005) 186 ff.

[491] AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules* (7th edn, Butterworth Heinemann 2012) 64.

the same time. The issue will be analysed from technical, safety, societal, and ethical perspectives.

3.7. Technical Approach

3.7.1. The Issue of 'Visual' Observations

In order to identify and address potential issues at framework level, the terms 'in sight of one another' and 'restricted visibility' need to be scrutinised. Since an analysis of the two regimes may require familiarity with navigation lights of a power-driven vessel, such lights have been illustrated in Figure 4.1 below.

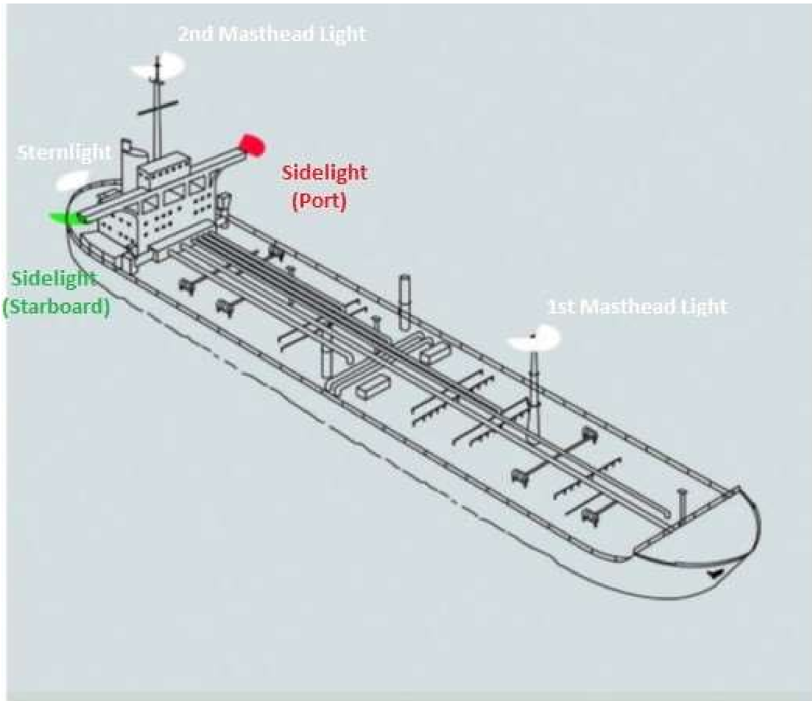

Figure 4.1 (Lights of a power-driven vessel underway, 50 m or more in length)[492]

Rule 3(k) provides that '[v]essels shall be deemed to be in sight of one another only when one can be observed *visually* from the other.'[493] This definition raises three questions in the context of MASS. The first question is about the term 'visually'. In order to be 'in sight of one another', vessels must be able to observe each other 'visually'. Does this mean observations made only with human eyes or does it include electronic e.g. radar

[492] The United States Coast Guard, *Navigation Rules and Regulations Handbook* (CreateSpace 2020) 38 (The light *names* are added to the picture).

[493] Emphasis added.

observations too? Only observations made with human eyes (and not radar observations) count. This was obliquely confirmed by Karminski J who stated "'in sight' must mean something you could see if you looked round"[494] and recently reconfirmed (but this time more directly) by the High Court of Singapore where it was stated that 'the phrase "observed visually" does not mean seen by radar; it means observing by eye or with aid of binoculars'.[495] This interpretation is also fully consistent with Rule 7(d)(i) which states that risk of collision may be determined by taking a series of 'compass bearings' (which involve human eyes) on the approaching vessel.[496] Moreover, not all vessels at sea have operational electronic equipment such as radar to observe other vessels electronically and thus, requiring all vessels to ascertain whether other vessels are in sight through electronic observations would be unreasonable and impractical. Thus, if due to fog, two approaching vessels can only observe each other through electronic observations, then they cannot be said to be 'in sight of one another'. Rather, they are in 'restricted visibility'. The issue, however, in relation to the third and fourth categories of MASS is that there is no human aboard such vessels and hence, no 'visual' and direct observation can be made. It has been argued that the action of 'seeing' does not have to be limited to its human functions and could be construed more widely in order to include electronic eyes such as cameras too.[497] For example, for the third category of MASS, it may be interpreted that the on-board cameras (electronic eyes) are 'visually' observing other vessels in the vicinity and simultaneously sending the live pictures to the remote controller who will then be observing the pictures 'visually' with their eyes. However, there is a subtle issue here. Assume that vessels A and B are navigating in a patch of light fog and there is a risk of collision between them. Vessel A is manned and the OOW cannot 'visually' see vessel B but can detect it on radar. Thus, the OOW concludes that vessel A is in 'restricted visibility' and complies with Rules governing conduct of vessels in restricted visibility. Vessel B, however, is a MASS Degree 3 and is remotely controlled and the remote controller can (if the foregoing interpretation is correct) 'visually' see vessel A because the sight of the cameras installed on vessel B are much stronger than the sight of an average human being or because the cameras use thermal imaging technology and can 'see through' the fog. Consequently, the remote controller assumes that vessel A is 'in sight of' vessel B and thus complies with less strict Rules governing conduct of vessels 'in sight of on another'. This is clearly undesirable. In fact, if the same remote controller could instantly be placed on vessel B, then because of the fog he/she would not be able

[494] *The Lucile Bloomfield* [1966] 2 Lloyd's Rep 239, 245.

[495] *The Dream Star* [2017] 2 Lloyd's Rep 538 [55].

[496] Craig H Allen, *Farwell's Rules of the Nautical Road* (8^{th} edn, Naval Institute Press 2005) 68.

[497] Harry Hirst, 'COLREGS: Still Fit for Purpose?' (*The Maritime Executive*, 07 March 2020) <https://www.maritime-executive.com/editorials/colregs-still-fit-for-purpose> accessed 07 February 2023.

to observe vessel A ‘visually’ with his/her eyes and would therefore have to follow Rules relating to restricted visibility.

Conversely, an on-board camera may not be strong or intelligent enough to detect and identify the lights or shapes of a vessel in the distance as human eyes would do. Thus, the interpretation that cameras installed on a remotely-controlled MASS play the role of human eyes is not entirely free from problems. When it comes to the fourth category of MASS, since there is no human in the loop of data analysis, it may be argued that no ‘visual’ observation can be made at all. Assuming that the current structure of Rules relating to the state of visibility is to be kept unchanged, a solution has to be found. A MASS can obviously detect other objects around itself only through its electronic sensors. When such a MASS electronically detects an approaching vessel, how can it determine whether the approaching vessel is ‘in sight’ within the meaning of COLREGs? It is safe to assume that the approaching vessel would be ‘in sight’ of the MASS if a seafarer with average eyesight was hypothetically placed on the MASS, he/she could observe the approaching vessel visually with his/her eyes. The STCW Code establishes the eyesight standards for seafarers. For example, the in-service distance vision for masters, deck officers and ratings[498] involved in lookout duties must not be less than 0.5 in Snellen decimal notation[499] and the maximum distance vision of human eyes is about 3.0.[500] One solution is using these standards as a benchmark for regulating ‘electronic eyes’ that may be installed on MASS as an electronic version of human eyes. Of course, this is not to say that a MASS should not be allowed to have optical sensors with distance vision of higher than 3.0. It can and should have powerful sensors with various abilities and purposes, but any sensor that is used to decide whether a detected vessel is ‘in sight’, must necessarily have the same or similar characteristics as human eyes. If so, these artificial eyes can then observe the surroundings ‘visually’ and in a similar way as human eyes do. This would require a provision to be added to Rule 3(k) clarifying that any optical sensors used to determine whether other vessels are ‘in sight’, must be made in accordance with eyesight standards for seafarers as established in, for example, the STCW Code or elsewhere as appropriate. This solution, however, would unnecessarily complicate COLREGs. The better and simpler solution, it is submitted, is that MASS should be required to keep out of the way of all other vessels irrespective of the method or equipment they use to observe those vessels.

[498] A seafarer who is not an officer.

[499] STCW Code, Section A-I/9, Table A-I/9.

[500] ‘Visual acuity’ (*Wikipedia*, 06 May 2020) <https://en.wikipedia.org/wiki/Visual_acuity> accessed 07 February 2023.

3.7.2. In Sight of 'One Another': A Potential Gap in COLREGs

The second question is whether *both* vessels must visually observe each other in order to be considered to be in sight of one another. The language of Rule 3(k), in this respect, is somewhat ambiguous where it could be much clearer.[501] Rule 3(k) starts with the phrase 'in sight of one another' which suggests a need for visual observation by 'both' vessels, but goes on to say 'only when one can be observed visually from the other' which dispels some of the ambiguity created by the first phrase in the definition.[502] There are, nevertheless, clues in the Rules themselves that may help solve this conundrum. Rule 18 which applies to 'vessels in sight of one another',[503] determines responsibilities between vessels based on the category and navigational status of the vessels involved and vessels display their category and navigational status through their lights (at night) or shapes (at day). For instance, Rule 18(a)(iii) obliges a power-driven vessel underway to keep out of the way of a vessel engaged in fishing. This means that the power-driven vessel *must* take early and substantial action to keep well clear[504] and at the same time, the vessel engaged in fishing *must* initially keep her course and speed.[505] Each vessel, therefore, has an obligation to fulfil. However, these two vessels can properly fulfil their obligations *only if* they *both* can visually observe each other and can therefore ascertain the category and navigational status of each other through their lights or shapes. In other words, without observing the lights of the power-driven vessel, the vessel engaged in fishing would not know that she must keep her course and speed as the stand-on vessel. Similarly, if the power-driven vessel cannot visually see the lights or shapes of the vessel engaged in fishing, then she will not know whether she must keep out of the way as a give-way vessel or must keep her course and speed as a stand-on vessel. Without seeing the lights or shapes of the other vessel, neither of the two vessels would know what action they must take. This interpretation holds true also with regard to other Rules in Section II. For example, Rule 12 applies when two vessels involved in a situation are both sailing vessels and Rules 14 and 15 apply when both vessels are power-driven vessels. Without seeing the lights or shapes of the other vessel, neither of the two vessels involved in a situation would be able to determine what the situation is or what action must be taken. By inference, therefore, two vessels must be deemed to be 'in sight of one another' only when *both* vessels can visually observe one another. Rules in Section II can work efficiently only if *both* vessels involved in a situation can visually observe one another.

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[501] Craig H Allen, *Farwell's Rules of the Nautical Road* (8th edn, Naval Institute Press 2005) 69.

[502] Ibid.

[503] Rule 11.

[504] Rule 16.

[505] Rule 17(a)(i).

The equivocal language used in Rule 3(k), however, if intentional, might have an explanation. A conceivable reason might be the fact that a vessel that visually observes another vessel and finds herself to be the *give-way* vessel in an encounter, must keep out of the way irrespective of whether or not the other vessel is also able to visually observe her. Reverting to the above example, if the power-driven vessel can visually observe the lights or shapes of the vessel engaged in fishing, then she can easily identify herself as the give-way vessel under Rule 18(a)(iii) and must therefore take early action to keep out of the way regardless of whether or not the vessel engaged in fishing is also able to visually observed her. This might be the reason why Rule 3(k) does not explicitly say *both* vessels must be able to see each other visually.

One may consider the issue as a purely theoretical matter that does not warrant a lengthy legal analysis. The conundrum of 'in sight of one another', however, has practical implications for both navigators and programmers of MASS Degree 4. In *Yarmouth Sea Products Ltd v Scully*,[506] a sailing vessel collided with a fishing vessel at night and in good visibility because the sailing vessel failed to display her navigation lights and also failed to visually observe the lights of the fishing vessel. Also, the fishing vessel could not visually observe the sailing vessel in time because the sailing vessel's navigation lights were extinguished. The owner of the sailing vessel (Scally) argued that under Rule 18(a)(iv), the fishing vessel was the give-way vessel and thus should have kept out of the way of the sailing vessel. The US Court of Appeal (Fourth Circuit), however, upheld the interpretation of the district court that the provisions of Rule 18 apply only to 'vessels in sight of one another'. It was upheld that the two vessels were *not* 'in sight of one another' because although the fishing vessel was 'in sight' of the sailing vessel, the latter was not 'in sight' of the former. The decision confirms the above inference that two vessels will be 'in sight of one another' only when *both* can visually observe each other. Practical and theoretical issues are bound to arise here. Although the fishing vessel did not detect the sailing vessel on radar due to sea clutter,[507] the question is what action should the fishing vessel have taken if she *had* detected the sailing vessel on radar? What Rules should she have followed? Section II governs conduct of vessels 'in sight of one another' and Section III guides vessels in 'restricted visibility'. However, the issue is that the two vessels were neither in restricted visibility (because the night was 'clear with stars visible in the sky')[508] nor in sight of one another (because the fishing vessel could not 'visually' see the sailing vessel). This seems to be a gap in the structure of the Steering and Sailing Rules in Part B of COLREGs, and it is particularly important in the context of MASS navigating during hours of darkness because the only things that vessels can *visually*

[506] 131 F.3d 389 (4th Cir. 1997).

[507] Ibid 391.

[508] Ibid.

observe at night are the navigation lights of each other. When a navigation light of a manned ship burns out, an alarm will go off and the ship's crew will change the burnt-out light bulb or rectify the fault in the circuit. There are also spare navigation lights which can be turned on manually or automatically in the meantime. Such a situation, thus, is unlikely to continue for a long period of time in case of a manned vessel. On a MASS Degree 3 or 4, however, all of the navigation lights may stop functioning due to a fault in the electrical system and without any on-board technician or intelligent system to fix the problem, other vessels in the area may not be able to *visually* observe this vessel at night.

Furthermore, although COLREGs specify the 'minimum' luminous intensity for a vessel's navigation lights, they do not *specify* a maximum intensity for the lights and instead, state that the maximum luminous intensity should be *limited* to avoid undue glare.[509] As a result, a vessel with very high intensity lights may be 'in sight' of a vessel with lower intensity lights from a certain distance without the latter being 'in sight' of the former. For example, while the minimum range of visibility for the masthead lights of a vessel of 50 metres or more in length is 6 miles,[510] the actual range may be 7 miles for vessel A and 12 miles for vessel B. It should be noted that these ranges remain correct only if the vessels are in a meteorological visibility of approximately 13 nautical miles[511] and if the meteorological visibility drops, these ranges will also drop accordingly. Thus, in a hazy atmosphere, where the vessels are not deemed to be in 'restricted visibility', those ranges may drop to, for example, 3 and 6 miles for vessels A and B respectively. This means vessel A will be able to visually see the masthead lights of vessel B when it is 6 miles away but vessel B will be able to visually observe the masthead lights of vessel A only when it is 3 miles away. There are, therefore, certain collision situations in which while visibility is not restricted, only one vessel is visually 'in sight' of the other. Put differently, there are situations in which two vessels are neither 'in sight of one another' nor in 'restricted visibility'. This issue is, again, more pronounced in the context of MASS. Given that MASS Degrees 3 and 4 do not carry crew members, fresh water or provisions, and that they have no accommodation and will probably use batteries in lieu of heavy fuel oils, they will be lighter than their manned counterparts and will most probably operate at a higher speed. The higher speed, thus, may require a MASS to take collision avoidance actions at a greater range where the navigation lights of other vessels may not be visible i.e. where other vessels may not be 'in sight' of the MASS. It should be observed by designers and programmers of autonomous collision avoidance systems that while COLREGs deals only with two regimes of collision avoidance, namely, a regime for vessels 'in sight of one another' and a second regime for vessels in or near 'restricted visibility', there is potentially

[509] Annex I, paragraph 8.

[510] Rule 22(a).

[511] Annex I, paragraph 8(a).

a third situation that has not been addressed by COLREGs: a situation where vessels are neither ‘in sight’ nor in ‘restricted visibility’. In such a circumstance, a pre-programmed collision avoidance system for which this third potential situation has not been defined, may simply not take any action at all or may navigate the autonomous vessel in a manner unexpected to other vessels and dangerous to the safety of navigation. Navigators should also be aware of this possible encounter and know how to deal with it. The conundrum of ‘in sight of one another’, thus, boils down to this question: where two vessels are neither ‘in sight of one another’ nor in ‘restricted visibility’ and risk of collision exists, what are the rights and responsibilities of each vessel? In a rather unlikely but imaginable situation, while not in restricted visibility, neither of the two vessels is ‘in sight’ of the other.

There are two general ways in which the issue may be addressed. The first solution is indirect and non-specific: Rule 2(a) makes it clear that nothing in the Rules will exonerate any vessel, or its owner, master or crew members 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 2(a), in effect, means that any situation not specifically addressed by the Rules, must be dealt with by observing the principles of good seamanship or according to the special circumstances of the case. This approach, however, would not be workable for designers of autonomous algorithms as complying with Rule 2(a) will require real-time human judgement and, principles of good seamanship and special circumstances of every imaginable case are difficult to codify if at all possible. Even in relation to manned vessels, it is safer to address the issue specifically rather than leave it to each navigator to take an action according to their own understanding of good seamanship in a not very common situation where no clear seamanship has so far developed through common practice of seamen. The second solution, therefore, is direct and specific: a new provision may be added to the Rules to fill the gap and specify obligations of each vessel. To this end, one aspect of the question can be answered with some degree of certainty: a vessel which detects another vessel only on radar without being able to see her visually, will have no reliable means of determining the category and navigational status of that vessel and thus, must keep out of the way of that unknown vessel. This is because the unknown vessel might be a vessel that is less able or even unable to manoeuvre to avoid collision. This view is consistent with Rule 19(d) under which a vessel that does not visually see another vessel but detects her only on radar, *must* determine if risk of collision exists and if so, *must* take avoiding action. In other words, there is a rather similar situation where the Rules *do* specify the duties of each vessel and that is a situation where a vessel cannot visually observe another vessel; not due to its non-functioning navigation lights or different range of visibility of its lights, but because the two vessels are navigating ‘in or near an area of restricted visibility’.[512] In such circumstances, Rule 19(d) provides that

[512] Rule 19(a).

such a vessel which 'detects by radar alone' the presence of another vessel, must determine if risk of collision exists and then it goes on to specify what action must the vessel take if such a risk does exist. It would, thus, be reasonable to adopt this principle also for vessels navigating in good visibility and require vessels which cannot for whatever reason visually observe another vessel, to comply with Rule 19(d). However, while programmers of autonomous vessels would welcome such specification, navigators may perceive a new provision as yet another layer of complication to an already complicated set of rules. Studies have shown that nautical students do not fully understand the existing Rules[513] and even practising licenced officers 'generally lack a full and complete understanding' of the Rules.[514] Again, in order to avoid making the Rules more complex or complicated, the gap could be filled simply by requiring MASS to keep out of the way of all manned vessels regardless of whether the vessels are in sight of one another or in restricted visibility.

3.7.3. 'How Many' Lights Must be Observed?

The third issue around the concept of 'in sight of one another' is when a vessel can visually see the lights or shapes of another vessel but not perfectly. How many lights or how much of the physical appearance or the day shapes of a vessel must be seen before it can be said to be 'in sight'? As Craig Allen has observed, generally, a vessel must visually see enough of the other vessel to be able to assess and manage risk of collision.[515] What this means in practical terms is particularly important during hours of darkness and in relation to MASS because during daylight hours it is generally easier for a vessel to assess the situation based on the physical aspect of the other vessel. At night, however, the only things visible to the 'eye' are the 'lights' of the other vessel and the difficulty lies in the fact that different navigation lights of a vessel have different 'ranges' of visibility[516] and thus, not all of them may be visible at a given distance at the same time. Furthermore, navigation lights have also different 'arcs' of visibility[517] and, therefore, not all of them can be observed from a given position at the same time. Allen remarks that a

[513] Astrid Zekić, Dani Mohović and Robert Mohović, 'Analysis of the Level of Knowledge and Understanding of Regulations for Preventing Collisions at Sea' (2015) 29(2) Scientific Journal of Maritime Research 143, 149.

[514] Djani Mohovic, Robert Mohovic and Mate Baric, 'Deficiencies in Learning COLREGs and New Teaching Methodology for Nautical Engineering Students and Seafarers in Lifelong Learning Programs' (2016) 69(4) The Journal of Navigation 765, 775.

[515] Craig H Allen, *Farwell's Rules of the Nautical Road* (8th edn, Naval Institute Press 2005) 68ff.

[516] Rule 22.

[517] Rule 21.

'single' light may be enough at night[518] and this may well be the case as an overtaking vessel will normally see only the sternlight of an underway power-driven vessel ahead.[519] However, there are circumstances under which a single light e.g. one approaching white light on the port side[520] may not suffice to ascertain the type of the vessel and thereby the required action. For instance, Figure 4.2 below illustrates a *crossing situation* where a risk of collision exists between two power-driven vessels that are more than 50 metres in length and underway. If visibility is good and the two vessels are 'in sight' i.e. if both vessels can visually observe each other's lights, then according to Rules 15 and 16, vessel A that has vessel B on her starboard side[521] is the 'give-way' vessel and must keep out of the way of vessel B which is the 'stand-on' vessel and must, under Rule 17(a)(i), initially keep her course and speed. More precisely, if B observes all lights of A which are capable of being observed from that position i.e. two white masthead lights and a green sidelight, then B can conclude that A is a power-driven vessel underway and 'in sight'; that this is a crossing situation between two power-driven vessels; that herself is the stand-on vessel; and that she must therefore keep her course and speed. It is clear what Rules each vessel must follow.

However, if the meteorological visibility is slightly reduced, the only lights visible to each vessel may be their white masthead lights as these lights have higher intensity than the sidelights. In such circumstances, what is the situation if B observes only one white light of A? if B assumes that A is 'in sight', then she must comply with Rules in Section II which apply to vessels in sight of one another. But if she concludes that A is *not* 'in sight', then she will follow the provisions applicable to vessels in restricted visibility as set out in Section III. It is submitted that the former assumption would be erroneous because judging the vessel category of A and her navigational status *only* by one white light is impossible. Such a single white light may represent a power-driven vessel of less than 50 metres in length that her starboard (green) sidelight cannot be seen in the reduced visibility due to its lower luminous intensity in which case it would be a crossing situation between two power-driven vessels where A must keep out of the way as the give-way vessel under Rule 15 in Section II. A single white light may also signify a vessel *restricted in her ability to manoeuvre* that her starboard sidelight and all-round lights[522] cannot be observed due to their lower intensity[523] in which case the situation would be governed by

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[518] Craig H Allen, *Farwell's Rules of the Nautical Road* (8th edn, Naval Institute Press 2005) 69.

[519] Rule 13(b).

[520] The left side of a vessel when facing ahead.

[521] The right side of a vessel when facing ahead.

[522] Rule 27(b).

[523] Rule 22.

Rule 18(a)(ii) in Section II where B would be the give-way vessel who must take action to avoid collision. There are, therefore, different possible interpretations that would require vessel B to take totally different actions under different Rules applicable to vessels in sight of one another. This leads to the conclusion that A cannot be considered to be 'in sight' of B. Thus, B cannot keep her course and speed and expect A to keep out of the way as a give-way vessel in a crossing situation.

Figure 4.2 (Crossing Situation)[524]

This conclusion is supported by the decision of the Admiralty Court in *The Skyron and Hel*,[525] where due to reduced visibility the two vessels could see only one white light of each other and it was held that the two vessels were not in sight of one another but were in restricted visibility and should have followed the rules relating to navigation in restricted visibility.[526]

An autonomous vessel may find it difficult to specify the category and navigational status of a vessel from which only one white light is visible because sometimes a single white light is the only light that a vessel is required by the Rules to display. For instance, a power-driven vessel less than 7 metres in length whose maximum speed cannot exceed 7 knots may display only one all-round white light when underway.[527] In such circumstances, radar and AIS can be used to determine the speed and length of the vessel. Pursuant to Regulation 19.2.4 in Chapter V of SOLAS, many vessels are now equipped with an AIS which transmits the vessel's *static* data such as name and length that remain unalterable, together with her *dynamic* data such as the number of the crew

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[524] 'Understanding COLREGS' (*RYA*) <https://www.rya.org.uk/newsevents/e-newsletters/up-to-speed/Pages/understanding-colregs2.aspx> accessed 07 February 2023.

[525] [1994] 2 Lloyd's Rep 254.

[526] Ibid 261.

[527] Rule 23(d)(ii).

members and the name of the destination that can be updated by the OOW as appropriate. Although the navigational status of the vessel transmitted by her AIS can occasionally be incorrect as it is part of the dynamic data that is variable and is updated manually by the OOW, the length of the vessel transmitted by her AIS is always reliable because it cannot be changed by the OWW as it is part of the static data of the vessel that remains the same throughout the voyage and most probably, her entire life. Thus, in the above example, if vessel B finds out through AIS that the length of vessel A is 180 metres, then based on Rule 23(a), B should be able to see *two* white masthead lights from A. If only one white light is observable, then B should conclude that A is not in sight. This method, nevertheless, is not always reliable. Firstly, radars can only calculate the instantaneous speed of other vessels but not their *maximum* speed. Secondly, other vessels may not have AIS and if they do, it might be faulty. In certain situations, therefore, a MASS may not know whether the visual information obtained from another vessel is complete or scanty to then be able to determine whether that vessel is in sight or not. For example, in the above scenario, if vessel B is a MASS Degree 4 that observes only a white light of vessel A which is a vessel restricted in her ability to manoeuvre, then there is a danger that B will assume that A is a give-way ordinary power-driven vessel. Accordingly, B may consider herself as a stand-on vessel and maintain her course and speed which may result in a close-quarters situation or collision. Given that in the future the population of small and slow MASS (which can exhibit only one white light) may increase, and that some navigation lights of larger MASS may extinguish due to technical issues, there will be certain situations where the visual information received from a vessel's navigation lights is scanty. A MASS in such a situation will struggle to determine whether the vessel is in sight and what action must be taken. The issue may be resolved by obliging MASS to take avoiding action at all times without having to determine whether the vessel is 'in sight'.

3.7.4. (In)ability of MASS Degree 4 to Perceive Lights and Shapes

Can vessel A that due to her insufficient lookout failed to see vessel B visually, claim that the latter was not in sight? Under Rule 3(k), a vessel is in sight only when it *can* be observed visually from another vessel. This means that the test is objective, not subjective and that Rule 3(k) focuses on the *ability* to observe and not the fact of observance itself.[528] If a vigilant lookout on vessel A could have visually seen vessel B, then vessel B is in sight of vessel A, even if the lookout actually failed to see vessel B visually. As Karminski J put it, *in sight* means 'something which is visible if you take the trouble to keep a look-out'.[529] The text of Rule 3(k) and its interpretation cause issues for MASS Degree 4 that

[528] Craig H Allen, *Farwell's Rules of the Nautical Road* (8th edn, Naval Institute Press 2005) 69.

[529] *The Lucile Bloomfield* [1966] 2 Lloyd's Rep 239, 245.

may not be capable of identifying or perceiving lights or shapes of other vessels. Currently, the *Sea Hunter*, which may well be the most advanced MASS Degree 4 in the world, does not have the ability to understand lights or shapes of other vessels around it.[530] Assume that the *Sea Hunter* detects a vessel in a head-on situation in perfect meteorological visibility and at a distance where the lights or shapes of that vessel *can* be observed visually and perfectly. Based on Rule 3(k) and its authoritative interpretation, that vessel is 'in sight' of the *Sea Hunter* even if the *Sea Hunter* is not advanced enough to identify or discern those lights or shapes. Thus, since that vessel is in sight, the *Sea Hunter* 'must' follow the Rules in Section II. The problem, however, is that the *Sea Hunter* does not know which Rules in Section II to follow as she is not capable of determining the category of that vessel according to its lights or shapes. The Rules as they stand, therefore, may preclude operation of MASS Degree 4.

The proposed amendment will resolve these difficulties too. If an obligation is placed on MASS to keep out of the way of other vessels, then it becomes irrelevant whether or not they can detect and perceive lights and shapes of other vessels. If an autonomous vessel detects another vessel by cameras or radars where risk of collision is developing, then it must take avoiding action without having to identify or comprehend the lights or shapes of that vessel. The situation between two MASS will be addressed in due course.

3.7.5. Practical Issues Concerning Implementation of Rules in Section II: the issue of 'In Sight' for Manned Vessels

In the context of MASS, the issues around the concept of 'in sight of one another' may be resolved by making the MASS a give-way vessel in most situations. Some issues, nonetheless, still remain in the context of manned vessels. Under the existing COLREGs, when vessels are 'in sight of one another', they must follow the Rules in Section II and the application of different Rules in Section II will depend on the category of the vessels involved.[531] In other words, in order for a vessel to know which Rules in Section II must be applied, she must know the category of the other vessel involved. Vessels indicate their category by exhibiting the relevant shape(s) (by day) or lights (at night) as required by COLREGs. In 2018, China submitted a document[532] to the Maritime Safety Committee of the IMO in which it brought to the Committee's attention some of the practical issues about compliance of vessels 'in sight of one another' with the Rules in Section II. The

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530 'DARPA Christens (Mostly) Autonomous Vessel' (*The Maritime Executive*, 19 June 2020) <https://www.maritime-executive.com/features/darpa-christens-mostly-autonomous-vessel> accessed 07 February 2023.

531 Except for the overtaking situation under Rule 13.

532 IMO Doc MSC 99/INF.7, 'Practical Issues Concerning Implementation of the International Regulations for Preventing Collisions at Sea, 1972' (23 February 2018).

document highlights that such shapes were introduced to be used by small and slow ships in the 19th century i.e. in the era of short-range collision avoidance.[533] As an example, the diameter of a ball that was originally required to be two feet (equivalent to 61 cm), is today 60 cm which is virtually the same. Using Table A-I/9 of the STCW Code that specifies the minimum in-service eyesight standards for seafarers, the document points out that even a seafarer with a distance vision double the minimum mandatory requirement, is able to identify a round object of 60 cm in diameter only when the object is 1.1 nautical miles away but not further.[534] Due to the substantial increase in the size and speed of today's ships, however, large ships have to decide which set of Rules to apply at a range of four to five miles i.e. at a distance where they are not able to visually identify the shapes of other vessels.[535] The document stated that there is a similar issue, though to a lesser extent, with regard to the all-round lights indicating the category of a large vessel at night which have a minimum visibility of 3 nautical miles as specified in Rule 22(a).[536]

In principle, these can be considerable issues because based on Rules 3(k) and 11, a large or fast vessel that can visually observe another vessel, must comply with Rules in Section II but she *does not know* what Rules in Section II will apply as she cannot recognise in sufficient time and at sufficient range the shapes or lights of the other vessels. In practice, however, these issues are unlikely to pose any serious risk to safe navigation of vessels. First, in busy coastal waters, the speed of vessels is relatively slow and vessels usually take action at close distance where they are able to see the light or shapes of other vessels. Second, the overwhelming majority of vessels that operate in open sea are ordinary power-driven vessels that are equipped with AIS and must keep out of the way of other categories of vessels anyway.[537] For example, a power-driven vessel overtaking any other type of vessel must keep out of the way even if it cannot determine the category of the vessel being overtaken.[538] A power-driven vessel involved in a head-on situation must also take avoiding action in accordance with either Rule 14 or Rule 18(a) irrespective of the category of the other vessel. A power-driven vessel which has another vessel on its own starboard side is also under an obligation to keep out of the way of that vessel under Rule 15 or Rule 18(a) regardless of the category of that vessel. The only uncertain situation is when a power-driven vessel (A) has another vessel (B) on its own port side but cannot determine the category of that vessel. If vessel B is

[533] Ibid para 1 of the Annex.

[534] Ibid para 2.

[535] Ibid para 4.

[536] Ibid.

[537] COLREGs, Rule 18(a).

[538] Ibid Rule 13(a).

any vessel other than ordinary power-driven vessel, then vessel A must keep out of the way.[539] However, if vessel B is an ordinary power-driven vessel, then A is initially obliged to keep her course and speed.[540] The issue is that at long range when action is needed, vessel A may not be able to determine the category of vessel B by its lights, shapes, AIS information or through radio communications. In such a situation, good seamanship dictates that A must keep out of the way of B. Even if on the presumption that B is a give-way ordinary power-driven vessel, A initially maintains her course and speed in accordance with Rule 17(a)(i), when the two vessels approach closer and B takes no action, then A is relieved of its initial obligation to maintain her course and speed and *may* take avoiding action.[541] If neither A nor B takes no action and the two vessels approach closer into the next stage of collision situation, then A *must* take avoiding action.[542]

In summary, in coastal waters, manned vessels can readily identify each other's category and act accordingly. In open waters (that are predominantly navigated by ordinary power-driven vessels), a power-driven vessel is able to determine its COLREGs responsibilities in most situations without even knowing the category of the other vessel involved in the situation. In rare situations where the other vessel's category cannot be determined in sufficient time, good seamanship requires a power-driven vessel to keep out of the way. If the power-driven vessel does not, then it will have to do so in next stages under Rule 17. The current rules are therefore still effective and practical. China in the said document suggests that since AIS can be used as an 'electronic sight' in all conditions of visibility to identify the category of an approaching vessel, 'it would be meaningless for the current Steering and Sailing Rules to maintain two different sets of rules based on condition of visibility, because visibility is no longer a determining factor in identifying a vessel's category.'[543] As mentioned previously, even if technology enables future vessels to determine each other's category with certainty, given that some vessels may not have operational radar equipment on board, it is still essential to have a set of rules to regulate navigation of vessels in restricted visibility.

539 Ibid Rule 18(a).

540 Ibid Rule 17(a)(i).

541 Ibid Rule 17(a)(ii).

542 Ibid Rule 17(b).

543 IMO Doc MSC 99/INF.7, para 7.

3.8. Safety Approach

3.8.1. Lack of Situational Awareness

The principal objective of COLREGs is preventing accidents, in particular, collisions. Statistics, however, show that despite all the advancements in ship navigation technology, collisions are still happening and causing loss of life, loss of property and damage to the marine environment. In order to address the issue, it is first necessary to determine the underlying causes of collisions. It has been estimated that 75% to 96% of all maritime accidents, including collisions, can be attributed to 'human error'.[544] When it comes to collisions, various reports confirm that human error manifests itself mainly in the form of poor lookout or lack of situational awareness. In 2004, MAIB published a report entitled 'Bridge Watchkeeping Safety Study' in which it reviewed in detail the evidence of 66 collisions, near collisions, groundings and contacts that occurred between 1994 and 2003 and were investigated by the Branch.[545] The study found that the most common factors that were present in all of the collisions were 'poor lookout' and poor use of radar.[546] In fact, 65% of the vessels involved in collisions, contravened Rule 5 of COLREGs that requires all vessels to keep a proper lookout at all times.[547] For example, in 19% of the collision cases, the OOW was completely unaware of the other vessel's presence prior to collision and in 24% of the cases, the OOW became aware of the other vessel's proximity when it was too late for any avoiding action to be successful.[548] While part of the failure to keep a proper lookout was reported to be due to under-manning and a lone and fatigued watchkeeper on the bridge, the majority of vessels involved in collision were manned in accordance with the provisions of the STCW Convention, yet still failed to maintain a proper lookout.[549] The report states that there are several 'possible reasons' for this and that 'competency' may be more contributory than fatigue.[550] Since in 57% of the collision cases the OWW was aware of the presence of the other vessel,[551] and in

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[544] Allianz, 'Safety and Shipping Review' (2017) page 3 – available at <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Safety-Shipping-Review-2017.pdf> accessed 07 February 2023.

[545] MAIB, 'Bridge Watchkeeping Safety Study' (2004) page 1 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/377400/Bridge_watchkeeping_safety_study.pdf> accessed 07 February 2023.

[546] Ibid 15.

[547] Ibid 17.

[548] Ibid 17ff.

[549] Ibid 18ff.

[550] Ibid 19.

[551] Ibid 17.

73% of the cases the OOWs potentially contravened Rule 7 of COLREGs,[552] it seems reasonable to conclude that the OOWs either failed to interpret the applicable COLREG Rule(s) correctly or failed to implement those Rule(s) properly and in ample time. At any rate, it follows that there was a lack of competency to understand and/or implement the COLREG Rules.

The fact that the MAIB study investigated only a relatively small number of accidents which occurred over two decades ago and involved only UK-flagged vessels and accidents in UK waters, may raise doubts as to the validity of extrapolation of the results to non-UK vessels involved in more recent collisions and in other waters around the world. However, more recent reports investigating a large number of accidents involving vessels of different nationalities and accidents occurring in various geographical locations have equally reached the same conclusion as to the most common cause of maritime collisions. In 2018, the Seafarers International Research Centre (SIRC) published the results of a very comprehensive investigation into causes of maritime accidents around the world. The research collated and analysed different accident investigation reports published by MAIB, the Australian Transport Safety Bureau (ATSB), the (US) National Transportation Safety Board (NTSB), the (German) Federal Bureau of Maritime Casualty Investigation, and the Danish Maritime Accident Investigation Board (DMAIB) between 2002 and 2016 inclusive.[553] Accident investigation reports from Maritime New Zealand were also included, but only from 2002 to 2004 as their publication was discontinued in 2004.[554] Analysing a total of 693 accident reports,[555] the SIRC research identified ‘collision, close quarters and contact’ as the most common type of accident with ‘inadequate lookout’ as the most common immediate cause of this type of accidents.[556] Other organisations whose statistics can equally help identify the causes of maritime collisions are P&I clubs which constitute the International Group of P&I Clubs. This is because these P&I clubs provide liability cover for about 90% of the world’s ocean-going tonnage[557] which means they cover a wide range of various ships that are registered in different States and are operated by ship managers and seafarers of different nationalities

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[552] Ibid 21.

[553] I Acejo, H Sampson, N Turgo, N Ellis and L Tang, ‘The Causes of Maritime Accidents in the Period 2002-2016’ (2018) Seafarers International Research Centre (SIRC) page 1 – available at <https://orca-mwe.cf.ac.uk/117481/1/Sampson_The%20causes%20of%20maritime%20accidents%20in%20the%20period%202002-2016.pdf> accessed 07 February 2023.

[554] Ibid.

[555] Ibid.

[556] Ibid 4.

[557] ‘About the International Group’, (*International Group of P&I Clubs*) <https://www.igpandi.org/about> accessed 07 February 2023.

across the world. In 2019, one of those P&I clubs, The Swedish Club, published the result of its investigation into the causes of a wide range of incidents including collisions. The report identified 'lack of situational awareness' as the most common cause for its collision claims between 2013 and 2017.[558]

Thus, since at least two decades ago, lack of situational awareness and breach of Rule 5 is known and has continued to be the most common cause of maritime collisions involving ships, seafarers and ship managers from all over the world. The issue, thus, is not limited to seafarers from a specific country or region, or to any specific type of vessel or flag State. The issue is universal. The significance of a proper lookout in preventing collisions was stressed by the IMO when replacing the 1960 Collision Regulations with the 1972 COLREGs. In the 1960 Regulations, the duty of lookout was only briefly included in Rule 29 which was about responsibility and the principle of good seamanship.[559] In the 1972 Regulations, however, the lookout responsibility is expressed positively in a new and substantive rule (Rule 5) which emphasises more strongly the importance of a proper lookout.[560] The importance of lookout has also repeatedly been brought to the attention of shipowners and mariners by P&I clubs[561] and other professional maritime organisations.[562] Yet, insufficient lookout has persistently remained at the top of the list of collision causes. In fact, the need for mariners to talk to someone other than their shipmates, may bring about 'modern times' collisions[563] where the ship's captain or OWW is distracted by using his or her mobile phone while keeping a navigational watch. In 2005, anecdotal evidence via the Confidential Hazardous Information Reporting Programme (CHIRP) about the use of mobile phones by seafarers while on duty and MAIB reports highlighting the danger of using mobile phones on board ships by the ship's master or

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558 The Swedish Club, 'Claims at a Glance' (2019) page 54 – available at <https://www.swedishclub.com/media_upload/files/Publications/Loss%20Prevention/Claims_at_a_Glance_2019%20WEBnew.pdf> accessed 07 February 2023.

559 Richard HB Sturt, *The Collision Regulations* (3rd edn, LLP 1991) 139.

560 Simon Gault (ed) *et al.*, *Marsden and Gault on Collisions at Sea* (14th edn, Sweet & Maxwell 2016) para 5-183.

561 See, e.g., The Standard Club, 'Keeping a Look-out: COLREGS Rule 5' (2012) Standard Safety 1, 5 – available at <https://www.standard-club.com/media/1558268/colregs-rule-5.pdf> accessed 07 February 2023.

562 See, e.g., The Nautical Institute, 'Lookout: Seeing the World by All Available Means' (2018) – available at <https://www.nautinst.org/uploads/assets/uploaded/c7aef002-5ad2-46a4-a5dac1f4e720d6f0.pdf> accessed 07 February 2023.

563 Ronald Wöhrn, 'Collisions at sea – Unavoidable?' (*Gard* 01 February 2007) <http://www.gard.no/web/updates/content/51705/collisions-at-sea-unavoidable> accessed 07 February 2023.

OOW,[564] prompted the UK MCA to publish a Marine Guidance Note (MGN) and warn about the distraction caused by making or receiving mobile phone calls at inappropriate times during the navigation of a vessel.[565] Five years later, based on the findings of the US National Transportation Safety Board investigations into collisions, the United States Coast Guard (USCG) also issued a Safety Advisory that reiterates much of the warning and advice issued by the UK MCA regarding the use of mobile phones on board ships.[566] A recent example of a maritime accident as a result of lack of situational awareness caused by using mobile phone, is the accident in which the bulk carrier *Aris T* collided with a moored tank barge on the Mississippi River in Norco (Louisiana) in July 2016 which resulted in injury to two dock workers and a total damage of more than $60 million.[567] Similarly, in the grounding of the general cargo ship *Priscilla* in the eastern entrance of Pentland Firth (Scotland) in July 2018, the OOW was distracted by watching videos on his mobile phone and lacked the required situational awareness.[568] In a more tragic (although not collision-related) accident in Brocklebank Dock (Liverpool) in May 2019, a third mate who was standing on the stern ramp of a ro-ro ferry and was distracted by talking on his mobile phone, was hit and killed by a semi-trailer that was being pushed down the ramp.[569] Although the accident occurred on the ramp of a vessel, the MAIB Chief Inspector of Marine Accidents warned that 'the use of mobile phones in other

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[564] E.g. MAIB, 'Report on the Investigation of the Grounding of the Italian Registered Chemical Tanker Attilio Ievoli' (2004) – available at <https://assets.publishing.service.gov.uk/media/547c70b9e5274a428d0000bf/Attilio_Ievoli.pdf> accessed 07 February 2023.

[565] MCA, 'MGN 299 (M+F): Interference with Safe Navigation through Inappropriate Use of Mobile Phones' (2005) para 2 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/882010/299.pdf> accessed 07 February 2023.

[566] USCG, 'Advisory 01-10: Distracted Operations: Don't Let it be You!' (2010) – available at <https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/INV/Alerts/0110adv.pdf> accessed 07 February 2023.

[567] NTSB, 'Marine Accident Brief: Collision of Bulk Carrier Aris T with Tank Barge WTC 3019, Towing Vessel Pedernales, and Shoreside Structures' (2016) <https://www.ntsb.gov/investigations/AccidentReports/Reports/MAB1701.pdf> accessed 07 February 2023.

[568] MAIB, 'Report on the Investigation of the Grounding of the General Cargo Vessel Priscilla' (2019) para 2.4.2 – available at <https://assets.publishing.service.gov.uk/media/5d93631a40f0b65e5ec0dd35/2019-12-Priscilla.pdf> accessed 07 February 2023.

[569] MAIB, 'Report on the Investigation of the Death of a Third Officer Struck by a Freight Vehicle on the Stern Ramp of the Ro-Ro Freight Ferry' (2019) Synopsis – available at <https://assets.publishing.service.gov.uk/media/5ee08229e90e07141fd1a990/2020-10-SeatruckProgress.pdf> accessed 07 February 2023.

hazardous workspaces *and on the bridge of ships* is becoming a serious concern'.[570] The report warned against seafarers becoming 'smartphone zombies' who do not pay attention to their surroundings while working.[571]

Considering the above, in an encounter between a manned and an autonomous vessel when there is a risk of collision, if collision regulations treat the autonomous vessel as an ordinary power-driven vessel, then in certain situations, the prime responsibility to take avoiding action will be on the manned vessel,[572] and in other situations, on the autonomous vessel.[573] However, as the foregoing reports show, manned vessels are highly susceptible to inadequate lookout and may therefore fail to take the avoiding action. Thus, in order to bypass this element of human error i.e. the potential danger of lack of situational awareness, autonomous vessels should be required to avoid impeding the navigation of manned vessels in the first place, and when risk of collision arises, the prime responsibility to take avoiding action should *always* be placed on the vessel which is less likely to suffer from human error i.e. the autonomous vessel. If regulations put this prime responsibility on manned vessels, then in many cases such regulations will be flogging a dead horse – lack of situational awareness on manned vessels has persistently remained the most common cause of collisions over the last decades and there is nothing to suggest that it will go away in the foreseeable future.

One may argue that regulations should not draw such a distinction line because in situations where the manned vessel fails to give way, the autonomous vessel can be required to avoid collision by its own action alone. Be that as it may, there are three strong counter-arguments. First, in situations where one vessel is give-way and the other stand-on, in order to provide the give-way vessel with sufficient sea-room and prevent conflicting actions, the stand-on vessel *must* (initially) keep her course and speed i.e. must avoid taking any action.[574] It is only at the later stages, when the two vessels approach closer to the potential collision point, that the stand-on vessel is allowed[575] or is (in the next

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570 'Fatal Accident on the Stern Ramp of a Ro-Ro Freight Ferry at Brocklebank Dock, Liverpool' (*MAIB* 11 June 2020) (emphasis added) <https://www.gov.uk/government/news/seatruck-progress-report-and-flyer-published> accessed 07 February 2023.

571 MAIB, 'Report on the Investigation of the Death of a Third Officer Struck by a Freight Vehicle on the Stern Ramp of the Ro-Ro Freight Ferry' (2019) para 2.7. – available at <https://assets.publishing.service.gov.uk/media/5ee08229e90e07141fd1a990/2020-10-SeatruckProgress.pdf> accessed 07 February 2023.

572 E.g. a manned vessel that has an autonomous vessel on its own starboard side (as per Rule 15).

573 E.g. an autonomous vessel that has a manned vessel on its own starboard side (as per Rule 15).

574 COLREGs, Rule 17(a)(i).

575 Ibid Rule 17(a)(ii).

stage) obliged[576] to take collision-avoiding action. In other words, by the time the autonomous vessel starts taking evasive action, the two vessels may have already approached into a close-quarters situation where avoiding collision is generally more difficult. Along or even above preventing collisions, another crucial purpose of any collision avoidance regulation should be preventing close-quarters situations from developing in the first place. One may argue that collision regulations, however well-designed, cannot always prevent close-quarters situation from developing between 'two manned vessels'. This is true because in such encounters, both vessels may lack situational awareness and therefore approach too close to each other. Regulations simply *cannot* prevent all close-quarters situations between manned vessels by requiring them to keep out of the way in ample time where research clearly indicates that manned vessels are likely to lack sufficient situational awareness. That is why collisions keep happening and inadequate lookout keeps appearing at the top of the list of collision causes. However, where close-quarters situations between manned and autonomous vessels *can* be avoided by requiring the autonomous vessel to keep clear, why should regulations not be designed to do so? Why should rules be formulated in a way that would allow close-quarters situations to develop to then require one vessel or another to avoid collision in extremis? One of the aims of autonomous shipping is eliminating or minimising collisions by addressing the human error issue. However, this goal cannot be achieved simply by manufacturing and operating autonomous vessels if collision regulations do not take into consideration the issue of human error that still exists on many manned vessels. Autonomous ship technology has finally brought about the opportunity to overcome the situational awareness issue at least in encounters between manned and autonomous vessels. The rules are ripe for reform and the opportunity should be welcomed by the IMO.

Second, in certain encounters, even the action of the autonomous vessel as a stand-on vessel may not save the situation. Assume that an autonomous vessel observes a manned vessel approaching from dead astern and intending to overtake. As things currently stand, this would be an overtaking situation governed by COLREGs Rule 13 which requires the manned vessel to keep out of the way of the autonomous vessel.[577] The autonomous vessel must (initially) keep her course and speed and avoid taking any action.[578] However, assume that due to lack of situational awareness, the manned vessel is utterly unaware of the presence of the autonomous vessel and approaches closer. As soon as this becomes apparent to the autonomous vessel, then under Rule 17 she is allowed (and in the next stage obliged) to take avoiding action itself. If the autonomous

[576] Ibid Rule 17(b).

[577] Ibid Rule 13(a).

[578] Ibid Rule 17(a)(i).

vessel is navigating at her maximum speed, then she can only avoid collision by turning either to port (left) or starboard (right) side. The vital question, however, is: 'which' side? There is no guarantee that the autonomous vessel turns to starboard (or port for that matter) and the manned vessel who suddenly wakes up to the danger, does not simultaneously turn to starboard (or port) side too. There is no way for the autonomous vessel to know which action will definitely save the situation. This is particularly so in confined and/or busy waters where vessels are restricted in their ability to alter their course safely and may have to wait until there is sufficient sea room to do so. For example, in the above scenario, if there are oncoming vessels on both sides of the autonomous vessel, then she will not be able to turn to either side until those vessels are past and clear. Thus, it is safer to require the autonomous vessel to keep out of the way of the manned vessel before risk of collision is triggered. In this way, the autonomous vessel will have to turn to port or starboard well before the manned vessel approaches too close, and the risk of conflicting actions will be eliminated.

Third, in addition to the danger of conflicting actions, another compounding factor in close-quarters situations that can exacerbate the issue, is hydrodynamic *interaction*; a complicated phenomenon which is not always easy to understand. Hydrodynamic interaction is the reaction of a vessel's hull to the pressure which is exerted on its underwater volume[579] by the presence of another nearby vessel, or by the bank of a river or canal, or by the seabed when the vessel's under-keel clearance is small. In other words, interaction occurs when a vessel comes too close to another vessel or too close to a river or canal bank,[580] which will result in sudden sheer of the vessel to one side and this in turn may cause accidents. In 2002, the UK MCA issued a Marine Guidance Note entitled 'Dangers of Interaction' in which it warned that interaction 'continues to be a major contributory factor in marine casualties and hazardous incidents' and provided advisory guidance for vessel owners and operators.[581] Interaction, nonetheless, still causes collisions. For instance, the final report into investigation of a collision between the tug *Arafura Sea Delta* and the general cargo ship *Thorco Crystal* at Weipa Harbour (Queensland) which was released by the Australian Transport Safety Bureau in June

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[579] David J House, *Seamanship Techniques: Shipboard and Marine Operations* (5th edn, Routledge 2019) 739.

[580] CB Barrass and DR Derrett, *Ship Stability for Masters and Mates* (7th edn, Butterworth-Heinemann 2012) 397.

[581] MCA, 'MGN 199 (M): Dangers of Interaction' (2002) para 1 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/282279/mgn199.pdf> accessed 07 February 2023.

2017, concluded that the collision was caused by interaction forces.[582] In fact, the above-mentioned Swedish P&I Club report found that the issue of 'understanding natural forces (*interaction*)' was the second most common cause of the collision claims after lack of situational awareness.[583] This means that two decades on after the issuance of 'Dangers of Interaction' and other similar advisory guidelines, interaction still continues to be a major contributory factor in collisions because it is difficult to understand. In sum, hydrodynamic interaction forces in close encounters are difficult to predict and make the prediction or the control of the vessel's behaviour extremely difficult. This is the third reason why regulations should be designed so as to prevent close-quarters situations from developing in the first place.

Thus, from a pragmatic point of view, it stands to reason that in an encounter between a manned and a MASS Degree 4, regulations should put the prime responsibility of taking avoiding action on the autonomous vessel. Any regulation shifting this responsibility onto the manned vessel, can prove to be a costly failure to address the most common cause of collisions i.e. the lack of situational awareness on manned vessels. It is true that if the prime responsibility is placed on the manned vessel and if in such an encounter the manned vessel fails to take proper avoiding action then the autonomous vessel will be required to take evasive action. However, as observed above, such a regulation can possibly lead the two vessels into a close-quarters situation where the risk of conflicting actions and complicated interaction forces will make collision avoidance extremely difficult or even impossible. As the commander of Apollo 8, Frank Borman, once quipped, '[a] superior pilot uses his superior judgment to avoid situations which require the use of his superior skill'.[584] Similarly, the doctrine behind a wise and rigorous set of collision regulations should be prevention of close-quarters situations from developing in the first place, rather than relying on vessels or navigators to use their superior skills in extremis where avoiding collision may be wholly at the mercy of chance.

3.8.2. Traffic Density and Information Overload

Lack of situational awareness is not the only reason to support such a doctrine. As waters are becoming more congested, navigation bridges more complex, and ships faster, the task of ship navigation is becoming more difficult and collisions may occur even if the

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[582] Australian Transport Safety Bureau, 'Collision between the Tug Arafura Sea Delta and General Cargo Ship Thorco Crystal' (24 June 2017) page 5 – available at <https://www.atsb.gov.au/media/5773720/332-mo-2017-005_final.pdf> accessed 07 February 2023.

[583] The Swedish Club, 'Claims at a Glance' (2019) page 54 (emphasis added) – available at <https://www.swedishclub.com/media_upload/files/Publications/Loss%20Prevention/Claims_at_a_Glance_2019%20WEBnew.pdf> accessed 07 February 2023.

[584] Lim Khoy Hing, *Life in the Skies: Everything You Want to Know About Flying* (Marshall Cavendish International Asia Pte Ltd 2013) 56.

OOW has a high level of situational awareness. This is because human beings have a limitation in their cognitive ability to receive, process and understand large amounts of data simultaneously. Global initiatives such as 'Just in Time Arrival' are developing a concept to allow commercial ships around the world to adjust their speed during the voyage so as to arrive at the port when the availability of berth, fairway and nautical services is ensured.[585] While such initiatives will help reduce the traffic density in coastal waters, it still cannot completely eliminate the issue of information overload. Rule 5 requires the navigator to maintain a lookout by 'all available means' which are appropriate in the prevailing conditions. The bridge team has to keep a continuous listening watch on VHF radio on the local port channel and/or channel 16 in order to be aware of the radio messages communicated by the Vessel Traffic Services (VTS) and the surrounding vessels and respond to the relevant radio calls. The team also has to keep a close eye on the ship's geographical position to ensure the ship is not being driven by the tide and/or wind towards shallow waters and to counter the effect of the tide/wind by adjusting the ship's heading and/or speed as required. Another crucial task is keeping a radar watch and monitor the position and movement of the surrounding vessels and take action in accordance with COLREGs if it is necessary to avoid collision. However, not all vessels have a strong radar signature – smaller or wooden vessels may not be detected by radar. Hence, the bridge team must also maintain a continuous visual watch to detect such vessels visually. Additionally, the bridge team will have to answer important telephone and radio calls from the engine room and the deck crew who are preparing for berthing or un-berthing. To add to the complexity, the ever-increasing technology on ships' bridges and various alarms going off, will require the attention of the members of the bridge team which may distract them from their immediate navigational responsibilities. In the middle of such a confused situation of multi-tasking, it is easy for the bridge team to become 'cognitively overloaded' with a lot of different information, and for the ship to go aground or collide with another vessel or structure. Even if the bridge team does not become cognitively overloaded, the stress imposed on them may adversely affect their cognitive ability to assess the situation and take proper action. The following example illustrates the point. In October 2018, in a foggy morning in Cowes Harbour (Isle of Wight), the passenger ferry *Red Falcon* ran aground after colliding with and sinking the yacht *Greylag*. The subsequent MAIB investigation found that the collision occurred because the master of *Red Falcon* lost his orientation as a result of suffering from 'cognitive overload'[586] and becoming 'fixated' on the information displayed on the ship's Electronic

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[585] IMO, 'Just in Time Arrival Guide: Barriers and Potential Solutions' (2020) page xiii – available at <http://www.imo.org/en/OurWork/PartnershipsProjects/Documents/GIA-just-in-time-hires.pdf> accessed 07 February 2023.

[586] MAIB, 'Report on the Investigation of the Collision between the Ro-Ro Passenger Ferry *Red Falcon* and the Moored Yacht *Greylag*' (2020) 1 – available at

Chart System (ECS) due to 'high task load and [high] levels of stress'.[587] According to the report, the master was probably not able to 'attend' or 'take in' all the relevant information provided to him by his bridge team and by the visual displays.[588]

As the number of the world's commercial fleet increases, it is conceivable that even oceans may potentially become a dangerous place for ships to navigate in. Before the advent of electronic navigational aids such as GPS, a ship's position at sea was fixed through celestial sights and calculations which are subject to various errors. Additionally, cloudy skies meant that celestial bodies could not be used to fix the ship's position and the navigator had to use 'dead reckoning'[589] which would make the estimated ship's position even more inaccurate. As a result, ships were likely to be sailing far from their intended routes and thus, far from each other in a particular area of water. Today, however, electronic navigational aids have enabled ships to fix their position accurately and to stay on their planned route during the voyage. It is, therefore, not surprising that nowadays many ships navigate on exactly the same shipping route and frequently encounter each other in head-on and overtaking situations.

Thus, the growing number of vessels and complexity of electronic navigational aids are likely to make the task of collision avoidance more difficult for navigators in both coastal and open waters in the future. Since autonomous systems do not suffer from stress or fatigue and can multi-task while processing large amount of data obtained from various sources, it is reasonable to place the prime responsibility of collision avoidance on autonomous rather than manned vessels. This doctrine will help to eliminate or minimise possible future collisions between manned and autonomous ships in all waters. Some may argue that such a doctrine may, in effect, cause navigators on manned vessels to be less watchful and it may create an assurance that autonomous vessels will always successfully keep out of the way of manned vessels, and thereby ironically exacerbating the issue of insufficient lookout. A reasonable OOW on a manned vessel, however, by keeping the following points in mind will always remember that such an assurance is not only false, but also dangerous to rely on. First, there is always a possibility that an autonomous vessel may fail to give way, for example, through a fault in its software and/or hardware. Second, in addition to autonomous vessels, a manned vessel may also encounter other navigational hazards such as other manned vessels, oil platforms, islands, wrecks, icebergs and dangerous derelicts such as floating shipping containers.

<https://assets.publishing.service.gov.uk/media/5e4e4575d3bf7f393d5ab2ad/2020-6-RedFalcon-Greylag.pdf> accessed 07 February 2023.

587 Ibid para 2.5.4.

588 Ibid.

589 Dead reckoning is a method of fixing a ship's current position by using its previously determined position and estimating its course and speed.

No OOW knows what lies in wait for the vessel in his or her hands; hence, he or she must always maintain a proper lookout at all times. Third, maintaining a proper lookout is not just about the safety of one's *own* ship through avoiding collisions, allisions, groundings, stranding or other navigational accidents; it is also about the safety of *other* ships or even aircraft at sea. The STCW Code makes it clear that the duty of 'proper lookout' imposed by Rule 5 of COLREGs must, *inter alia*, serve the purpose of detecting shipwrecked persons and ships or aircraft in distress.[590] Hence, the importance and relevance of lookout. Under the SOLAS Convention, when a vessel receives information 'from any source' that persons are in distress at sea, then the master of the vessel is bound to respond to such a distress signal and proceed with all speed to their assistance.[591] The reference to information 'from any source', emphasises the fact that a distress signal may be communicated by a person or a vessel in various ways such as the spoken word 'Mayday', an orange-coloured smoke signal, a rocket parachute flare, an international maritime flag signal of N (November) flown above C (Charlie) and signals transmitted by survival craft radar transponders that can be seen on own vessel's x-band radar.[592] The OOW on a manned vessel can receive and identify any of these distress signals only if he or she keeps a 'proper lookout' by sight and hearing *at all times* as required by Rule 5. Thus, an amendment to COLREGs placing the prime responsibility of avoiding collisions on autonomous vessels, cannot and will not encourage any reasonable OOW on a manned vessel to take his or her lookout responsibilities less seriously. Rule 2 warns that *nothing* will exonerate a master or OOW from the consequences of any neglect to comply with the Rules, including Rule 5 which imposes a duty to maintain a proper lookout *at all times*.

3.9. Societal Approach

Regulations should be just and fair in order to gain the trust and support of the society as a whole. If a rule confers a right on a particular legal entity but not another, there should exist a reason to justify the rule. In a two-vessel collision encounter, imposing the prime responsibility of collision avoidance on one vessel, would mean bestowing a privilege to the other. Apportioning and justifying such responsibility is more straightforward when the two vessels are both manned. For example, Rule 15 states that in an encounter between two (manned) power-driven vessels, the vessel that has the other on her own starboard side, must take avoiding action. However, this is not a substantive privilege granted to the crew on board the stand-on vessel or a disadvantage to the navigators on board give-way vessel. A few minutes later, the stand-on vessel may encounter another power-driven

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[590] Section A-VIII/2, paragraph 14(3).

[591] Regulation V/33(1).

[592] COLREGs, Annex VI.

vessel, but this time on her own port side, which means she will be the give-way vessel this time round. There is a balance and the rule is justifiable. As another example, in a situation between a manned power-driven vessel and a manned sailing vessel, Rule 18 (a)(iv) imposes the prime avoiding action duty on the power-driven vessel. This Rule, creates a substantive privilege for sailing vessels over power-driven vessels. This privilege, nonetheless, is justifiable on the basis that sailing vessels, compared to power-driven vessels, are less manoeuvrable as changing their course and/or speed takes more time and physical effort. At times, a sailing vessel may even become becalmed and unable to carry out any manoeuvre whatsoever. Because of the vulnerable circumstances of sailing vessels, the privilege conferred on sailing vessels by Rule 18 (a)(iv) is acceptable and understandable by crewmembers on power-driven vessels as they may find (or at least envisage) themselves serving on a sailing vessel at some point in the future.

Evaluating whether a rule is just, however, becomes philosophically more difficult if one of the two vessels is a MASS Degree 3 or 4. Imagine two identical power-driven vessels with exactly the same equipment and manoeuvrability that are approaching each other on a collision course in a crossing situation. The only difference between them is that, while one of them is in manual mode and is being navigated by a mariner on the bridge, the other is in MASS Degree 4 mode with no humans on board. It was previously observed that for safety reasons e.g. poor lookout and information overload associated with manned vessels, the autonomous vessel should be required to avoid impeding the navigation of the manned vessel. Assume, however, that such safety risks and potential human errors have all been addressed and eliminated for the manned vessel. Then, from an ethical point of view, which vessel should the rules require to take avoiding action? Should they just follow Rule 15 i.e. the vessel that has the other on her own starboard side, should keep out of the way? If so, then depending on the position of the two vessels, the manned vessel may be obliged to give way to the autonomous vessel. On the one hand, the navigator on the manned vessel may find such a rule unjust and an infringement of their ‘human rights’ and/or a disregard of their ‘human dignity’ as the rule bestows a navigational privilege on a machine and not a human being. On the other hand, some may support such a rule, arguing that machines have ‘rights’ just as much as (or even more than) humans do. Should the law differentiate between machines and humans; do machines have ‘rights’; and is there any balance to be struck by the law between ‘human rights’ and ‘robot rights’?

The question in the ontological approach is answered by deciding ‘who’ is morally significant and ‘what’ is not, based on the intrinsic properties of the entity in question.[593]

[593] David J Gunkel, ‘Mark Coeckelbergh: Growing Moral Relations. Critique of Moral Status Ascription’ (2013) 15(3) Ethics and Information Technology 239, 239.

In other words, 'what' the entity is, determines the degree of moral value it enjoys, if any.[594] The main problem with the ontological approach is that it is not clear which exact property or properties are sufficient for an entity to have moral status.[595] For example, during the course of history, the question 'can/should animals have any rights of their own?' has been answered in different ways depending on the distinction line used to determine what animals are. In ancient times, the distinction line in the Western world was 'rationality'. Aristotle argued that nature made all animals 'for the sake of humans' and that due to their irrationality, non-human animals rank far below humans in the Great Chain of Being.[596] Based on these arguments, the Stoics regarded all non-human animals as slaves and treated them as contemptible and beneath notice.[597] Under Roman law, animals were categorised as legal 'things' which existed in the law solely as the objects of the rights of legal persons, for example, as things over which legal persons may exercise property rights.[598] On the other hand, the distinction line in traditional Eastern religious and philosophical beliefs such as Hinduism and Buddhism, is 'life'. The ethical principle of ahimsa (which literally means non-injury) in such belief systems requires that one not kill or cause harm to 'any' form of 'life' including human beings, animals, insects, plants, or even microbes.[599] The principle of ahimsa is so important that some kings in ancient India, like the great king Ashoka (300 BC),[600] built hospitals for sick animals, and Jain monks wear cloth mouth covers to avoid unwittingly injuring or killing miniscule insects or living beings in the air through the process of breathing.[601] Different ontology regarding animal rights in the Western world started to gather momentum in the 18th century, when Jeremy Bentham shifted the focus of the prevalent animal rights philosophy from the active abilities such as 'can they reason?' to

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594 Luciano Floridi, *The Ethics of Information* (OUP 2013) 116.

595 David J Gunkel, 'Mark Coeckelbergh: Growing Moral Relations. Critique of Moral Status Ascription' (2013) 15(3) Ethics and Information Technology 239, 239.

596 Steven M Wise, 'Animal rights' (*Britannica*) <https://www.britannica.com/topic/animal-rights> accessed 07 February 2023.

597 Ibid.

598 Ibid.

599 'Ahimsa' (*Britannica*) <https://www.britannica.com/topic/ahimsa> accessed 07 February 2023.

600 R Somvanshi, 'Veterinary Medicine and Animal Keeping in Ancients India' (01 December 2012) <https://www.vethelplineindia.co.in/veterinary-medicine-and-animal-keeping-in-ancient-india/#:~:text=The%20great%20king%20Ashoka%20(300,his%20empire%20and%20adjoining%20kingdoms.> accessed 07 February 2023.

601 Padma Subba Rao, 'Muhapatti: Why Jain Monks Wear Cloth to Cover their Mouth? Know Detail Here' (06 May 2019) <https://english.newstracklive.com/news/muhapatti--why-jain-monks-wear-cloth-t-cover-their-mouth-know-detail-here-sc77-nu-1009162-1.html> accessed 07 February 2023.

the passive capabilities such as 'can they suffer?'[602] In 1992, Switzerland became the first country in the world to take up protection of the 'dignity' of animals into its constitution by changing the status of animals from 'things' to 'living beings'.[603] A decade later, Germany became the first EU country to enshrine animal 'rights' in its constitution.[604] In 2013, in an unprecedented decision, India declared that all cetaceans are 'nonhuman persons' and banned dolphin captivity within the country.[605] The decision is particularly important because it reflects an understanding which is based on 'who' rather than 'what' dolphins are.[606] However, there are still many countries across the world in which there is an absolute lack of any anti-cruelty laws or animal welfare laws.[607] Thus, there is no universal consensus on 'what' intrinsic property or properties an animal should have in order to become a moral subject with rights of its own. Depending on the distinction line, an animal may be regarded as some*thing* irrational that has been created 'for the sake of humans' and therefore can be hunted and slaughtered for human consumption. In other belief systems, all animals and even plants are *living beings* that live for their own sake, have the right to life, and may even be regarded as 'nonhuman persons'.

When it comes to technology and non-living objects, the ontological approach is less controversial and manifests itself in a paradigm which was developed by Martin Heidegger in the 1950s. He argues that based on ancient doctrine, the essence of a thing, such as a machine, is considered to be 'what' the thing is. He then provides two answers to the question '*what* is technology?': technology is a means to an end; and it is a human activity.[608] Accordingly, he conceptualises the concept of technology as something 'instrumental and anthropological' which is used by humans merely as a means to an

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602 Ibid.

603 Margot Michel and Eveline Schneider Kayasseh, 'The Legal Situation of Animals in Switzerland: Two Steps Forward, One Step Back - Many Steps to Go' (2011) 7 Journal of Animal Law 1, 3.

604 'Germany Guarantees Animal Rights' (*CNN*, 21 June 2002) <https://edition.cnn.com/2002/WORLD/europe/06/21/germany.animals/index.html#:~:text=BERLIN%2C%20Germany%20%2D%2D%20Animal%20rights,protect%20the%20dignity%20of%20humans.> accessed 07 February 2023.

605 Laura Bridgeman, 'What India's Decision to Ban Dolphin Captivity Means' (*Earth Island Journal*, 12 June 2013) <https://www.earthisland.org/journal/index.php/articles/entry/what_indias_decision_to_ban_dolphin_captivity_means/> accessed 07 February 2023.

606 Ibid.

607 'Animal Legislation in the World at National Level' (*Global Animal Law*) <https://www.globalanimallaw.org/database/national/index.html> accessed 07 February 2023.

608 Martin Heidegger, 'The Question Concerning Technology' (1977) Environmental Ethics 1, 1.

end.[609] The corollary of this instrumentalist theory is that equipment, tools, machines, robots, and MASS for that matter, are merely instruments that are designed and employed by humans to serve their specific interests. They are, therefore, not capable of becoming moral or legal subjects and thus, possess no independent moral or legal rights 'of their own'. For example, under UK law, a person who intentionally damages any property e.g. a car belonging to another person will be guilty of an offence.[610] This does not mean that the car itself is a moral subject and has a right of its own not to be damaged. A person who damages the car, is not guilty of an offence against the car itself, but against the 'person' who is a moral subject and exercises property rights over the car. Applying the instrumentalist theory to autonomous vessels, it is obvious that they cannot be moral subjects nor can they have rights 'of their own'. This, however, does not mean that we cannot 'grant' them any rights or impose on them any responsibilities. Some people not only deny robots 'rights', but deny that robots are 'the kinds of things that could be granted rights in the first place'.[611]

Our world is surrounded by intelligent and sophisticated machines, and AI is becoming commonplace in our society. Nowadays, it is not uncommon for people who answer phone calls in a call centre to be verbally abused by an invisible frustrated client at the other end of the line. AI has already replaced human beings in the call centres of some credit companies and major retailers to, inter alia, eliminate the possibility of their staff being dehumanised through verbal abuse. What is the position if a client verbally abuses the AI that is answering their call? Does the client owe a duty of care to the AI as a moral entity? The instrumentalist theory would answer this question in the negative because the AI is just a technology which is utilised by humans for a particular purpose. However, if the AI is so advanced that it has feelings akin to humans, and if verbal abuse adversely affects its efficiency, then it is at least debatable that we should 'grant' the AI the right not to be abused. A further example is a social robot that is designed to be a companion to elderly people or to help children suffering from autism to learn responses from the robot through various interactions. Given the very purpose of such robots, it would not be a pure fantasy to envisage that in the future they will share mental, emotional, and psychological characteristics much similar to those of human beings. Widespread use of such social robots can contribute to the phenomenon of post-humanisation i.e. a process by which "a society comes to include members other than 'natural' biological human beings who, in one way or another, contribute to the structures, dynamics, or meaning of

[609] Ibid.

[610] Criminal Damage Act 1971, sec 1(1).

[611] Abeba Birhane and Jelle van Dijk, 'Robot Rights? Let's Talk about Human Welfare Instead' (2020) Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society, page 1.

the society".[612] Thus, although not natural or biological human beings, social robots may inevitably become interwoven with the fabric of the human society to which they contribute. Again, it may be argued that despite being machines, we may need to 'grant' social robots certain rights in the post-humanisation era. As another example, under UK law, a worker who works more than 6 hours a day, is entitled to a minimum of 20 minutes rest break during his/her working day.[613] Since the whole point of using robots is that they are more accurate, cheaper, and tireless, it would be absurd to argue that robots have rights 'of their own' and therefore must be entitled to the same rest break. They have been designed to work tirelessly and serve humans. Nevertheless, it is conceivable that future robots will think and act more and more like humans. Octavia, a humanoid robot that is designed to fight fires on navy ships,[614] indicates that the notion of robots with humanoid thinking or feeling is not implausible. With this in mind, if some robots are so intelligent that can understand the discrimination against them regarding the rest break and subsequently stop working or develop a sense of hostility, then 'granting' them the right to rest breaks can be justifiable or even inevitable. Thus, as Gunkel proposes, the moral status of robots should be decided based not on their internal properties, but on our relationships with them.[615] For instance, if it is desensitising to humans to be violent towards humanoid robots, then there would be an argument for granting legal protection to such robots.[616] In other words, we 'grant' such rights to a robot 'not for the robot's sake, but for our own'.[617] It is, therefore, submitted that the issue should be looked at from the positive and not natural law perspective.

Thus, although some argue that robot rights would not necessarily follow from human rights, but it can precede and even in some cases exceed human rights,[618] the question is whether our society is prepared to 'grant' machines any rights equal to or higher than that of humans and the answer appears to be negative. In 2016, the European

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612 Matthew Gladden, *Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization* (2nd edn, Synthypnion Press 2018) 19

613 The Working Time Regulations 1998, Regulation 12(3).

614 Louisa Hall, 'How We Feel About Robots That Feel' (*MIT Technology Review*, 24 October 2017) <https://www.technologyreview.com/2017/10/24/148259/how-we-feel-about-robots-that-feel/> accessed 07 February 2023.

615 David J Gunkel, *Robot Rights* (The MIT Press 2018) 165.

616 Rachel Gbolaru, 'Rise of the Robots: Should We Give Robots 'Rights'?' (*Delta 2020*, 28 June 2019) <https://delta2020.com/blog/224-rise-of-the-robots-should-we-give-robots-rights> accessed 07 February 2023.

617 Ibid.

618 Jennifer Robertson, 'Human Rights vs. Robot Rights: Forecasts from Japan' (2014) Critical Asian Studies 46(4) 571, 580.

Parliament's Committee on Legal Affairs published a draft report on 'Civil Law Rules on Robotics'[619] in which it proposed to grant the most sophisticated autonomous robots the legal status of 'electronic persons' with specific 'rights'. On the 05th of April 2018, an open letter signed by a group of robotics, industry leaders, law, medical and ethics experts called on the European Commission to reject the proposal, criticising it as 'ideological and non-sensical and non-pragmatic'.[620] Three weeks later, the European Commission outlined its approach to ethical guidelines in the context of AI without mentioning the term 'electronic persons' or anything about robot 'rights'.[621] Where society is not prepared to grant even sophisticated humanoid robots any rights, it is unlikely that granting such rights to autonomous vessels will attract the support or trust of society as a reasonable regulation.

If regulations do not grant autonomous vessels navigational rights and impose on them the prime collision avoidance responsibility, then as observed earlier, it will be safer and there will be no negative reaction from them as they cannot understand the difference. But if regulations do grant them such rights, not only will it be unsafe, but also absurd or even a disregard of seafarers' human dignity. It will be absurd because, as observed above, experts from different parts of society find such regulations unreasonable. There is a consensus amongst robotics, law, and ethics experts that AI should be designed, regulated, and implemented for the benefit of humanity. For example, in April 2018, the House of Lords Select Committee on Artificial Intelligence published a report[622] on design and implementation of AI in the UK and suggested five overarching principles for an AI Code, the first of which reads: 'Artificial intelligence should be developed for the *common good and benefit of humanity*.'[623] Similarly, in 2019, the IEEE published a collaborative work in which it suggested that to best respect human rights, AI should be designed and

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[619] European Parliament, Committee on Legal Affairs, 'Draft Report: with recommendations to the Commission on Civil Law Rules on Robotics' (2016) – available at <https://www.europarl.europa.eu/doceo/document/JURI-PR-582443_EN.pdf?redirect> accessed 07 February 2023.

[620] Artificial Intelligence and Robotics Experts, 'Open Letter to the European Commission: Artificial Intelligence and Robotics' (2018) – available at <https://images.politico.eu/wp-content/uploads/2018/04/RoboticsOpenLetter.pdf> accessed 07 February 2023.

[621] 'Artificial intelligence: Commission Outlines a European Approach to Boost Investment and Set Ethical Guidelines' (*European Commission*, 25 April 2018) <https://ec.europa.eu/commission/presscorner/detail/en/IP_18_3362> accessed 07 February 2023.

[622] The House of Lords Select Committee on Artificial Intelligence, 'AI in the UK: Ready, Willing and Able?' (2018) – available at <https://publications.parliament.uk/pa/ld201719/ldselect/ldai/100/100.pdf> accessed 07 February 2023.

[623] Ibid para 417 (emphasis added).

operated in a way that 'benefits humans'[624] and they should not be granted 'rights and privileges'[625] equal to those of humans. The following year, a study prepared for the European Parliament also expressed the same view.[626] In 2020, another set of guidelines prepared by an independent expert group on AI which was set up by the European Commission, also stressed that AI should be used to 'benefit all human beings, including future generations.'[627] These studies go a long way towards establishing that autonomous vessels should be regulated in a way to benefit humans, in particular, seafarers. Requiring autonomous vessels not to impede navigation of other vessels will benefit seafarers in that it will reduce their navigational workload so that they can focus on avoiding collision with manned or remotely-controlled vessels. Not imposing such responsibilities on autonomous vessels would mean that in some situations, seafarers would have to give way to an inanimate object. This may also be viewed as disregard of human dignity which is the foundation of human rights. Although the European Convention on Human Rights does not explicitly mention the concept of human dignity, the European Court of Human Rights acknowledged in *SW v United Kingdom* that respect for human dignity and human freedom is 'the very essence' of the Convention.[628] Article 1 of the Charter of Fundamental Rights of the European Union, stipulates that human dignity is inviolable and must be respected and protected. It can be argued that obliging seafarers to give way to an autonomous vessel where it could have been the other way round, would be putting their 'intrinsic worth'[629] lower than an inanimate object and thus disregarding their human dignity.

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[624] IEEE, 'Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems' (2019) page 19 – available at <https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead1e.pdf?utm_medium=undefined&utm_source=undefined&utm_campaign=undefined&utm_content=undefined&utm_term=undefined> accessed 07 February 2023.

[625] Ibid 20.

[626] Eleanor Bird *et al*., 'The Ethics of Artificial Intelligence: Issues and Initiatives' (2020) Scientific Foresight Unit, European Parliamentary Research Service, page 45 – available at <https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf> accessed 07 February 2023.

[627] The High-Level Expert Group on AI, 'Assessment List for Trustworthy Artificial Intelligence' (2020) page 19 – available at <https://ec.europa.eu/digital-single-market/en/news/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment> accessed 07 February 2023.

[628] (1995) ECHR 52, para 44.

[629] The High-Level Expert Group on AI, 'Assessment List for Trustworthy Artificial Intelligence' (2020) page 19 – available at <https://ec.europa.eu/digital-single-market/en/news/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment> accessed 07 February 2023.

3.10. Ethical Approach

In 2016, a collision occurred in California between a Google self-driving car which was moving at 2mph, and a bus travelling at 15mph behind it.[630] The cause of the collision was that the Google car's self-driving algorithm and the human in the Google car believed that they had the right of way i.e. they assumed that the bus would stop or slow down to allow the Google car to continue and therefore did not take any action.[631] Google said it will refine the self-driving algorithm to 'more deeply understand that buses and other large vehicles are less likely to yield to us than other types of vehicles'.[632] In another accident in 2018, an Uber autonomous car killed a pedestrian who was pushing a bike and crossing a road in Arizona. The NTSB preliminary investigation found that the car's radar and LIDAR systems detected the pedestrian 6 seconds before the impact, but the algorithm classified the pedestrian 'as an unknown object, as a vehicle, and then as a bicycle with varying expectations of future travel path.'[633] It was only at 1.3 seconds before the impact that the algorithm determined that an emergency stop was needed to mitigate the impact.[634] Autonomous systems are not always flawless and there is no reason to think autonomous vessels will not be involved in similar accidents. In fact, the consequences of a large MASS that does not take early avoiding action because its software wrongly concludes that the other vessel (e.g., a laden tanker not under command) must take avoiding action, can be far more catastrophic.

One way of avoiding such accidents is obliging autonomous vessels to take, so far as possible, early action so that they do not end up in situations where the correct judgement and/or action to avoid collision may be difficult for them. If regulations fail to do so, an autonomous vessel that becomes involved in a risk of collision, may face a second and more complicated problem; the 'trolley problem'. This is a decision-making problem that was introduced in 1967 by Philippa Foot who posed the following question. Suppose that an out-of-control tram is about to hit five people who are on the track ahead. A person is standing next to a lever which can be turned to send the tram to a side track on which there is only one person. Anyone on either track the tram enters is bound to be killed. The

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[630] Dave Lee, 'Google Self-Driving Car Hits a Bus', (*BBC News*, 29 February 2016) <https://www.bbc.co.uk/news/technology-35692845> accessed 07 February 2023.

[631] Ibid.

[632] Ibid.

[633] 'Preliminary Report' (*NTSB*, 2018) <https://www.ntsb.gov/investigations/AccidentReports/Reports/HWY18MH010-prelim.pdf> accessed 07 February 2023.

[634] Ibid.

question is whether the person should turn the lever.[635] As an example of the trolley problem in a maritime context, a large MASS that becomes involved in an inevitable collision, will have to decide between colliding with a passenger ship with many people, and a small vessel with only a few people on board. Which one should the MASS decide to hit?

From a practical standpoint, a MASS may not be able to distinguish between the two types of vessels or know the exact number of people on each vessel. From a legal/regulatory perspective, although some surveys suggest that most people may favour a utilitarian approach i.e. taking an action that will kill the smaller group of people but will save the larger group,[636] programming an autonomous vessel to swerve away from a vessel carrying a large group of people on board and towards a vessel with a smaller group of people, may attract some degree of 'criminal' liability for the vessel's owners and/or programmers. The situation will be the same if the autonomous vessel is programmed to ignore the imminent collision with the ship carrying the larger group and collide with it. Extrapolating Wu's argument[637] to a maritime context, this is because while seafarers in a trolley problem situation will have to decide in the agony of the 'moment', the programmers of the autonomous vessel decide in advance and with 'aforethought' to 'target' a specific vessel with the full knowledge that the people on the vessel will be harmed or killed. Thus, possible criminal sanctions for either way of programming and the uncertain legal position may deter potential manufacturers or owners of such vessels and delay their safety benefits that they would otherwise bring to the shipping industry. In the context of autonomous 'vehicles', Wu argues that the manufacturer's best choice to minimise their liability under US law is to programme the vehicle to try to avoid collision with both the small and the larger group of people, even if such attempt proves unsuccessful and results in harming or killing both groups.[638] This is because a jury is more likely to be more sympathetic to a manufacturer that attempts to avoid all harm to all potential victims than to a manufacturer that targets a specific individual, knowing that the individual will definitely be harmed.[639] However, because programming the autonomous vehicle to attempt to avoid collision with both groups may result in harming or killing both groups, it is an unethical decision and the only way to implement the ethical

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[635] Philippa Foot, 'The Problem of Abortion and the Doctrine of the Double Effect' (1967) 5 Oxford Review 1, 2 – available at <https://philpapers.org/archive/footpo-2.pdf> accessed 07 February 2023.

[636] Stephen S Wu, 'Autonomous Vehicles, Trolley Problems, and the Law' (2020) 22(1) Ethics and Information Technology 1, 5.

[637] Ibid 12.

[638] Ibid 1-13.

[639] Ibid.

decision, Wu argues, is through lobbying by the manufacturer for a change in the law to provide immunity from liability for implementing a documented ethical decision.[640]

While such a change in the national laws of a State can be achievable, reaching an international consensus with regard to COLREGs may prove impossible, given the controversial nature of the trolley problem. It is submitted, therefore, that COLREGs should be amended to require autonomous vessels to take early action even before a risk of collision develops in order to avoid trolley problem situations in the first place. This is a principle that the German Ethics Commission arrived at in its 2017 report on automated vehicles:

> '[Automated and connected technology] must be designed in such a way that critical situations do not arise in the first place. These include dilemma situations, in other words a situation in which an automated vehicle has to "decide" which of two evils, between which there can be no trade-off, it necessarily has to perform.'[641]

In the context of MASS, the trolley problem has been recognised in a position paper by the Classification Society DNV in 2018[642] and in a report published by Finland's Ministry of Transport and Communications in November 2020.[643] Although both papers state that complicated trolley problems may be rare between vessels, the Finnish report emphasises that MASS should be designed to minimise the 'risk of encountering trolley problem events'.[644] In fact, there is evidence that the industry is willing to take this approach without even being required to do so by regulations. For instance, in October 2020, Mitsui O.S.K. Lines (MOL), one of the largest shipping companies in the world, announced that they have started a multi-partner project to develop an autonomous collision avoidance system that 'realizes medium-to-long-term strategies for avoidance navigation *well before target ships pose a risk* in congested sea lanes'.[645]

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[640] Ibid 12.

[641] 'Ethics Commission: Automated and Connected Driving' (2017) <https://www.bmvi.de/SharedDocs/EN/publications/report-ethics-commission-automated-and-connected-driving.pdf?__blob=publicationFile> accessed 07 February 2023.

[642] Bjørn Johan Vartdal *et al.*, 'Remote-controlled and Autonomous Ships in the Maritime Industry' (*DNV GL-Maritime*, 2018) page 31 – available at <https://www.dnvgl.com/maritime/publications/remote-controlled-autonomous-ships-paper-download.html> accessed 07 February 2023.

[643] Centrum Balticum *et al.*, 'Charting Regulatory Frameworks for Maritime Autonomous Surface Ship Testing, Pilots, and Commercial Deployments' (2020) para 4.2.3.6.2 – available at <https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162560/LVM_2020_20.pdf?sequence=1&isAllowed=y> accessed 07 February 2023.

[644] Ibid.

[645] 'MOL Steps up Research Aimed at Autonomous Collision Avoidance' (*Mitsui O.S.K. Lines*, 19 October 2020) <https://www.mol.co.jp/en/pr/2020/20067.html> accessed 07 February 2023 (emphasis added).

Such regulations will help the industry avoid controversial ethical dilemmas. If despite such regulations, a MASS does end up in a trolley problem situation, it will have to comply with principles of good seamanship set out in Rule 2; a rule that will be analysed in Chapter 4.

In order to address all the above-mentioned issues associated with the definition of ‘in sight of one another’ while also keeping the Rules simple, clear and comprehensible, the current two regimes of collision avoidance rules should not be fundamentally disturbed. Instead, MASS should be required to take avoiding action *before* risk of collision is involved. This can be done by adding a paragraph to Rule 8:

> *(g) Except where Rules 9 and 10 otherwise require, a fully autonomous MASS shall not impede the passage of any other vessel at any time*.

The only exception to this requirement is when the MASS Degree 4 is navigating in a narrow channel (where Rule 9 applies) or in a TSS (where Rule 10 applies) because in such situations the MASS may not have enough sea-room to take early avoiding action which is why Rule 9 and 10 oblige small vessels, sailing vessels and vessels engaged in fishing not to impede the passage of other vessels which are navigating within the narrow channel or TSS.

Chapter 4: Analysis of Gaps and Issues of COLREGs at Rule Level

4.1. Scope and Objectives

Having analysed the framework of COLREGs, the previous chapter established that, firstly, there is no need for adoption of a totally new collision convention and, secondly, a number of changes to the framework of COLREGs are necessary to surmount the difficulties of integrating MASS degree four into COLREGs. This chapter will scrutinise COLREGs at rule level in order to identify and address potential gaps or issues in important rules of COLREGs. The methodology employed in this chapter will be a combination of expository and theoretical to determine the meaning of the relevant rules and tackle any uncertainty and legal or safety issues that arise. This chapter will start by assessing the final results of the IMO Regulatory Scoping Exercise on MASS. It will then investigate whether MASS can comply with Rule 2 (responsibility) and Rule 5 (Lookout) of COLREGs as these rules seem to be the most problematic rules in the context of autonomous vessels and have also been the focus of attention in the literature. The chapter, however, will also analyse Rule 19 and whether MASS should have a special category and/or should exhibit a special light or day shape. The theoretical framework that holds this chapter together is 'safety'. The safety yardstick, however, is not an absolute one. Rather, it is that level of safety which is acceptable by society as well as pragmatic and achievable from a commercial or technical point of view.

4.2. Final Results of the IMO Regulatory Scoping Exercise on MASS

At the 100th session of the IMO's Maritime Safety Committee, Member States volunteered to either undertake the Regulatory Scoping Exercise (RSE) of an IMO instrument or assist in the RSE.[646] The Marshall Islands volunteered to undertake the RSE of COLREGs, with the voluntary support of China, Japan, Singapore, Spain, Sweden and the United States.[647] In February 2020, the Marshall Islands submitted a report containing the results and conclusion of the RSE to the Maritime Safety Committee and in order to determine the most appropriate way(s) of addressing MASS operation, the report introduced four options as follows:

[646] IMO Doc MSC 102/5/3, para 5.

[647] Ibid.

Option I: equivalences as provided for by the instruments or developing interpretations; and/or
Option II: amending existing instruments; and/or
Option III: developing a new instrument; or
Option IV: none of the above as a result of the analysis.[648]

Depending on the degree of autonomy of a MASS, the report recommends the following solutions:[649]

MASS 1: option I
MASS 2: option I or II
MASS 3: option I or II
MASS 4: option II

In its 103rd session in May 2021, the MSC approved[650] the outcome of the RSE and stated that the best way forward to integrate MASS into the IMO regulatory framework could be through development of a goal-based MASS instrument (e.g. a MASS Code), noting that addressing every instrument separately could lead to inconsistencies or confusion and may raise potential barriers for the application of the existing regulations to conventional ships.[651] Noting that the earliest entry into force date for such a mandatory MASS Code would be the 1st of January 2028, the Working Group stressed the need to develop interim guidelines to close the safety gap for vessels that use autonomous technology until the gaps are closed by mandatory requirements for MASS operations.[652] However, the MSC also noted that the introduction of such a MASS instrument might still require amendments to the existing IMO instruments[653] and if the IMO is to amend the existing instruments rather than to develop a new instrument, it should categorise the instruments

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648 Ibid para 12.

649 Ibid para 17.

650 IMO Doc MSC.1/Circ.1638, 'Outcome of the regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS)' (3 June 2021) para 1.2. – available at <https://wwwcdn.imo.org/localresources/en/MediaCentre/HotTopics/Documents/MSC.1-Circ.1638%20-%20Outcome%20Of%20The%20Regulatory%20Scoping%20ExerciseFor%20The%20Use%20Of%20Maritime%20Autonomous%20Surface%20Ships...%20(Secretariat).pdf> accessed 07 February 2023.

651 IMO Doc MSC 102/5/3, para 6.2.

652 IMO Doc MSC 103/WP.8, 'Report of the Working Group' (13 May 2021) para 18.

653 IMO Doc MSC 103/21, 'Report of the Maritime Safety Committee on its 103rd Session' (25 May 2021) para 5.47 – available at <https://www.imokorea.org/upfiles/board/19.%20MSC%20103%20%B0%E1%B0%FA%BA%B8%B0%ED%BC%AD%28%BF%B5%BE%EE%29%281%29.pdf> accessed 07 February 2023.

into high-, medium- and low-priority groups.[654] The RSE concluded that COLREGs, the STCW Convention and Code and most chapters of SOLAS are amongst the 'high-priority' IMO instruments.[655]

Thus, the result of the RSE and the conclusion of the MSC suggest that in order to integrate MASS degrees 1, 2 and 3 into COLREGs, the IMO may just use 'equivalences' provided for by COLREGs or develop 'interpretations' without making any actual amendments to COLREGs. As pointed out by Craig Allen, this solution raises two issues.[656] The first issue is related to the existence or relevance of any 'equivalent' provision in COLREGs to exempt MASS from complying with certain COLREGs requirements. Some IMO instruments include provisions to permit equivalent measures to comply with the requirements of the instrument. For example, the STCW Convention expressly allows the Contracting States to retain or adopt other educational and training arrangements provided that such arrangements are at least 'equivalent' to the requirements of the Convention and details of the arrangements are reported as early as practicable to the Secretary-General of the IMO.[657] In COLREGs, there are two such equivalent provisions. For vessels of special construction or purpose that cannot comply with the COLREGs requirements relating to lighting and sound-signalling appliances, Rule 1(e) permits flag States to comply with such other provisions that are the closest possible compliance with the COLREGs provisions. In a similar vein, Rule 38 provides limited exemption from complying with the lighting and sound-signalling requirements for vessels the keel of which was laid prior to entry into force of COLREGs. The issue, however, is that these equivalent provisions apply only to lighting and sound-signalling requirements and do not exempt any vessel from complying with Steering and Sailing Rules which form the most important part of collision avoidance rules. As observed in Chapter 3, observations made to determine the state of visibility, must be visual i.e. must be made with human eyes. There is simply no equivalent provision under COLREGs that would permit flag States to substitute on-board human eyes with electronic ones. The second issue concerns developing 'interpretations' to accommodate MASS and/or exempt them from complying with certain COLREGs rules. If a particular provision of an IMO instrument is open to different interpretations, the MSC usually approves and publishes a 'unified interpretation' to clarify the meaning of the provision. The issue, nevertheless, is that such unified interpretations do not, *per se*, constitute international law and thus Member States are not obliged to follow them. In all its 'unified

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[654] IMO Doc MSC.1/Circ.1638, para 6.6.

[655] Ibid para 6.7.1.

[656] See Craig H. Allen, Sr., 'Why the COLREGS Will Need to be Amended to Accommodate Unmanned Vessels' (2021) Social Science Research Network 1.

[657] Article IX, entitled 'Equivalents'.

interpretations', the IMO 'invites' Member States to use the interpretations as 'guidance' when applying the relevant provisions.[658] Even if such interpretations were binding on Member States, the IMO would still not be able to simply 'develop' suitable interpretations in such a way to integrate MASS into COLREGs. Since COLREGs is a multilateral treaty that was signed and came into force after the adoption of the Vienna Convention on the Law of Treaties in 1969, any interpretation of COLREGs is subject to the rules of the Vienna Convention.

As an example, Rule 5 of COLREGs requires every vessel to maintain a proper lookout 'by sight and hearing' and since 'sight and hearing' imply physical presence of crew members on board, the rule is often cited in the literature as one of the biggest hurdles on the way of integration of MASS into COLREGs. The question then is whether the IMO can overcome the issue simply by developing a liberal interpretation that on-board cameras and aural sensors are capable of discharging the 'sight and hearing' obligation. As part of the first step of the RSE and in order to identify common potential gaps in different IMO instruments, Germany submitted a report to the MSC in which it notes that the existing IMO instruments 'have been written at a time when, as a basic assumption, all ships were manned, i.e. having a master and a crew, as defined by the STCW-Convention, on board'.[659] It then concludes that individual provisions of the IMO instruments are directly addressed to the master, officers or crew members[660] and that such provisions are generally referred to as the 'main issues' or 'common potential gaps' that have been identified during the RSE.[661] Accordingly, the report identifies 'watchkeeping' i.e. lookout as the 'common potential gap' in COLREGs.[662] Similarly, considering the above difficulties, Japan also stated during the RSE that it is not clear whether cameras and aural sensors can satisfy the 'sight and hearing' requirement.[663] In fact, Article 31(1) of the Vienna Convention provides that a treaty must be interpreted 'in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' Arguably, the 'ordinary' meaning of the term 'sight and hearing' does not include AI or electronic sensors on a MASS not

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[658] See, for example, IMO Doc MSC.1/Circ.1577, 'Unified Interpretation on the Application of COLREG with Respect to the Placement of Sidelights' (16 June 2017) para 3.

[659] IMO Doc MSC 102/5/7, 'List of Common Potential Gaps/Themes Identified During the First Step of RSE for STCW Convention and Code, STCW-F, SOLAS, ISM Code, TONNAGE 1969, LL 1966, LL PROT 1988, IS Code, III Code, COLREG and SAR 1979' (10 February 2020) para 10.

[660] Ibid para 11.

[661] Ibid para 13.

[662] Ibid the Annex.

[663] IMO Doc MSC 99/INF.14, 'Studies conducted in Japan on mandatory regulations relating to Maritime Autonomous Surface Ships – SOLAS, STCW and COLREGs' (13 March 2018) para 8.

least because although MASS Degree 4 may be able to 'see' objects or 'hear' sounds around the MASS, they are currently unable to analyse or understand the aural data 'to make a full appraisal of the situation and of the risk of collision' which is the main 'object and purpose' of Rule 5. It can be argued that even in case of a MASS Degree 3 where the visual and aural data are sent to a remote-control centre where a human will be able to interpret the data and make a full appraisal of the situation, the 'sight and hearing' obligation is still not discharged. This is because a special meaning can be given to a term of a treaty only if it is established that the parties to the treaty so intended[664] and there is no evidence to suggest that the parties to COLREGs intended to give the term 'sight and hearing' that special meaning. Thus, the only way of addressing the issue in this example is 'amending' COLREGs rather than developing interpretations. In fact, the IMO has used amendment rather than interpretation in the past to address the issue of the 'sight and hearing' requirement for high-speed craft. An OOW who keeps a navigational watch on an enclosed bridge or on a high-speed craft may not be able to hear the sound signals around the vessel very well due to the high ambient noise. Alternative solutions were accepted first informally through class requirements and then formally through an amendment to SOLAS.[665] SOLAS now requires a ship with a totally enclosed bridge to have 'a sound reception system, or other means, to enable the officer in charge of the navigational watch to hear sound signals and determine their direction'.[666] The IMO could have developed a 'unified interpretation' to clarify that a watch officer in a totally enclosed bridge can use a sound reception system to comply with Rule 5. The IMO, however, decided to 'amend' SOLAS arguably because the latter method will be unequivocally binding on all Member States.

In light of the foregoing arguments, the final conclusion of the RSE, suggesting that MASS degrees 2 and 3 may be integrated into COLREGs through equivalences or developing interpretations, is questionable from a treaty interpretation point of view. Moreover, it is not guaranteed that independent courts in different Member States will always interpret COLREEGs provisions in the same way that an IMO unified interpretation may have done. This is particularly important for litigants in the United States where there is a strong presumption of causation under the *Pennsylvania* rule that holds a vessel that violated COLREGs liable unless it is proved that the violation did not cause the collision.[667] It is therefore submitted that in order to comply with international law and provide reliability

[664] The Vienna Convention on the Law of Treaties, Article 31 (4).

[665] Henrik Ringbom, 'Regulating Autonomous Ships—Concepts, Challenges and Precedents' (2019) Ocean Development & International Law 1, 13.

[666] Regulation V/19.2.1.8.

[667] Craig H. Allen, Sr., 'Why the COLREGS Will Need to be Amended to Accommodate Unmanned Vessels' (2021) Social Science Research Network 1, 12.

and certainty for all stakeholders, amending COLREGs should take precedence over developing interpretations where necessary. Unnecessary recourse to amendment, however, should also be avoided. As a retired Coast Guard officer, a professor emeritus of law at the University of Washington, and a co-author of an essential text on COLREGs, Craig Allen points out that any significant amendment to COLREGs will have to be followed by an enormous seafarer training effort as well as a substantial effort to re-programme and test the current autonomous collision avoidance systems that have already been developed in accordance with the existing COLREGs.[668] A reasonable balance, therefore, should be struck between lawfulness and certainty of any COLREGs interpretations on the one hand, and added complexity of any COLREGs amendment on the other.

4.3. MASS Trials and Operations in the Interim Period

One of the findings of Chapter 2 was that MASS are entitled to operate on the high seas and between ports of States that support MASS operations. However, no company would send a MASS to sea without completing the required trials first. Even newly built manned vessels have to go through sea trials to ensure their safety and seaworthiness before their maiden voyage. When it comes to MASS, sea trials are even more crucial and may also be dangerous not least because there is no human on board and the state of their compliance with COLREGs is not entirely clear. The arguments in Chapter 2 indicate that MASS are entitled to operate at least in the high seas, the EEZs and the territorial waters of States who recognise the freedom of navigation for such vessels. Beyond the territorial waters, however, MASS like their manned counterparts come under several international requirements. Although necessary, UNCLOS requirements as they stand are not sufficient or at least detailed enough. In very general terms, UNCLOS only requires flag States to comply with 'international regulations'[669] the details of which may be found, *inter alia*, in IMO conventions such as COLREGs, SOLAS and MARPOL. However, since these conventions were not adopted with MASS in mind, it is currently unclear whether MASS can comply with such regulations and if so, to what extent. Obviously, the IMO conventions as they stand today are unlikely to address all safety issues of MASS operations which is why the IMO carried out the MASS regulatory scoping exercise. The question then arises whether this uncertainty means that MASS can engage in 'full-scale' operations beyond the territorial waters of their flag States in the absence of international regulations.

Being recognised as 'ships' under UNCLOS and thereby having the right to enjoy the freedom of navigation on the high seas means there is nothing that could legally prevent

[668] Ibid footnote 2.

[669] Article 94(5)

MASS trials or operations on the high seas. Currently, such trials and operations are limited but they are nevertheless growing as more and more countries come on the scene. For instance, in the UK, the Maritime and Coastguard Agency's MARLab chose Portland harbour as a test site in October 2019.[670] Although not fully employed in commercial shipping yet, many MASS are already being operated and/or tested in the military and research sectors which can cause safety issues. As will be noted below, even full-size cargo ships with different levels of autonomy have been tested on the high seas. And given the fact that MASS Degree 4 seagoing ships such as *MV Yara Birkeland* are being prepared for full operation, MASS are likely to face their manned counterparts on the seas soon. Thus, the absence of any MASS regulation calls for a mechanism to ensure the safety of such operations which is why the IMO has published the Interim Guidelines for MASS Trials to address the issue.

4.3.1. Significance of the IMO Interim Guidelines for MASS Trials

At its 101st session in June 2019, the Maritime Safety Committee approved the 'Interim Guidelines for MASS Trials'[671] which is the first ever IMO instrument to address operations of MASS. The Guidelines and the interim period are absolutely crucial from both regulatory and practical standpoints for the following reasons. First, in the complete absence of any specific MASS-related regulation, the Interim Guidelines is currently the only instrument that specifically addresses MASS operations and thus, it should be adhered to. Interestingly, unlike some other IMO interim guidelines that explicitly state the guidelines are recommendatory[672] the Interim Guidelines for MASS Trials does not expressly provide such clarification. Accordingly, Veal has argued that the 'Guidelines' are, by definition, recommendatory.[673] This argument seems plausible especially because the use of the recommendatory word 'should' throughout the Guidelines instead of binding terms such as 'shall' or 'must' also suggests that the nature of the Guidelines is recommendatory rather than mandatory. However, taking a broader approach to the IMO regulatory framework would suggest otherwise and may also offer an explanation as

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[670] 'Test Site to Help Develop Autonomous Ship Work' <https://www.gov.uk/government/news/test-site-to-help-develop-autonomous-ship-work> accessed 07 February 2023.

[671] IMO Doc MSC.1/Circ.1604 – available at <https://www.register-iri.com/wp-content/uploads/MSC.1-Circ.1604.pdf> accessed 07 February 2023.

[672] See, for example, IMO Doc MSC.1/Circ. 1526, 'Interim Guidelines on Maritime Cyber Risk Management' (1 June 2016) para 2.2.3 – available at <http://www.imo.org/en/OurWork/Security/Guide_to_Maritime_Security/Documents/MSC.1-CIRC.1526%20(E).pdf> accessed 07 February 2023.

[673] Robert Veal, 'IMO Guidelines on MASS Trials: Interim Observations' [2019] 19(8) Lloyd's Shipping & Trade Law 1, 1.

to why the Interim Guidelines for MASS Trials are silent on its legal status. Paragraph 2 in Regulation I/13 of the STCW Convention defines the term 'trial' as:

> [A]n experiment or series of experiments, conducted over a limited period, which may involve the use of automated or integrated systems in order to evaluate alternative methods of performing specific duties or satisfying particular arrangements prescribed by the Convention, which would provide at least the same degree of safety, security and pollution prevention as provided by these regulations.

Since this definition of 'trial' is almost identical to the definition provided (or rather reproduced) in the IMO Interim Guidelines for MASS Trials, it will apply to MASS trials too. Regulation I/13 goes on to make it clear in Paragraph 3 that '[s]uch trials ***shall*** be conducted in accordance with guidelines adopted by the [International Maritime] Organization.'[674] Thus, it may be concluded that although the Interim Guidelines for MASS Trials do not use a binding language, the STCW Convention makes them, in effect, mandatory guidelines. Compliance with the Interim Guidelines for MASS Trials is, therefore, mandatory at least for the State Parties to the STCW Convention which currently consist of some 164 countries. The mandatory nature of the Interim Guidelines will address the issue of self-regulation i.e. it will not only keep the IMO the only competent body to regulate MASS trials but also will prevent individual States, shipping companies, NGOs and other stakeholders from developing their own independent Codes of Practice which may be inconsistent and/or substandard.

The second significance of MASS trials (or trials of any new technology for that matter) is that they bring to light the potential gaps in relation to the current regulations and compliance of MASS with them. Practical experience and lessons learned from trials provide an important input to the development of the international regulation of MASS.[675] Trials, therefore, form a realistic basis on which the IMO can develop new or amend the existing regulations. For example, in the early 1990s, a new technology introduced a console-style workstation on the bridge to allow the navigational officer to act as his or her own helmsperson and lookout while serving as the OOW at night.[676] Consequently, the IMO adopted interim guidelines[677] which permitted the OOW to act as the sole lookout in a period of darkness. It was only after the interim period that the IMO, having analysed

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674 Emphasis added.

675 IMO Doc MSC 100/5/2, para 6.

676 Christopher Young, 'IMO and One-Man Watchkeeping' (1990) 47(1) The USCG Proceedings of the Marine Safety Council 10, 10.

677 IMO Doc MSC/Circ.566, 'Provisional Guidelines on the Conduct of Trials in which the Officer of the Navigational Watch Acts as the Sole Look-out in Periods of Darkness' (2 July 1991).

the results of the trials, concluded that the new technology could not replace a separate and independent lookout during periods of darkness and thus, the relevant STCW provision on lookout remained unchanged.[678]

Third, interim periods after the introduction of a new technology generally tend to be lengthy and the actual reform process which can start in earnest only after completion of trials, is also likely to be time consuming for various reasons. Given the novelty of MASS technology, it is, therefore, very likely that the Interim Guidelines will have to remain in effect for a long time. As an example, the trials of the console-style workstation to allow the OOW to act as the sole lookout on the bridge began in 1991 and continued for about 7 years until 1998 when the IMO reached a conclusion on the matter. Given that the technology of MASS is by far more novel and complicated than that of the console-style workstation, its corresponding trials may potentially be of similar length if not longer. Thus, the Interim Guidelines play a key role in the development of both regulation and safe operation of MASS. There are, nevertheless, two issues that the Interim Guidelines do not address. These issues will be discussed below.

4.3.2. Gaps in the IMO Interim Guidelines for MASS Trials

First, it appears that the Interim Guidelines apply to MASS 'trials' only and do not cover full-scale MASS operations. The title 'Interim Guidelines for MASS *Trials*', however, implies that the Guidelines cover only the 'trials' and not full operation of MASS. In fact, the Guidelines make it clear that they should be used when conducting 'trials' of MASS-related systems and infrastructure[679] and that the aim of the Guidelines is to ensure that the 'trials' of MASS-related systems and infrastructure are conducted safely and securely.[680] Paragraph 1.2.2 of the Interim Guidelines also defines 'trial' as an experiment or series of experiments that are conducted over a 'limited period'. The reference to 'limited period' indicates that the Guidelines do not apply to full-scale MASS operations. Given that adopting new regulations or amending the existing ones may well be a long process, the question arises as to whether MASS can engage in 'full operations' in the absence of international guidelines or regulations during the interim period. The current IMO Interim Guidelines do not deal with the issue of MASS routine operations.

Second, given that MASS trials are potentially risky, one of the questions that needs to be answered is 'where' should MASS trials be carried out? The International Federation of Shipmasters' Association (IFSMA) and the ITF have taken the view that since non-

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[678] IMO Doc MSC/Circ.867, 'Officer of the Navigational Watch Acting as the Sole Look-out During Periods of Darkness' (27 May 1998) para 3.1.

[679] IMO Doc MSC.1/Circ.1604, para 1.2.2.

[680] Ibid para 1.1.

mandatory guidelines may lead to self-regulation, in order to protect the safety of shipping, a mandatory regulatory framework needs to be developed to avoid compromising standards to gain competitive advantage. They further argue that to protect the safety of shipping, the IMO should affirmatively establish that MASS should not be permitted to operate on 'international voyages' until their operation has been internationally regulated. This, in effect, means that MASS trials should geographically be limited to territorial waters of each individual State.[681] The Interim Guidelines make no reference to geographical location in which MASS may conduct trials. This *prima facie* means that the geographical scope of MASS trials is not limited to a State's territorial sea. In fact, in September 2019, NYK conducted the world's first MASS trial performed in accordance with the IMO's Interim Guidelines for MASS Trials which involved *Iris Leader*, a large car carrier, that navigated automatically from Xinsha (China) to Nagoya (Japan) using the Sherpa System for Real ship (SSR) navigation system.[682] Part of the trial was, therefore, conducted on the high seas i.e. the East China Sea. The Mayflower Autonomous Ship also crossed the Atlantic Ocean and completed a 2,700-mile voyage from Plymouth in the UK to Halifax in Canada in June 2022.[683] However, allowing MASS trials to take place in all geographical locations is not risk free. Since the risk levels associated with trials of MASS Degrees 1 and 2 are lower and more manageable due to the presence of on-board seafarers, their trials on the high seas is justifiable; the low and manageable risks are balanced against the benefits of such trials in real sea conditions. With regard to MASS Degrees 3 and 4, however, the absence of seafarers on board the MASS would call for more stringent rules on trials. Although it is unlikely that any prudent MASS owner or operator would start trialling a MASS Degree 4 in an area of heavy maritime traffic, the Interim Guidelines, nevertheless, allow all stakeholders to do so which can compromise safety of navigation. For example, a MASS Degree 4 which is trialled for the first time in a busy area, may cause a series of collisions with other vessels due to its unexpected technical shortcomings. Thus, MASS trials, at least initially, should take place in designated test areas well away from high-risk areas such as congested waters and oil and gas marine installations. It is, therefore, suggested that MASS should be trialled step by step and move from isolated waters to busier areas only if certain criteria are met. This approach will not only bring to light the shortcomings of the MASS under trial in a piecemeal and manageable fashion, but also will prepare the MASS for the ultimate full operations in high density traffic waters. The next sections of this thesis will discuss a

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681 IMO Doc MSC 99/5/1, para 11 and 20.8.

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682 'NYK Conducts World's First Maritime Autonomous Surface Ships Trial' (*NYK Line*, 30 September 2019) <https://www.nyk.com/english/news/2019/20190930_01.html> accessed 07 February 2023.

683 'AI-driven Robot Boat Mayflower Crosses Atlantic Ocean' (*BBC News*, 06 June 2022) <https://www.bbc.co.uk/news/uk-england-devon-61710706> accessed 07 February 2023.

three-stage process which can ensure safe trials and operations of MASS during the interim period.

Third, the Interim Guidelines state that 'compliance with the *intent* of mandatory instruments should be ensured.'[684] There are two issues with this requirement. Firstly, compliance with the 'intent' of an instrument is a very general and vague requirement and it is not clear how closely a MASS in 'trial' should follow a specific provision of a relevant instrument so as to remain in compliance with the 'intent' of the instrument. Secondly, compliance with the general 'intent' of an instrument without regard to specific provisions in the instrument can potentially compromise safety. For example, a MASS Degree 4 may violate a specific Rule of COLREGs but nevertheless still remain in compliance with the general 'intent' of the instrument which is preventing collisions. Such violations can confuse other vessels and create an uncertain environment where MASS may navigate in unexpected ways to avoid collision. It is, therefore, submitted that MASS should be required to comply with all provisions of mandatory instruments as much as possible.

Fourth, paragraph 2.6 of the Interim Guidelines provides: 'Reasonable steps should be taken to ensure that potentially impacted third parties are informed of the trial of MASS systems and infrastructure.' This guideline seems to be too general as it does not specify the way(s) of informing third parties. The communication particularly matters in case of a MASS being trialled on the high seas. The first obvious way of communication that comes to mind, is via VHF radio. However, this would not be the best way of ensuring that potentially impacted third parties are informed of the trial. First, there is no guarantee that the VHF equipment on the bridge of other vessels, especially small vessels, is operational or on channel 16.[685] Second, sometimes channel 16 gets so busy and occupied that it becomes hard, if not impossible, to receive and understand one complete message. Third, fixing the geographical position of a MASS in trial only from the information received on the VHF can be difficult and time consuming. Fourth, there might be some language difficulties in saying or understanding verbal messages on the VHF. Lastly, verbal messages received on the VHF are not always genuine and reliable. Alternatively, lights, day shapes and AIS signals may be used to warn nearby third parties of the MASS trial. However, this would require the appropriate authorities such as the IMO to introduce such lights and signals so that they will be recognisable and understandable internationally. Special lights and signals for MASS identification will be discussed in the next sections of this chapter.

[684] IMO Doc MSC.1/Circ.1604, para 2.2.1 (emphasis added)

[685] This is the VHF channel on which all vessels keep a radio watch.

4.4. Good Seamanship and Artificial Intelligence

Rule 2 of COLREGs which is entitled ‘Responsibility’ is said to be the ‘touchstone’ of all collision regulations[686] and the CMI International Working Group's Position Paper on Unmanned Ships describes it as the most important provision in the COLREGs.[687]

Paragraph (a) of the Rule reads:

> Nothing in these Rules 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.

This rule which is mainly drawn from Rule 29 of the former 1960 Collision Regulations,[688] may appear as if it was written for the courts rather than mariners, and even the courts have on occasion complained that it is poorly drafted.[689] Being poorly drafted and hard to understand, however, does not diminish the importance of the rule for the mariner facing civil liability, loss of professional licence, or even criminal prosecution.[690] Nonetheless, a few points can immediately be drawn from a plain reading of the rule. First, it applies to *any* vessel on waters that are subject to COLREGs i.e. it applies to *all* vessels on covered waters: large and small; commercial, recreational and military; when underway, at anchor and (in some aspects) even when moored.[691] Second, it also applies to the vessel owner, the master or crew thereof. Third, the requirement under Rule 2(a) can be broken down into three elements. It reminds anyone involved in the management and operation of the vessel that nothing in COLREGs will excuse them if they fail to comply with ‘these Rules’ (i.e. COLREGs), to take any ‘precaution’ that a reasonable seafarer would take under the circumstances, and to take into consideration any ‘special circumstances’ which may require even more precautions.[692] These three elements will be scrutinised separately in the following sections.

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686 William P Crawford, *Mariner’s Rules of the Road* (Norton & Co 1983) 13.

687 Robert Veal and Henrik Ringbom, ‘Unmanned Ships and the International Regulatory Framework’ (2017) 23(2) Journal of International Maritime Law 100, 110.

688 Craig H Allen Sr and Craig H Allen Jr, *Farwell’s Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 76.

689 Ibid 77.

690 Ibid.

691 Ibid 76.

692 Ibid 77.

4.4.1. Duty to Comply with COLREGs

As of September 2021, there are 163 Contracting States that have ratified COLREGs and represent 98.91% of the world's merchant fleet.[693] This means that almost all vessels must comply with COLREGs while operating on the relevant waters. This is the first element of Rule 2(a). Since the lawmakers who formulated the collision regulations included several leading professional seafarers, the current regulations are considered to provide the most practical and effective collision avoidance actions in different situations and compliance with the regulations is therefore the first test of good seamanship.[694] In fact, many rules of COLREGs have originated from historic rules of seamanship and even vessels that are not bound by COLREGs may be expected to comply with them as rules of good seamanship.[695] It should, however, be noted that compliance with the rules of COLREGs is subject to Rule 2(b) which permits and, in fact, obliges vessels to depart from a particular rule or rules of COLREGs if such a departure is necessary to avoid immediate danger. In addition, COLREGs contain certain phrases such as 'close quarters' and 'special circumstances' that have not been defined. Shipowners and seafarers, therefore, must comply with both the text of the rules and any authoritative interpretation of them.[696] Whether a MASS will be able to fully comply with the Rules of COLREGs or to depart from them under Rule 2(b) and/or to comply with authoritative interpretations of the Rules will be dealt with in the next sections that will analyse those rules.

4.4.2. Ordinary Practice of Seamen

Compliance with COLREGs is necessary but not always enough to discharge the responsibility that is imposed upon vessel owners and mariners by Rule 2(a). At the time when the 1960 collision regulations and their successor, 1972 COLREGs, were adopted, safety of ship operation was not heavily regulated as it is today. Codifying and including all principles of safe ship operation into COLREGs which is meant to be a concise and accessible public-facing set of regulations would also be impractical and even injudicious. The issue was therefore addressed by Rule 2(a) which embodies all those unwritten rules of safe ship operation. That is to say, certain situations may call for a precaution that is not expressly required by COLREGs or indeed any other legal or regulatory instrument,

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693 IMO, 'Status of Treaties' (14 June 2022) – available at <https://wwwcdn.imo.org/localresources/en/About/Conventions/StatusOfConventions/StatusOfTreaties.pdf> accessed 07 February 2023.

694 Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 78.

695 Richard HB Sturt, *The Collision Regulations* (3rd edn, LLP 1991) 37.

696 Ibid 77.

but that precaution is, nevertheless, required by the catch-all term ‘ordinary practice of seamen’ which forms the second element of Rule 2(a) and is widely known as ‘the rule of good seamanship’.[697] In a similar but more general way, UNCLOS also requires every State to ensure ships flying its flag are in the charge of a master and officers who possess appropriate qualifications in seamanship and navigation[698] and are fully familiar with the applicable international collision avoidance regulations.[699] As an example of good seamanship, given that vessels at anchor may suddenly move in their swinging circle, a vessel underway should give vessels at anchor a wide berth as a matter of good seamanship, notwithstanding the lack of this specific requirement in COLREGs or any other set of regulations for that matter. With the adoption of new and binding safety regulations over the course of past decades, some of the unwritten rules of good seamanship found their way to such regulations i.e. not only are they considered to be the ordinary practice of seamen, they are also mandatory by virtue of a binding national or international law. For example, SOLAS[700] and the MSC[701] oblige ‘every ship’, while at sea and when practical, to maintain a continuous listening watch on VHF channel 16 until such time as the MSC may determine. Although the adoption of new regulations has given recourse by the courts to the rule of good seamanship a residual character, such a character is by no means unimportant[702] as there are still some rules of good seamanship that are not covered by regulations applicable to certain vessels. To put this in context, the STCW Code requires the officer in charge of the navigational watch to notify the master immediately if he or she encounters or expects restricted visibility.[703] Since the STCW Convention does not apply to seafarers who work on board ‘fishing vessels’[704] and because the STCW-F Convention (which is applicable to seafarers on fishing vessels) does not contain such a requirement either, the watch officer on a fishing vessel is not

[697] BA Fransworth, Larry C Young and Steven D Browne, *Nautical Rules of the Road* (4th edn, Cornell Maritime Press 2010) 7.

[698] Article 94(4)(b).

[699] Article 94(4)(c).

[700] Chapter IV, Regulation 12.3.

[701] Through the IMO Resolution MSC.131(75), ‘Maintenance of a Continuous Listening Watch on VHF Channel 16 by SOLAS Ships Whilst at Sea After 1 February 1999 and Installation of VHF DSC Facilities on Non-SOLAS Ships’ (21 May 2002) – available at <https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MSCResolutions/MSC.131(75).pdf> accessed 07 February 2023.

[702] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 7-049.

[703] Chapter VIII, Part 4-1, paragraph 40.

[704] Article III(b).

expressly required by either of those Conventions to inform the master when visibility deteriorates. Such a precaution is not expressly required by COLREGs either. Nevertheless, Rule 2(a) serves as a stern reminder that although notifying the master in such circumstances may not be an express requirement under STCW, STCW-F, COLREGs or any other national or international law, a reasonable navigator would take that precaution and failure to do so will amount to disregard of good seamanship. If collision ensues from a failure to inform or call the master to the bridge, nothing in COLREGs will exonerate the watch officer.

It follows that COLREGs as a whole 'are not a complete and comprehensive code of navigation'[705] and that vessel owners and navigators must also comply with precautions of good seamanship. The importance of good seamanship raises the question whether there is a definition for the term or an elaboration on the requirement. Good seamanship has been described by Lord Porter in *The Llanover* as 'that degree of the skill and care which are ordinarily to be found in a competent seaman'.[706] It does not mean 'extraordinary skill or extraordinary diligence',[707] but it is 'negligence not to take all reasonable steps to avoid danger in navigation'.[708] Essentially, therefore, the rule of good seamanship is the maritime equivalent of the rule of reasonable care and skill in terrestrial tort law. Under the principle of reasonable care and skill, a driver on a road or a navigator at sea is not expected to be perfect and anticipate every possible eventuality and take preventative action. Rather, they are expected to exercise a reasonable degree of care and skill that might be expected of their calling under the circumstances. Generally, the following factors may call for additional precautions as a matter of good seamanship:

1) adverse weather conditions;
2) traffic density;
3) failure or degradation of any important navigational equipment;
4) unusual conditions of loading or trim; and
5) transport of dangerous cargo.[709]

Seafarers acquire the required seamanship knowledge and skills in a variety of ways. First, they can learn good seamanship knowledge and skills through the mandatory training set out in national or international laws and then become more competent by practising those skills on board. For example, as part of a minimum standard for watch

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[705] Grant Gilmore and Charles L Black, *The Law of Admiralty* (2nd edn, The Foundation Press 1975) 509.

[706] (1944) 78 Ll L Rep 461, 468.

[707] Ibid.

[708] Ibid.

[709] William H Tate, *A Mariner's Guide to the Rules of the Road* (2nd edn, Naval Institute Press 1982) 70.

officers working on ships of 500 gross tonnage or more, they must take a radar course and demonstrate competence in operating radar and analysing the information obtained from it.[710] The second source for learning the rules of good seamanship is case law. However, the issue is that over time courts of different States have sometimes come to different conclusions as to what constitutes good seamanship in a particular set of circumstances, and a decision made by the court of one State does not bind the courts of other States.[711] Also, over time and as a result of the use of a new technology (e.g. ECDIS) on ships, courts may conclude that the ordinary practice of seaman has evolved and thereby requiring navigators to follow a different or higher standard of care than was required in earlier decisions.[712] Third, advisory information or guidelines e.g. the advice given in particular Merchant Shipping Notices (published by the UK Maritime and Coast Guard Agency) can also constitute good seamanship and evidence of a reasonable standard of care.[713] Fourth, there are also expert texts that embody standards of good seamanship in various areas of ship operation.[714] A fifth criterion for determining what good seamanship may be in a particular case, is customary practice. However, the existence of a particular custom (or lack thereof) cannot always be considered as good seamanship even if it is widespread. For instance, in the case of *T.J. Hooper*, the US Court of Appeals for the Second Circuit held that even though coastwise tugs did not carry radio sets to receive warnings of a change in the weather, this widespread practice was not reasonable especially because the new technology was reliable and available at a low cost.[715] Lastly, sometimes good seamanship can also be described as 'common sense'.[716] For example, a mariner may come across a novel situation where prior training, knowledge or custom cannot save the day and this is where common sense should take over.

4.4.3. Special Circumstances

The third element in Rule 2(a) entails additional precautions that may be required by the 'special circumstances' of the case. The term 'special circumstances' which also appears

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[710] STCW Code, Table A-II/I.

[711] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 80.

[712] Ibid.

[713] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 7-050.

[714] A prominent example is: David J House, *Seamanship Techniques: Shipboard and Marine Operations* (5th edn, Routledge 2019).

[715] 60 F.2d 737 (2nd Cir. 1932).

[716] *The Roseline* [1981] 2 Lloyd's Rep 410, 411 (per Sheen J).

in Rule 2(b) has not (for good reasons) been defined in COLREGs. Recourse to case law, however, will help shed light on the meaning of the term. In *The Sestriere*,[717] the Admiralty Court held that dropping a pilot created 'special circumstances'[718] and required particular caution and timely action from the defendants' vessel to avoid the claimants' vessel which had arrived on the scene first and was trying to drop her pilot. The claimants' vessel was also found contributorily negligent for not taking a seamanlike action and the Court rejected the claimants' argument that the action was taken 'in the agony of the moment'.[719] It appears, therefore, that the term 'special circumstances' includes navigational situations that are not specifically covered by the Steering and Sailing Rules because COLREGs were obviously not designed for application to situations such as vessels manoeuvring into and out of berths; coming to anchor or leaving an anchorage; or taking on or dropping pilots.[720] Such situations simply constitute special circumstances which require additional precautions adapted to the special circumstances of the case. A special circumstance may even require a departure from the Rules. For example, in an earlier case, *The Sans Pareil*,[721] a tug and tow observed a squadron of thirty warships in four columns approaching on her port bow on a crossing course. The tug kept her course and speed and her tow was struck and sank by one of the warships. Although under normal circumstances involving the tug and only one power-driven vessel on her port bow the tug would be the stand-on vessel, the Court of Appeal ruled that the situation amounted to a 'special circumstance' and the tug should have kept out of the way of the fleet because it would be impossible or impractical for the squadron to keep out of the way of the tug without either colliding with her or with other vessels of the squadron.[722] The Court held that the ordinary rules of the collision regulations did not apply not because there is any special favour or exemption to Her Majesty's warships, but because 'when they are steaming in company, a special set of circumstances arises which make it dangerous and bad seamanship to apply the ordinary regulations'.[723]

It should, however, be noted that special circumstances do not always necessitate a departure from the Rules. Sometimes, as in *The Sestriere*, a special circumstance only requires additional precautions that are adjusted to that special circumstance i.e. danger

[717] [1976] 1 Lloyd's Rep 125.

[718] Ibid 130.

[719] Ibid 131.

[720] Nicholas J Healy and Joseph C Sweeney, *The Law of Marine Collision* (Cornell Maritime Press 1998) 77.

[721] [1900] P 267.

[722] Ibid 275.

[723] Ibid 285.

can be avoided by taking enhanced risk management measures without departing from the Rules. This is the response that is required under Rule 2(a). However, at other times, as in *The Sans Pareil*, a special circumstance may create a situation where additional precautions alone cannot save the day and this is where a departure from the Rules is allowed and in fact required by Rule 2(b) which will be discussed below.

4.4.4. Departure from the Rules

Rule 2(b), which was first added to the 1890 collision regulations, is commonly known as 'the general prudential rule'[724] and reads:

> In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.

This rule warns against a literal and doctrinaire compliance with the Rules into a collision or any other type of accident. For instance, Rule 14 obliges two power-driven vessels in a head-on situation to alter their course to starboard. If, however, one of the vessels has a dangerous shoal on her starboard side, a slavish and blind adherence to Rule 14 by that vessel would mean grounding and possibly pollution. The whole purpose of the Rules is to prevent rather than cause accidents. Rule 2(b), therefore, requires mariners to take three risk factors into account when interpreting and complying with the Rules: (a) all dangers of navigation; (b) all dangers of collision; and (c) any special circumstances of the case, including the limitations of the vessels involved. It then goes on to say that one or more of these three factors 'may' necessitate a departure from the Rules, but only if such a departure is 'necessary' to avoid immediate danger. It should be noted that the existence of such risk factors is not, in itself, a licence to depart from the Rules. As required by Rule 2(a), those risks and special circumstances may be managed by taking additional precautions while still following the Rules. Thus, when there is a special circumstance, a vessel is allowed and must depart from the Rules only if such a departure is 'necessary' to avoid immediate danger. The Rules cannot foresee and formulate every special circumstance or contingency and that is why it is left to mariners to assess the situation and take the safest action. Over the years, however, courts have recognised the following recurring situations that create special circumstances that may justify departure from one or more of the Rules:

1) physical conditions that make compliance with one or more rules impracticable;
2) multi-ship situations that involve risk of collision;

[724] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 93.

3) situations that are not specifically covered by the Rules; and
4) in extremis situations.[725]

4.4.5. Good Seamanship and MASS

It is clear from the foregoing discussions that all of the Steering and Sailing Rules in COLREGs are subject to Rule 2 which requires good seamanship and the ability to appreciate when one or more Rules of COLREGs must be broken. The elephant in the room that cannot be avoided, therefore, is applicability of Rule 2 to MASS and the relevant technical and legal issues.

MASS degrees one and two can arguably discharge the duty of good seamanship as there are qualified crew members on board who can supervise the ship's operation and take the required precautions provided the MASS is equipped with the necessary alarm systems. However, since sufficiency of the crew on a vessel has been considered by case law as an important element of good seamanship,[726] the question arises whether the requirement of good seamanship can be met where there is no crew on a vessel at all. The answer to this question might be different depending on whether one considers MASS Degree 3 or 4. The issue in regard to MASS Degree 3 was raised by Question 4.1 of the CMI questionnaire which asked MLAs whether operation of an 'unmanned' ship i.e. a MASS Degree 3 would be contrary to the duty or principle of 'good seamanship' under the COLREGS, as interpreted nationally, regardless of the safety credentials of the remote control system. Most of the MLAs who did answer the question and did take a position, stated that unmanned operation should not necessarily be considered contrary to good seamanship.[727] Nevertheless, the Croatian and Maltese MLA stated that unmanned operation 'would be' contrary and Spanish MLA stated that 'it is possibly' contrary to the standards of goods seamanship under their national interpretations of COLREGs.[728] However, as observed above, case law suggests that the notion of good seamanship evolves over time and a particular practice which was once considered necessary as a matter of good seamanship in the past, may no longer be required in light of a new technology. For example, a long series of early UK and US court decisions established that the normal position of the ship's lookout should be as low to the water

[725] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 99.

[726] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 5-42 to 5-45.

[727] IMO Doc MSC 99/INF.8, 'Work conducted by the CMI International Working Group on Unmanned Ships' (13 February 2018) 8.

[728] Ibid.

and as far forward in the ship as possible.[729] It was, therefore, common practice to station a lookout with a monocular in the crow's nest on the bow of the ship.[730] After the invention of marine radar and sonar technology, however, that practice was gradually abolished and the crow's nest on the bow gave way to radar on the bridge for obvious reasons. Nowadays, the old requirement of a lookout on the bow is no longer rigidly applied and when radar is in use, the tendency is to station the lookout on the bridge.[731] In the same vein, sufficiency of crew has long been considered an element of good seamanship on traditional ships. However, with the emergence of MASS technology, if a MASS can safely be operated from a remote-control centre by a competent and duly certified person, then arguably the physical presence of crew on a MASS can no longer be considered as a requirement of good seamanship. If MASS technology allows a competent remote controller to thoroughly assess the situation and take the required good seamanship measures in the same way that a competent mariner would, there is no reason why the duty of good seamanship cannot be discharged from a remote location. Decades ago, radar technology allowed the position of the ship's lookout to be moved from the crow's nest to the bridge. Today, it appears that MASS technology will once again move not only the position of the ship's lookout but the whole bridge team from the bridge to a remote control-centre ashore. Although this emerging practice may currently be considered by some States as contrary to the standards of good seamanship under their national interpretation of COLREGs, sooner or later when MASS technology proves safe and successful, the concept of good seamanship will ultimately evolve under the national laws of those States too.

However, when it comes to MASS Degree 4, the answer to the question is more difficult as there is no human on board or ashore to supervise the vessel's navigation and take the seamanship precautions that may be required under certain circumstances. Since there is a human (whether on board or remote) in the loop of decision-making for operation of MASS degrees 1 to 3, the requirement of good seamanship does not raise any particular issue. With regard to MASS degree 4, however, the question arises as to whether fully autonomous collision avoidance systems can ever become good seamen,

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[729] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 120.

[730] Harry Valentine, 'The Airborne Crow's Nest and Modern Navigation' (*The Maritime Executive*, 09 October 2018) <https://www.maritime-executive.com/editorials/the-airborne-crow-s-nest-and-modern-navigation> accessed 07 February 2023.

[731] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 121.

or whether the concept of good seamanship must be changed or even abandoned.[732] Question 4.2 of the CMI questionnaire asked whether autonomous operation of a MASS Degree 4 would be contrary to the standards of good seamanship as interpreted nationally, regardless of the safety credentials of the autonomous control system. Six MLAs answered the question in the negative; four MLAs answered it in the positive; two MLAs stated that such operation is likely to be inconsistent with the standards of good seamanship; and five MLAs did not take a position.[733] This uncertainty is also pervasive in the literature as it mainly considers Rule 2 as a regulatory or technical barrier to operation of MASS Degree 4. For instance, the CMI International Working Group's Position Paper on Unmanned Ships states that Rule 2 requires contemporaneous human judgement in the decision-making loop e.g. in deciding when a potentially completely different action to what COLREGs prescribe is required.[734] Accordingly, it then concludes that unsupervised autonomous vessels would fall foul of Rule 2 in its current form.[735] It is, however, submitted that the good seamanship requirement of Rule 2 is not a positive or absolute requirement because of the following reasons.

4.4.6. Good Seamanship is not a Mandatory Requirement

It is frequently stated in the MASS-related literature that good seamanship is a 'requirement'[736] or a 'duty'[737] that is imposed on seafarers by Rule 2. The Rule, however, does not directly impose any express good seamanship obligation on navigators as it has been drafted in negative terms. In other words, it does not expressly state that navigators must (in addition to the Rules) comply with the standards of good seamanship. It is simply a stern warning that nothing in the Rules will exonerate them if they do not and collision follows. In *The Queen Mary*,[738] Lord MacDermott said that Rule 2(a) 'is not aimed at authorising departure from regulations, and I doubt if it is more than *a solemn warning*

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[732] Frank Stevens, 'Seaworthiness and good seamanship in the age of autonomous vessels' in: Henrik Ringbom, Erik Røsæg and Trond Solvang, *Autonomous Ships and the Law* (Taylor & Francis Group 2020) 251.

[733] IMO Doc MSC 99/INF.8, 'Work conducted by the CMI International Working Group on Unmanned Ships' (13 February 2018) 9.

[734] Robert Veal and Henrik Ringbom, 'Unmanned Ships and the International Regulatory Framework' (2017) 23(2) Journal of International Maritime Law 100, 110.

[735] Ibid.

[736] See, for example, Frank Stevens, 'Seaworthiness and good seamanship in the age of autonomous vessels' in: Henrik Ringbom, Erik Røsæg and Trond Solvang, *Autonomous Ships and the Law* (Taylor & Francis Group 2020) 251.

[737] See, for example, Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 324.

[738] (1949) 82 Ll L Rep 303, 341 (emphasis added).

that compliance [with COLREGs] does not terminate the ever present duty of using reasonable skill and care.' It has, therefore, been said that Rule 2(a) is no more than a restatement of the rule of common law and the general maritime law, and that its necessity is questionable.[739] Marsden remarks that Rule 2(a) is best seen as inserted as a *cautious reminder* of the legal consequences of negligence.[740] A strong argument for insertion of such a declaration in COLREGs and highlighting its importance is that not every watchkeeping officer is familiar with the common law concept of negligence and majority of them may not even be aware of such concepts, particularly those who come from countries where the legal system is not based on common law.[741]

This general use of the term 'duty' or 'requirement' is not uncommon in the legal literature. For instance, it is sometimes said in the context of contract law that an injured party is under a 'duty' to mitigate his or her loss.[742] The use of this phrase, however, can be potentially misleading because it does not actually mean that the injured party 'must' mitigate any avoidable loss or damage. The injured party is completely free to act as they wish and there will be no liability if they fail to mitigate. The phrase 'duty to mitigate' simply means that if the injured party fails to act reasonably to mitigate their loss, then there will be a restriction on the payable damages that might otherwise have been recoverable.[743] From a legal point of view, therefore, a claimant is only 'expected' (but not legally required) to take reasonable steps to minimise avoidable loss. Similarly, by the phrase 'duty of good seamanship' or 'requirement of good seamanship' is simply meant that seafarers are 'expected' to know and exercise good seamanship to avoid or minimise loss or damage. The CMI Questionnaire uses the phrase 'the *duty/principle* of good seamanship'[744] which implies that there is a distinction between a duty which is expressly imposed by law and a duty which is required by common sense rather than the text of the law. The so-called good seamanship requirement, thus, is not an absolute or mandatory requirement for seafarers' qualification; it is legally required only in the sense that observance of good seamanship needs to be established as a defence after a collision has happened. After an accident, in order to establish that they observed standards of good seamanship, seafarers need to show that they took reasonable steps to prevent or minimise the

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[739] Nicholas J Healy and Joseph C Sweeney, *The Law of Marine Collision* (Cornell Maritime Press 1998) 75.

[740] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 7-074.

[741] IPA Stitt, 'The COLREGS – Time for a Rewrite?' (2002) 55 The Journal of Navigation 419, 424.

[742] See, for example, Jack Beatson, Andrew Burrows and John Cartwright, *Anson's Law of Contract* (31st edn, OUP 2020) 514, 561 and 564.

[743] Hugh Beale (ed), *Chitty on Contracts* (34th edn, Sweet & Maxwell 2021) vol I, para 26-089.

[744] Question 4.1. and 4.2 (emphasis added).

consequences of the accident. They are not expected to be perfect or to have 'superhuman' skills; they just need to demonstrate a reasonable level of knowledge, skill and good seamanship that might be expected of an ordinarily competent seaman.[745] As such, the good seamanship principle under Rule 2 may be considered as a quasi-legal duty. This principle is not limited to maritime law only and can be found in road traffic laws too. For example, although drivers are required by law to stop at red lights, if a car driver is stopped at a red light and notices in his/her mirrors a truck hurtling down the road, the driver would at least be excused if they ran the red light, and may even be liable to others in the car if he/she blindly follows the law and does not run the red light.[746] In order to obtain a driving licence, candidates in a theory test usually are not asked any question where the driver has to break one or more traffic laws to avoid an accident. Nor are they put in such a situation in an actual driving test given the high risks involved. Rather, it is presumed that candidates will use their own common sense to deal with such exceptional situations. Candidates, therefore, are only required to know the law and demonstrate practical driving skills i.e. the common sense expectation is not an absolute requirement for obtaining a driving licence. If an accident could reasonably have been avoided by breaking a specific road traffic law (as in the above example), then nothing in the road traffic laws will exonerate the driver for not breaking that law and saving the situation. In a similar way, Rule 2(a) is only a warning that nothing in COLREGs will exonerate the watch officer if he/she slavishly follows a specific rule of COLREGs where common sense (good seamanship) would have required a different action to avoid collision. The good seamanship duty, therefore, is more of a warning than a positive requirement for a maritime certificate of competency.

One may argue that the reason why Rule 2(a) does not impose a positive good seamanship obligation on navigators, is a presumption that since navigators are human beings, most (if not all) of them already do understand what good seamanship or common sense may require in different situations and will depart from the Rules when necessary to avoid danger. Artificial intelligence, on the other hand, may not have the common sense of human beings and thus, MASS Degree 4 may not always be safe to operate and should therefore be banned. In order to evaluate this argument and investigate whether AI may have the common sense that humans naturally have, it is helpful to assess the education, training and examinations that watch officers go through before they are certified. As a paradigm, the minimum international requirements for certification of officers in charge of a navigational watch on ships of 500 gross tonnage or more will be considered. In order to obtain a maritime certificate of competency in any country, candidates usually go

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[745] IPA Stitt, 'The COLREGS – Time for a Rewrite?' (2002) 55 The Journal of Navigation 419, 423.

[746] Frank Stevens, 'Seaworthiness and good seamanship in the age of autonomous vessels' in: Henrik Ringbom, Erik Røsæg and Trond Solvang, *Autonomous Ships and the Law* (Taylor & Francis Group 2020) 253.

through three stages. They first learn the theoretical basis of navigation at a university, college or an approved training centre and pass the required written examinations. They then spend a cadetship period at sea to put their theoretical knowledge into practice and improve their practical skills. In the third stage, they have to pass written and oral examinations which are carried out by the relevant maritime organisation in their country. These three stages will be analysed below.

4.4.6.1. MASS Simulations vis-à-vis Nautical Colleges

The STCW Convention requires State Parties to ensure that the training and assessment of seafarers are administered and supervised in accordance with the provisions of the STCW Code.[747] In the UK, only nautical colleges or training centres that have gained MCA approval can offer education and training leading to the issue of a Certificate of Competency.[748] Awards leading to such qualification currently are HND/HNC, Foundation Degree, Scottish Professional Diploma or Honours Degree.[749]

An important part of the knowledge that candidates must acquire, is the principles of watchkeeping. All candidates must gain 'thorough knowledge of the content, application and intent' of COLREGs and know how to use the information from navigational equipment.[750] In the past, nautical students in the UK had to memorise COLREGs.[751] Even though citing the Rules of COLREGs off by heart is no longer an official requirement, some shipping companies or maritime bodies still expect mariners to know and quote some of the COLREG Rules word for word.[752] Remembering the Rules is not the most difficult challenge for a MASS Degree 4 as the entire content of COLREGs can be incorporated into computer systems. In addition, rules of good seamanship that have been identified by courts or published in maritime books as common practice of seamen can also be added to the computer systems on the MASS. For example, a vessel navigating against the current should hold back as necessary to allow a vessel navigating

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747 Chapter I, Regulation 1/6.

748 MCA, 'MSN 1856 (M+F): Training & Certification Guidance: UK Requirements for Master and Deck Officers' (11 June 2015) page 32 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/436503/MSN1856.pdf> accessed 07 February 2023.

749 Ibid.

750 STCW Code, Table A-II/1.

751 Dag Pike, *Dag Pike's Cruising Under Sail* (Bloomsbury Publishing 2012) 188.

752 For example, the MAIB stated in a Safety Digest in 2002 (Issue 2, Case 7) that 'even the most inexperienced watchkeeper' should know Rule 16 off by heart – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/876415/2002-SD2-MAIBSafetyDigest.pdf> accessed 07 February 2023.

with the current, and is thus unable to reduce her speed over the ground, to navigate around a bend or obstruction.[753] Also, a vessel in the vicinity of pilot stations should exercise extra caution to allow other vessels to embark and disembark pilots safely.[754] All these rules can be added to the algorithm of a MASS and tested in simulation laboratories as a counterpart to the written exams that nautical students must pass as a prerequisite to their qualification. Over the past decades, many autonomous collision avoidance and path planning systems have been developed and tested in simulated environments. Thomas Statheros *et al*. categorise the work of most researchers in the area of autonomous navigation into the following three groups.[755] The first method is 'mathematical algorithms' i.e. the precise mathematical description of a ship's dynamics and its surrounding environment. Since mathematical algorithms use a sequence of strict definitions to solve the collision problem, they are not intelligent algorithms but function according to pre-determined definitions and solutions. The second method is 'soft computing' including evolutionary algorithms which represent AI by mimicking the evolutionary behaviour of biological systems;[756] neural networks that have unique learning capabilities; and fuzzy logic that can simplify complex computations due to its high mathematical abstraction. The third group of collision avoidance and path planning systems is 'hybrid autonomous navigation systems' which propose a possible optimal combination of all, or a subset of the above methods. Although majority of studies only address head-on, crossing and overtaking encounters,[757] the simulation results in a recent study demonstrated that the algorithm in question could comply with COLREGs in various situations.[758] Even in some of the simulations where unexpected targets' trajectory was deliberately changed to challenge the algorithm, the system managed to keep control of its own ship and departed from COLREGs to conclude the manoeuvre when necessary.[759] Whichever of the above algorithms ultimately finds its way on a MASS

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753 Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 91.

754 Ibid.

755 Thomas Statheros, Gareth Howells and Klaus McDonald Maier, 'Autonomous Ship Collision Avoidance Navigation Concepts, Technologies and Techniques' (2008) 61 The Royal Institute of Navigation 129, 130.

756 Anete Vagale, Rachid Oucheikh, Robin T Bye, Ottar L Osen and Thor I Fossen, 'Path Planning and Collision Avoidance for Autonomous Surface Vehicles I: A Review' (2021) Journal of Marine Science and Technology 1, 12.

757 Hans-Christoph Burmeister and Manfred Constapel, 'Autonomous Collision Avoidance at Sea: A Survey' (2021) 8 Frontiers in Robotics and AI 1, 7.

758 Raphael Zaccone, 'COLREG-Compliant Optimal Path Planning for Real-Time Guidance and Control of Autonomous Ships' (2021) 9 Journal of Marine Science and Engineering 1.

759 Ibid.

Degree 4, the success of 'simulations' can be considered as if the algorithm has passed the 'theory' test of COLREGs.

Another crucial area of knowledge for deck officers is ship manoeuvring as the STCW Code requires candidates to know the effects of wind, current, deadweight, draught, trim, speed and under-keel clearance on ship handling.[760] While humans may forget, misunderstand or miscalculate the effects of these factors on ship handling, a MASS Degree 4 can more quickly and more accurately calculate such effects by its computer systems that have been programmed for this purpose. In fact, when it comes to complicated calculations, computers are always more accurate and more reliable than humans are. For instance, the first ship was equipped with an autopilot in 1921[761] and nowadays most (if not all) merchant ships are equipped with autopilot systems that do the tedious job of a helmsperson more effectively. In fact, all ships of 10,000 gross tonnage and upwards must have an autopilot system under SOLAS requirements.[762] A second example is calculating different types of forces that loading of a particular cargo in different holds of a ship exerts on different sections of the ship's construction. Since such calculations can be lengthy and complicated, there is a risk of human error which can consequently overstress the hull structure and break the ship in two. In addition, as the advancement of technology is increasingly making the loading time shorter, ship officers have less and less time to carry out such calculations while the ship is in the loading port. That is why SOLAS requires all bulk carriers of 150 metres in length and upwards to be fitted with a 'loading instrument' i.e. a loading computer (hardware) and a calculation programme (software) capable of calculating shear forces and bending moments on the ship's hull.[763] Even though there is no regulatory or statutory requirement for a loading instrument on board other types of ships, classification societies usually require all ships with large deck openings (e.g. tankers) of 100 meters in length and above to be fitted with a loading instrument approved by their class.[764]

There is, therefore, strong evidence and precedent which indicate when it comes to memorising and remembering rules and carrying out complicated computational tasks, not only are computers preferred to humans, they are sometimes even compulsory by laws and regulations. Moreover, no university, college or training centre in the world

[760] STCW Code, Table A-II/1.

[761] Aharon Kellerman, *Automated and Autonomous Spatial Mobilities* (Edward Elgar Publishing 2018) para 4.5.

[762] Chapter V, Regulation 19, paragraph 2.8.2.

[763] Chapter XII, Regulation 11.1.

[764] IACS Req. 1971/Rev.7, 'Requirements for Loading Conditions, Loading Manuals and Loading Instruments' (May 2010) para S1.2.1 – available at <https://www.iacs.org.uk/publications/unified-requirements/ur-s/> accessed 07 February 2023.

expects or requires nautical students to be perfect and pass all examinations with a result of 100%. That is to say, the knowledge requirement for nautical students is not absolute – they are only required to show a reasonable level of competency. For example, at University of Plymouth that offers a navigation course leading to an officer of the watch qualification,[765] the standard pass mark for the modules (like most other universities and colleges) is only 40%.[766] It is safe to say that a computer can almost always achieve a result of 100% provided that all the input data are correct and the computer system is maintained properly. Accordingly, it can be argued that the algorithm of a MASS Degree 4 can satisfy and even surpass the theoretical knowledge that is expected of a nautical student or indeed a practicing watch officer.

4.4.6.2. MASS Cadetship vis-à-vis Deck Cadetship

After completing the college or university phase, nautical students then usually complete a minimum of 12 months seagoing service which includes onboard training that meets the requirements of section A-II/1 of the STCW Code.[767] This period of onboard training is commonly known as cadetship, and a crucial part of onboard training of deck cadets is bridge watchkeeping and manual steering of the vessel. During the 12-month seagoing service, they must perform bridge watchkeeping duties under the supervision of the master or a qualified officer for a minimum of 6 months.[768] Upon successful completion of the cadetship, their onboard training will have been documented in the training record book approved by the master or the relevant training officer.[769] The main purpose of the cadetship phase is ensuring that the candidate receives practical training and experience in the duties and responsibilities of an officer in charge of a navigational watch.[770] The cadetship provides an opportunity for candidates to put their theoretical knowledge (e.g. collision regulations) gained during the college phase into practice in real-life situations under a controlled and supervised environment so that deck cadets acquire hands-on experience and will be able to navigate the vessel independently and in accordance with the applicable requirements such as COLREGs and the Radio Regulations. Also, if there is any gap in their knowledge, it will be addressed by the training officer or the master on

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[765] 'BSc (Hons) Navigation and Maritime Science' <https://www.plymouth.ac.uk/courses/undergraduate/bsc-navigation-and-maritime-science> accessed 07 February 2023.

[766] 'Frequently Asked Questions About Undergraduate Results' <https://www.plymouth.ac.uk/student-life/your-studies/essential-information/undergraduate-results-faq> accessed 07 February 2023.

[767] STCW Convention, Chapter II, Regulation II/1.

[768] Ibid.

[769] Ibid.

[770] STCW Code, Chapter II, Section A-II/1, Regulation 6.

the vessel. This standard of training can be emulated for MASS certification too. That is to say, after the simulation phase, a MASS degree 4 should (metaphorically speaking) pass a cadetship period where the navigational data, COLREGs and standards of good seamanship which have been incorporated into its algorithm will be put into practice in real sea conditions but in a controlled and supervised way e.g. there is a competent person on board or ashore to supervise the operation and take over control if necessary. In fact, for self-learning algorithms that 'learn' by observing their surroundings, the use of the term 'cadetship' not only does not seem a misnomer, it may even be unavoidable. The cadetship period will be an opportunity for the developers of the algorithm to observe and analyse compliance of the algorithm not only with COLREGs, but also with additional precautions as required by principles of good seamanship under Rule 2(a) and/or departure of the algorithm from COLREGs in special circumstances under Rule 2(b).

As alluded to above, one of the special circumstances that may require a departure from COLREGs under Rule 2(b), is a multi-vessel situation in congested shipping routes where a particular vessel becomes both a stand-on and a give-way vessel simultaneously. For example, where power-driven vessel A is being overtaken by vessel B, vessel A is required to keep her course and speed.[771] If at the same time, however, vessel A also finds herself in a head-on situation with power-driven C where risk of collision is involved, then vessel A must not keep her course but must alter to starboard.[772] It goes without saying that vessel A cannot comply with both Rules simultaneously i.e. she cannot both keep her course and also alter to starboard. This situation amounts to a special circumstance and if it is necessary to avoid immediate danger, vessel A must depart from one or more Rules of COLREGs e.g. she may reduce her speed substantially and let vessel B overtake her more quickly and then alter her course to starboard. Another special circumstance, which is expressly mentioned in Rule 2(b), is where one or more vessels have physical limitations to take action e.g. due to shallow depth of water in coastal waters. For instance, where power-driven vessel A observes power-driven vessel B approaching on her port side, vessel A must keep her course and speed as required by Rule 17 (a)(i) and let vessel B perform the required manoeuvre and keep out of her way as required by Rule 15. Vessel A, however, cannot and must not keep her course and speed if there is a shallow water area dead ahead where there is a risk of grounding. She must depart from Rule 17(a)(i) and take an appropriate action so as to avoid both collision and grounding e.g. she may alter her course to starboard side. A MASS Degree 4 is similarly expected to depart from one or more Rules of COLREGs and take such action as will best avoid collision and grounding under similar circumstances. One way of ensuring compliance with the object of Rule 2 could be defining a minimum closest point

771 COLREGs, Rule 17(a)(i).

772 COLREGs, Rule 14 (a).

of approach (CPA) in different situations depending on variables such as traffic density and the state of visibility. Thus, if compliance with a particular Rule of COLREGs results in a dangerously small CPA with another vessel, that small CPA is a good indication for the MASS to depart from that Rule in order to reach a greater and safer CPA with that vessel. Setting a minimum safe CPA can ensure that such a departure will not result in another dangerous CPA with, for example, a wreck, an oil rig or a shallow water area. Such manoeuvres can be carried out in the trial period under supervision and the results of the MASS performance can then be recorded for further analysis and possible improvement of the MASS algorithm by its developers. If the MASS performance does not meet the standards of good seamanship, its algorithm should be improved and the MASS should undergo additional periods of trial until it can meet standards of seamanship.

It appears that the shipping industry has started to adopt the above-mentioned procedures i.e. testing a MASS algorithm through simulations in laboratories and then trialling the algorithm in real conditions at sea. For example, in October 2020, Samsung Heavy Industries successfully demonstrated its autonomous navigation system called Samsung Autonomous Ship (SAS) which helped two autonomous ships to detect and avoid each other in seas off the southwestern island of Gageo.[773] In a partnership with Mokpo National Maritime University, the shipbuilding giant carried out tests on a sea route between two ports of Mokpo and Jeju, and the university was in charge of simulation and evaluation.[774] The demonstration was the first of its kind in the world as the autonomous system was tested on a large vessel i.e. a 9,200-ton ship of the university and a 300-ton tug of the company were used to demonstrate the performance of the SAS.[775] According to Samsung Heavy, the SAS is capable of recognising surrounding vessels and obstacles while appraising the risk of collision and finding an optimal route[776] which implies compliance with the general rules of good seamanship.

It is submitted that there is no need for a MASS to be trialled in all possible circumstances where good seamanship skills and/or departure from the Rules are vital firstly because the type and number of special circumstances are countless and secondly because a

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[773] Yonhap, 'Samsung Heavy Demonstrates Ship Collision Avoidance System' (*The Korea Herald*, 06 September 2021) <http://www.koreaherald.com/view.php?ud=20210906000448> accessed 07 February 2023.

[774] Lim Chang-won, 'Samsung shipyard to Test Remote Autonomous System with 9,200-Ton Ship' (*Aju Business Daily*, 10 February 2021) <https://www.ajudaily.com/view/20210210152716084> accessed 07 February 2023.

[775] Ibid.

[776] 'SHI Advances Merchant Vessel Autonomy With Collision-Avoidance Test' (*The Maritime Executive*, 06 September 2021) <https://maritime-executive.com/article/shi-advances-merchant-vessel-autonomy-with-collision-avoidance-test> accessed 07 February 2023.

MASS may never encounter such circumstances even after a long period of trial. By way of contrast, a deck cadet may never experience navigation in restricted visibility throughout his or her cadetship. This does not mean that the master of the vessel will not approve his/her record book or he/she will not be eligible to apply for a Certificate of Competency provided that he/she knows the rules of navigation in restricted visibility. In the same vein, it would be unrealistic to expect or require a MASS Degree 4 to encounter and successfully deal with *every* conceivable situation that may require good seamanship skills. Over a 1-year period of navigation, a seagoing MASS (or any other seagoing vessel for that matter) will come across the most common navigational hazards such as multi-ship situations, adverse weather conditions, shallow water areas and strong tidal currents.

The exact details of MASS trials such as the length of the trial and any geographical location where MASS trials can or cannot be carried out can be determined by competent authorities. The IMO has already approved and published the first interim guidelines for MASS trials[777] which provide very general guidelines for interim operations. Such guidelines can be updated to address any emerging issues and to provide more in-depth details such as minimum required situations that a MASS Degree 4 must deal with during its trial before it can be certified for full operation. If the guidelines prove successful over time, they can be compiled into a mandatory MASS Code.

4.4.6.3. MASS Sea Trials vis-à-vis Oral Examinations

The final stage towards a Certificate of Competency is passing the examinations that are required by the maritime administration of the relevant State who ultimately issues such certificates to successful candidates. Under the STCW Code, candidates' competence should normally be evaluated through different methods that can provide different types of evidence about their competence.[778] That is why most States require candidates to pass both written and oral examinations as suggested by the Code.[779] However, as with the college phase written examinations, the requirement is not absolute and students are not required or expected to pass all the examinations with flying colours. In practice, the competency requirement translates into an overall examination pass average of 50% to 65% under domestic regulations of most States. By way of example, in order to be eligible for the issue of a Certificate of Competency, candidates in the UK who undertake an Honours Degree, a Foundation Degree or a Scottish Professional Diploma, must achieve a minimum overall examination pass average of 50%, with a minimum of 60% in 'Stability

[777] IMO Doc MSC.1/Circ.1604, 'Interim Guidelines for MASS Trials' (14 June 2019).

[778] STCW Code, Chapter II, Section B-II/1, Regulation 17.

[779] Ibid.

and Operations' and a minimum of 65% in 'Navigation'.[780] Again, it is obvious that computer systems can easily satisfy and even exceed the pass marks for navigation.

Although after the commercialisation of GPS on merchant ships in the 1990s mariners nowadays hardly ever use celestial bodies to fix the ship's position, one of the required competences for watch officers on ships of 500 gross tonnage or more is still 'celestial navigation' under the STCW Code.[781] Oddly, however, SOLAS does not require any ship to carry a sextant which is the required tool for such celestial observations. Instead, it requires all ships irrespective of size to carry a receiver for a global navigation satellite system (e.g. GPS) or other means to establish and update the ship's position by automatic means.[782] The lack of regulatory requirement for carriage of a sextant and the fact that some ships do not carry one, cast doubt on whether watch officers should learn celestial navigation and/or pass the relevant examination under the STCW Code. In fact, the MCA recently carried out a survey to find out from the maritime industry and serving seafarers how effective the current STCW mandatory training requirements are and if anything can be added, removed or amended. The results of the survey which were published in a report in May 2021 did not show great support from the respondents for celestial navigation training in the context of the modern-day electronic navigation. Accordingly, the MCA advisor concludes that celestial navigation skill is not as essential as it used to be and recommends that 'part of the time spent on celestial navigation training can be dedicated to other relevant topics that are important to a navigator today'.[783] The report also suggests that appropriate celestial calculation 'software' should be approved and training on its use should be encouraged if necessary.[784] Although celestial navigation knowledge is still officially part of the candidates' competency examinations, many serving deck officers do not actually know how to fix the ship's position through celestial navigation calculations because they simply use the onboard GPS and hardly ever have to use a sextant. It is, therefore, conceivable that the written celestial navigation examination which is currently required by the MCA may be abolished in the future. It can also be observed that the traditional navigation knowledge and skills have been gradually giving way to knowledge and use of more automated and electronic navigational systems.

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[780] MCA, 'MSN 1856 (M+F): Training & Certification Guidance: UK Requirements for Master and Deck Officers' (11 June 2015) para 11.3.

[781] Table A-II/1.

[782] SOLAS, Chapter V, Regulation 19, paragraph 2.1.6.

[783] MCA, 'STCW Review Survey Report' (May 2021) page 6 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/986519/STCW_Review_Survey_Summary_Report_-_Navigation_Engineering_ETO.pdf> accessed 07 February 2023.

[784] Ibid.

Again, candidates are not expected to be perfect and know how to fix the ship's position by celestial navigation methods and the fact that carriage of a sextant is not mandatory on any ship under SOLAS lends support to this view. Rather, they are expected to know how to use the electronic navigation equipment on board the vessel. If computer systems can be better than humans in knowing and applying navigation principles and if mariners are losing their traditional navigation knowledge and skills and are increasingly relying on electronic systems, then there is no reason to think that an autonomous navigation system on a MASS Degree 4 cannot be equally or even more competent than human navigators.

In addition to the MCA written examinations, candidates in the UK must also pass an MCA oral examination[785] which requires the candidates to have 'thorough knowledge of the content, application and intent' of COLREGs.[786] The MCA examiners usually test the candidates' knowledge of COLREGs and may also ask them to explain their response to a hypothetical situation that is not specifically addressed by COLREGs i.e. a situation that requires good seamanship. As a counterpart to the oral examination, compliance of a MASS Degree 4 with COLREGs can be formally tested and approved by flag States through 'sea trials'. Sea trial is a series of tests that are carried out at sea in order to demonstrate that the vessel is in conformity with the shipbuilding contract as well as the requirements of the relevant classification society and the flag State.[787] Part of a sea trail involves testing of manoeuvrability of the vessel e.g. turning ability, crash-stop and crash-astern. In 2002, the IMO approved and published the 'Standards for Ship Manoeuvrability'[788] in which it sets out the criteria and standards[789] for satisfactory manoeuvrability of a ship and encourages flag States to apply the standards to ships constructed after 2004.[790] The IMO subsequently published explanatory notes to those

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[785] MCA, 'MSN 1856 (M+F): Training & Certification Guidance: UK Requirements for Master and Deck Officers' (11 June 2015) para 3.2(h).

[786] MCA, 'MIN 653 (M): Deck Oral Exam Syllabus' (13 May 2021) page 6 – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/986427/MIN_653.pdf> accessed 07 February 2023.

[787] ISO, 'ISO 19019: 2005: Seagoing Vessels and Marine Technology – Instructions for Planning, Carrying Out and Reporting Sea Trials' (2005) para 3.1. – available at <https://www.iso.org/standard/33732.html> accessed 07 February 2023.

[788] IMO Doc MSC.137(76), 'Standards for Ship Manoeuvrability' (4 December 2002) – available at <https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MSCResolutions/MSC.137(76).pdf> accessed 07 February 2023.

[789] Ibid para 5.3.

[790] Ibid Preamble.

Standards to provide flag States with more detailed and specific guidance and to assist in the uniform interpretation and application of the Standards.[791]

Such guidance can similarly be published by the IMO to determine minimum criteria that a MASS with an autonomous collision avoidance system must meet in order to be approved and registered by the flag State. As a minimum, a MASS Degree 4 must be able to avoid collision and allision in situations involving only one target e.g. another vessel, an oil rig or an islet. In addition, observance of the standards of good seamanship under Rule 2 should also be included in such criteria. For instance, the MASS should demonstrate departure from COLREGs in multi-ship situations or where the MASS has physical limitations and cannot comply with certain Rules of COLREGs. In fact, in 2014, an autonomous collision avoidance system developed by the American company Leidos was tested on a work boat by the US Defense Advanced Research Projects Agency's (DARPA) through completion of its Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ACTUV).[792] The evaluation of the autonomous system for COLREGs compliance included 26,000 simulation runs plus 42 days of at-sea testing that included 101 individual scenarios such as meeting, crossing, overtaking and transits.[793] The boat also safely avoided surface vessels it encountered along the route ‘in completely unscripted events’.[794] As observed above, a situation that is not specifically addressed by COLREGs may create a special circumstance that calls for good seamanship. Some elements of good seamanship, therefore, can be seen in the autonomous system developed by DARPA. The autonomous system developed by DARPA was later used in The Sea Hunter which completed her initial sea trial in June 2016 and according to Leidos she met or surpassed all performance objectives.[795] Also, in 2018, Rolls-Royce completed the £1.3 million MAXCMAS research project,[796] finding that AI-based navigation systems were able to enact COLREGs to avoid collision ‘even when approaching manned vessels were interpreting the rules differently’ and to make a collision avoidance judgement call

[791] IMO Doc MSC/Circ.1053, ‘Explanatory Notes to the Standards for Ship Manoeuvrability’ (16 December 2002).

[792] ‘COLREGS Compliant Autonomous Vessel Undergoes At-Sea Tests’ (*Digital Ship*, 21 November 2014) <https://www.thedigitalship.com/news/electronics-navigation/item/3527-colregs-compliant-autonomous-vessel-undergoes-at-sea-tests> accessed 07 February 2023.

[793] Ibid.

[794] Ibid.

[795] ‘Sea Hunter in New Performance Trials’ (*Shephard*, 27 July 2016) <https://www.shephardmedia.com/news/uv-online/sea-hunter-completes-initial-performance-trials/> accessed 07 February 2023.

[796] MAchine eXecutable Collision regulations for Marine Autonomous Systems.

‘even when the give-way vessel isn’t taking appropriate action’.[797] The leader of the project stated that the autonomous collision avoidance system effectively applied the COLREG rules in a manner that is ‘indistinguishable from good seafarer behaviour’ and that they confirmed this by having Warsash Maritime Academy instructors assess MAXCMAS ‘exactly as they would assess the human’.[798] This is another instance of good seamanship demonstrated by computer systems in real sea conditions which is claimed to be comparable or even better than that of human seafarers. In another trial in May 2022, a cargo ship called Suzaka successfully completed a 500-mile voyage during which it performed 107 collision avoidance manoeuvres without the help of a human.[799] According to Orca AI (the developer of the ship’s software), the safety navigation system of the ship was set up to operate as a ‘human watchkeeper’ with the help of eighteen on-board cameras combined to provide a 360° view, day and night.[800] It is submitted that the result of such MASS sea trials can potentially be more reliable than that of the oral examination that candidates take because candidates’ application of COLREGs in real sea condition on a ship is never formally tested by the MCA. In fact, in the STCW Review Survey Report published by the MCA, some of the respondents raise their concerns about lack of understanding of COLREGs by many watchkeepers and recommend more enhanced training regarding the application of the COLREGS.[801]

As noted above, one of the most common situations that requires good seamanship is a multi-ship situation i.e. a situation that is not specifically addressed by COLREGs. Navigators usually deal with such situations by communicating to each other via VHF radio and reaching an agreed and clarified course of action. Although MASS degree 4 are not currently capable of communicating via VHF radio, they can nevertheless be navigated by a remote controller in busy waters where the likelihood of multi-ship situations is higher. In open sea where there is ample sea room, a MASS Degree 4 can simply predict and avoid multi-ship situations by taking early action and this can satisfy the requirement of good seamanship for the MASS. Moreover, it is likely that advancement of technology will sooner or later enable MASS Degree 4 to communicate with manned vessels. The US Navy is currently planning to develop an automated bridge-

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[797] ‘MAXCMAS Success Suggests COLREGs Remain Relevant for Autonomous Ships’ (*Rolls-Royce*, 21 March 2018) <https://www.rolls-royce.com/media/press-releases/2018/21-03-2018-maxcmas-success-suggests-colregs-remain-relevant-for-autonomous-ships.aspx> accessed 07 February 2023.

[798] Ibid.

[799] Scooter Doll, ‘Autonomous Cargo Ship Completes 500 Mile Voyage, Avoiding Hundreds of Collisions’ (*electrek*, 13 May 2022) <https://electrek.co/2022/05/13/autonomous-cargo-ship-completes-500-mile-voyage-avoiding-hundreds-of-collisions/> accessed 07 February 2023.

[800] Ibid.

[801] MCA, ‘STCW Review Survey Report’ (May 2021) page 46, 48, 53 and 55.

to-bridge radio communication system that would give autonomous vessels the ability to talk to humans on traditional vessels and make passing arrangements over VHF radio.[802]

The results of the foregoing analyses can be summarised in three points. First, MASS Degree 4 can satisfy or even surpass the theoretical knowledge and practical skills that are expected of watch officers. Second, projects such as DARPA and MAXCMAS have demonstrated that AI is generally capable of making reasonable judgement calls akin to those of competent seafarers. Third, the technology is still continuing to improve collision avoidance algorithms and the overall performance of AI-driven vessels e.g. by enabling MASS Degree 4 to communicate with conventional vessels via VHF radio. Nevertheless, some may still argue that because such projects are very limited and do not cover many situations where good seamanship is key to avoiding collision, and because the autonomous navigation system of a MASS Degree 4 may fail at some point, operation of MASS Degree 4 should be banned due to safety concerns. It is submitted, however, that this argument does not stand up to scrutiny for the simple reason that safety is not absolute.

4.4.7. Safety is not Absolute

As observed in the previous sections, the requirement of good seamanship and indeed a navigator's competency to navigate a ship are not absolute under the current national or international regulations. Moreover, experienced navigators may not always be able to agree in every case what exactly good seamanship dictates which is why they are permitted and, indeed, required to make a judgement based on their experience.[803] Even experienced judges may sometimes have different views as to what good seamanship requires in certain situations and there is a recent case that illustrates this point. On a fine February night in 2015, a laden VLCC, *Alexandra 1*, collided with a laden container ship, *Ever Smart*, just outside the dredged channel of the port of Jebel Ali in the UAE when there were clear skies and good visibility of 10 to 12 miles.[804] *Ever Smart* was an outbound vessel who had disembarked her pilot and was navigating along the channel to leave the port and *Alexandra 1* was an inbound vessel approaching the pilot boarding area just outside the channel to embark that same pilot.[805] Nautical Challenge Ltd (the owners of *Ever Smart*) argued that the two vessels were crossing so as to involve risk of collision

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[802] 'U.S. Navy Wants its Unmanned Vessels to Make VHF Calls' (*The Maritime Executive*, 02 January 2020) <https://maritime-executive.com/article/u-s-navy-wants-its-unmanned-vessels-to-make-vhf-calls> accessed 07 February 2023.

[803] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 325.

[804] *Nautical Challenge Ltd v Evergreen Marine (UK) Ltd* [2017] 1 Lloyd's Rep 666 [12].

[805] Ibid [13].

and since *Alexandra 1* had *Ever Smart* on her starboard bow, she was under a duty to keep out of the way of *Ever Smart* under Rule 15 i.e. the crossing rule.[806] Evergreen Marine Ltd (the owners of *Alexandra 1*) on the other hand, contended that Rule 15 did not apply to a vessel navigating in a narrow channel and a vessel navigating towards that channel and preparing to enter it.[807] They also argued that even if Rule 15 did apply to vessels in and around a narrow channel, *Alexandra 1* was not on a sufficiently defined course to trigger Rule 15.[808] Sitting with two master mariners and the Elder Brethren of Trinity House as Nautical Assessors, Teare J in the Admiralty Court held that Rule 15 did not apply where one vessel was navigating along a narrow channel and another vessel was navigating towards that channel with a view to entering it.[809] Citing a statement made by Lord Wright in *The Alcoa Rambler*,[810] Teare J also held that in any event, *Alexandra 1* was not on a sufficiently defined course for the crossing rules to apply.[811] Accordingly, the Court held that *Alexandra 1* was not under a duty to keep out of the way of *Ever Smart*, but 'as a matter of good seamanship', her duty was to navigate in such a way that, when she reached the entrance of the channel, she would be on the starboard side of the channel in accordance with Rule 9.[812] Teare J found that both vessels were at fault and apportioned liability 80% to *Ever Smart* and 20% to *Alexandra 1*.[813] The owners of *Ever Smart* appealed from this decision arguing that the judge erred in disapplying Rule 15.

The Court of Appeal, however, dismissed the appeal and agreed with the judgment of Teare J referring to him as 'the very experienced Admiralty judge'[814] whose conclusion reflected the advice of the Elder Brethren.[815] The Court of Appeal also sat with a master mariner, a Rear Admiral and Elder Brethren of Trinity House as Nautical Assessors and the lead judgment was given by Gross LJ who was referred to as 'an experienced Admiralty practitioner' by the Supreme Court where the case ultimately ended up.[816] Sitting with Captain Nigel Palmer OBE MNM, Commander Nigel Hare RN and Elder

[806] Ibid [39].

[807] Ibid.

[808] Ibid.

[809] *Nautical Challenge Ltd v Evergreen Marine (UK) Ltd* [2017] 1 Lloyd's Rep 666 [53].

[810] (1949) 82 Ll L Rep 359, 367.

[811] Ibid [71].

[812] Ibid [64].

[813] Ibid [118].

[814] [2019] 1 Lloyd's Rep 130 [58].

[815] Ibid [55].

[816] [2021] 1 Lloyd's Rep 299 [30].

Brethren of Trinity House as Nautical Assessors,[817] the Supreme Court reversed the judgment of the courts below and ruled that where an inbound vessel is approaching the entrance of a narrow channel and is crossing with an outbound vessel in the channel so as to involve risk of collision, the crossing rules are not overridden by the narrow channel rules merely because the approaching vessel is intending and preparing to enter the channel.[818] The Supreme Court also answered the question of construction of Rule 15 in a different way. It held that if two vessels, both moving over the ground, are crossing so as to involve risk of collision, then Rule 15 will apply even if the give-way vessel is on an erratic course.[819] Lord Briggs stated, *obiter*, that for Rule 15 to apply, even the stand-on vessel need not be on a steady course either.[820] It is correct that once the crossing rules are engaged, the stand-on vessel must keep her course and speed as required by Rule 17, but it does not follow that she should already have been on a sufficiently defined course or speed before Rule 15 could apply.[821]

Three points may be made from this case. First, at the time of the collision, the masters of both vessels were on the bridge and the fact that both vessels ended up colliding with each other simply indicates that the vessels' masters failed to observe COLREGs and the rules of good seamanship. This means that qualified and certified navigators may from time to time fail to comply with the standards of good seamanship and this failure includes even the most senior and experienced navigators i.e. master mariners on board large ships belonging to reputable shipping companies. Second, based on the advice of Nautical Assessors, the Admiralty Court and the Court of Appeal both concluded that good seamanship required *Alexandra 1* to set a course that would put her on the starboard side of the channel rather than to take avoiding action as the give-way vessel in a crossing situation. The courts, therefore, invoked Rule 2 to disapply Rule 15. The Supreme Court, however, held that good seamanship did not require *Alexandra 1* to take such an action, but required it to take avoiding action as the give-way vessel in accordance with Rule 15. It described the approach to use Rule 2 as the basis for a complete disapplication of Rule 15 as 'misconceived' and pointed out that under Rule 2(a), compliance with the Rules (e.g. Rule 15) is the 'first principle of good seamanship'.[822] It follows that, even the most experienced Admiralty judges equipped with the expert advice of the most experienced nautical assessors such as the Elder Brethren of Trinity

[817] Ibid [36].

[818] Ibid [145].

[819] Ibid [111].

[820] Ibid [112].

[821] Ibid.

[822] Ibid [66].

House may not always be able to decide what exactly good seamanship would have required under certain circumstances. It is also important to note that the courts reached their conclusions ‘after’ the collision and without being in the ‘agony of the moment’. Third, where the highest courts of the UK i.e. the Supreme Court and the Court of Appeal may have a dissimilar interpretation of the application of COLREG rules (in this case, Rule 15), it would be unreasonable to expect or require seafarers or indeed collision avoidance algorithms to have and apply a uniform understanding of the Rules in all possible circumstances. Persons who programme an autonomous collision avoidance system are human beings who, like the judges in the *Alexandra 1* case, may have their own understanding of ambiguous aspects of some rules. Different interpretations of the rules in certain (and often rare) circumstances are, therefore, inevitable. Equivocality is not always avoidable in drafting qualitative regulations and so long as regulations achieve their overall objectives, the occasional ambiguities can be ironed out by the court when the issues arise.

Thus, where the number of situations not expressly covered by COLREGs is virtually infinite, where national or international regulations do not require navigators to be perfect, where experienced judges cannot always agree what good seamanship may require in certain circumstances, and where even the highest courts have different views as to interpretation of COLREG rules, imposing an ‘absolute’ safety requirement on autonomous vessels to comply with all rules of good seamanship in all situations would be unrealistic and regressive. The point of ‘perfection’ in the emerging autonomous ship technology is either unachievable or far away in time. It is only with actual utilisation of the technology that its latent flaws and/or shortcomings will come to light and can subsequently be addressed. Looking at the aviation industry as an example, the first generation of aircraft that dominated the world’s airline fleet in 1960 were piston-driven and had an accident rate of 27.2 accidents per million departures.[823] The advances in science and technology then created the second generation of aircraft in the 1960s and early 1970s which had an accident rate of 2.8 accidents per million.[824] The technology then progressed to the current generation of aircraft which have an accident rate of 1.5 accidents per one million departures.[825] Such accident rates are perceived to be acceptable by human societies as the odds of dying in a crash aboard an aircraft in the US or the European Union are currently calculated to be less than the odds of dying while

[823] ‘How Aviation Safety Has Improved’ (*Allianz Global Corporate & Specialty*) <https://www.agcs.allianz.com/news-and-insights/expert-risk-articles/how-aviation-safety-has-improved.html> accessed 07 February 2023.

[824] Ibid.

[825] Ibid.

riding a bicycle or the odds of being killed by lightning.[826] The acceptance of such a risk can be seen in the ever-increasing global number of air passengers which was only 106 million passengers in 1960, but then it grew to about 7 billion in 2014 and it is estimated to reach 16 billion by 2050.[827] If regulations had required 'absolute' safety for the operation of civilian aircraft, then no aircraft would ever have been able to take off as there is always a possibility that something can go wrong and the aviation industry and our societies would not have been in the position that they are today.

A similar pattern can also be seen in the shipping industry. Ship losses have decreased significantly from one ship in every 100 ships in 1910, to one ship in every 670 ships in 2010.[828] During this period, the technology used in ships' bridges has also changed beyond recognition. For instance, the first navigation sextant in the world that was used on ships' bridges was made by John Bird in 1757.[829] The device, however, was of no use when the skies were cloudy. In 1944, the Decca Navigator System solved the weather problem to some extent as it allowed accurate fixing of a ship's position, but only up to 400 miles offshore.[830] In 1994, the Global Positioning System (GPS) became fully operational,[831] which allowed accurate position finding regardless of the weather conditions or the ship's distance from the shore. Other technologies that have changed the appearance of the modern-day bridge include autopilot, gyro compass, radar, AIS, echo sounder and ECDIS.[832] The fact that the marine sextant was useless in cloudy weather or that the Decca Navigator System could not cover offshore areas beyond 400 miles, did not prevent or stop ships from sailing beyond that range or crossing the oceans. Ships have always been navigating the oceans with the help of the available technology of the day; be it sextant, Decca, or GPS. The shipping industry did not (and could not) wait for a perfect and 100% safe and reliable technology that would guarantee safe transportation of goods with no accident at all. Exporting and importing goods to and from

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826 Allianz Global Corporate & Specialty, 'Global Aviation Safety Study: A review of 60 years of improvement in aviation safety' (2014) page 4 – available at <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Global-Aviation-Safety-2014-report.pdf> accessed 07 February 2023.

827 Ibid.

828 Allianz Global Corporate & Specialty, 'Safety and Shipping 1912-2012: From Titanic to Costa Concordia' (2012) page 13 – available at <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Safety-Shipping-Review-2012.pdf> accessed 07 February 2023.

829 Saul Moskowitz, 'The World's First Sextants' (1987) 34(2) Journal of The Institute of Navigation 22, 22.

830 Ibid 26.

831 Ibid 27.

832 Electronic Chart Display and Information System.

around the world is the lifeblood of the world's economy that cannot be stopped due to possible safety risks associated with international shipping. Having tripled since 1970 to more than 8.4 billion tonnes of cargo loaded per year, the world seaborne trade which is driven by globalisation continues to grow rapidly.[833] Requiring a zero-accident technology would have delayed or prevented the considerable benefits that the less-than-perfect technology has already brought to the world.

History of the automobile also highlights the potential dangers of undue restrictions on new technologies. During the late 1800s when British innovators were trying to develop and improve different types of automobiles, acts of Parliament stifled the advancement of automobile technology through tough restrictions on motor vehicles. For example, the Locomotive Act of 1865 restricted the maximum speeds on public roads to 2 miles per hour within cities and 4 miles per hour in rural areas.[834] The Act later became known as the Red Flag Act because it required any self-propelled road vehicle to be manned by a crew of at least three, with one person walking ahead of the vehicle and carrying a red flag to warn. By the time when the Act was repealed in 1896, its restrictive provisions had effectively stifled the development of road transport in the British Isles.[835] Put another way, the Red Flag Act, delayed advances in automobile technology by about three decades.

In a similar vein, the emerging autonomous collision avoidance technology also cannot progress towards improved safety or the desirable 'perfection' if regulations prevent its implementation merely because it may not be able to satisfy the requirements of good seamanship in some unspecified but possible circumstances. As observed above, no technology can be absolutely safe or reliable at the very beginning – it is only with actual use of the technology over time that its safety issues can be identified and addressed accordingly. The question, therefore, is not whether autonomous collision avoidance technology should be 100% safe before regulations can permit its use on MASS Degree 4. The question, rather, is 'how safe' the technology should be in order for regulations to permit its implementation on such vessels. One uncontroversial answer is that the emerging technology should provide at least the same degree of safety as currently provided by conventional ships. The level of safety provided by the technology can be determined during the three stages that were analysed above i.e. simulation, cadetship and sea trials. States have already started MASS trials (cadetship) in accordance with the IMO Interim Guidelines for MASS Trials. For instance, in July 2021, the MSC

[833] Allianz Global Corporate & Specialty, 'Safety and Shipping 1912-2012: From Titanic to Costa Concordia' (2012) page 6.

[834] 'History of the Automobile' (*Britannica*) <https://www.britannica.com/technology/automobile/History-of-the-automobile> accessed 07 February 2023.

[835] Ibid.

published a report on MASS trials of the VN Rebel, an 80-metre French-registered merchant ship, which was successfully controlled from a remote control centre 800 kilometres away.[836] The vessel was equipped with various visual and auditory sensors which provided the officer in charge of navigation with a visual field and sound environment 'similar to what he would have if he were on board'.[837] The collected data from the sensors were sent to the remote-control centre through a high-performance satellite connection system and the MASS was equipped with an automatic 'fail-safe mode' in the event of a connection problem.[838] The trials proved availability of remote navigation functions such as steering, visual watch, VHF communications and anti-collision manoeuvres and the remote controllers also demonstrated responses to several scenarios including the loss of communications connectivity due to a weather incident and a cybersecurity attack with the detection of a GPS blurring.[839] Another example is the Chinese-registered autonomous cargo ship, Jin Dou Yun 0 Hao, which was successfully trialled several times and the results of the trials were again published by the MSC in July 2021.[840] The ship which was designed and built in 2019, is capable of autonomous navigation and autonomous collision avoidance 'in certain scenarios'.[841]

In fact, it can be argued that the collision between *Alexandra 1* and *Ever Smart* would have been far less likely to happen if both vessels were MASS Degree 4. The investigation report of the collision carried out by MAIB concluded that the reliance of *Alexandra 1*'s master on scanty VHF information and the failure of *Ever Smart*'s master to keep a proper lookout were pivotal to the collision.[842] Although Teare J did not accept the defendants' submission that the master and/or the third officer of *Alexandra 1* were intoxicated, the audio record of the vessel suggested that the master of the vessel was 'at times irritated, at times excited and at times voluble'.[843] The irritability of the master due to the delay in embarking the pilot may explain why he made wrong assumptions based on a VHF conversation that he overheard. The VHF conversation was between

[836] IMO Doc MSC 104/INF.19, 'Report on MASS Trials of "VN REBEL" Conducted in Accordance with the Interim Guidelines for MASS Trials' (30 July 2021).

[837] Ibid para 5.

[838] Ibid.

[839] Ibid para 21.

[840] IMO Doc MSC 104/INF.14, 'Report on MASS Trials' (30 July 2021).

[841] Ibid para 1.1.

[842] MAIB, 'Report on the Investigation of the Collision between the Container Ship *Ever Smart* and the Oil Tanker *Alexandra 1*' (2015) para 2.2 to 2.5. – available at <https://assets.publishing.service.gov.uk/media/5665aff8e5274a0367000010/MAIBInvReport-28_2015.pdf> accessed 07 February 2023.

[843] *Nautical Challenge Ltd v Evergreen Marine (UK) Ltd* [2017] 1 Lloyd's Rep 666 [108].

Port Control and another vessel which the master thought was *Ever Smart* where in reality it was an approaching tugboat.[844] By contrast, an autonomous navigation system on *Alexandra 1* would not have become irritated or excited in such circumstances and would not have made assumptions based on scanty VHF information. The master and the third officer on *Ever Smart* also failed to keep a good radar lookout as *Alexandra 1*'s echo was never acquired as an ARPA target on *Ever Smart*'s radar.[845] In fact, about three seconds before the collision, the master of *Ever Smart* said 'what's that?' and he said that probably after the deck lights of *Alexandra 1* were switched on.[846] Again, technologies used on a MASS Degree 4 e.g. radars and thermal or infrared cameras would have been able to detect *Alexandra 1* considerably sooner than three seconds. Moreover, Jebel Ali is a very busy port that a significant number of vessels call at every year. The role of the vessel traffic service officer (VTSO) in such busy ports, therefore, is imperative in alerting and instructing the vessels in the port area and preventing collisions between them. However, the MAIB investigation found that Jebel Ali's VTSOs did not participate in emergency drills and very few of them held the required qualifications for the job.[847] As a result, the MAIB report concludes that 'the VTSOs might not have been adequately equipped to recognise when potentially hazardous situations were developing and how to respond accordingly.'[848]

As vessel operations and interactions in busy ports become more complex, management of the collision risks also become more difficult even for fully qualified VTSOs. The use of AI in vessel traffic services (VTS) can address the issue. In 2019, Fujitsu announced the results of a trial carried out with the Maritime and Port Authority of Singapore which employed AI to analyse collision risks in the Singapore Strait, to predict potential collisions before they happen, and to increase the lead time in advising vessels on avoidance measures.[849] Fujitsu confirmed that the addition of AI analytics will help to improve management of collision risks and maritime traffic safety.[850] Arguably, an AI-based VTS in Jebel Ali would have predicted the risk of collision in good time, would have warned both vessels about the collision, and would have advised them on best action to avoid the

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[844] Ibid [17].

[845] Ibid [79].

[846] Ibid [33].

[847] MAIB, 'Report on the Investigation of the Collision between the Container Ship *Ever Smart* and the Oil Tanker *Alexandra 1*' (2015) para 2.9.

[848] Ibid.

[849] Thomas Wakelin, 'AI Based Marine Traffic Control Tested in Singapore' (*Royal Institute of Navigation*, 15 April 2015) <https://rin.org.uk/news/446677/AI-based-marine-traffic-control-tested-in-Singapore.htm> accessed 07 February 2023.

[850] Ibid.

collision especially if the vessels were also AI-driven. Furthermore, AI-lead vessels and VTS can also eliminate language difficulties that may hinder verbal communications between conventional vessels as well as between VTSOs and such vessels. According to the MAIB report, as *Ever Smart* was approaching *Alexandra 1*, there was less than 1 minute available for avoiding action to be taken and *Alexandra 1*'s master's decision to call Jebel Ali port control rather than *Ever Smart* directly, potentially cost valuable seconds.[851] Given that *Alexandra 1*'s crew were Russian, Ukrainian and Georgian and *Ever Smart*'s crew was a mix of Filipino, Taiwanese and Chinese seafarers, the MAIB report suggests that it is likely that 'language difficulties' caused *Alexandra 1*'s Russian master to call the port control rather than *Ever Smart* directly. However, in the case of MASS Degree 4 monitored by an AI-based VTS, messages can be sent, received and understood in standardised electronic format and instantaneously without any waste of time or language difficulties.

In conclusion, from a statistical point of view, new technologies have always in the long run improved maritime safety and have also supported international trade which benefits the international community at large. If the overall results of simulation, cadetship and sea trials of the next new technology (i.e. MASS) show a degree of safety which is at least equivalent to that of conventional ships, then there is no reason why the new technology should be banned or delayed. As observed above, autonomous ship technology is on the path towards the equivalent and even higher safety that is currently offered by conventional vessels. Thus, contrary to the dominant view in the literature, autonomous vessels would not fall foul of Rule 2. This, however, does not mean that Rule 2 will not require any amendment or clarification.

4.4.8. Conclusion on Rule 2

The foregoing sections demonstrate that the requirement of good seamanship under Rule 2 is not absolute not least because situations which may require departure from the Rules of COLREGs are countless and sometimes impossible to know in advance. Moreover, being qualitative regulations, COLREGs are not always entirely unambiguous which is why even senior judges may at times reach different conclusions about the meaning of the same rule of COLREGs. It would, therefore, be unreasonable to expect or require seafarers to know what exactly good seamanship would dictate or how exactly a particular Rule should be interpreted in every single situation.

In order for seafarers to be certified, they must demonstrate (usually through a three-stage process) that they have the minimum knowledge and skills that are required to navigate a ship safely. MASS should also demonstrate at least the same level of safety

[851] MAIB, 'Report on the Investigation of the Collision between the Container Ship *Ever Smart* and the Oil Tanker *Alexandra 1*' (2015) para 2.6.1.

through a similar three-stage process. The evidence available thus far suggests that MASS collectively are likely to be able to pass all three stages of the tests successfully. One may argue that humans generally have the common sense to prevent collisions in unspecified or unexpected circumstances and that MASS Degree 4 lack such common sense and should therefore be banned from operation. Such a conclusion, however, cannot be reached without investigating the results of the actual tests carried out during the three stages. If necessary, the period of the metaphorical MASS cadetship can be extended to two or three years by the IMO to test the MASS navigational abilities more comprehensively. Another potential objection to MASS Degree 4 operations might be that, after a collision has occurred and in order to apportion liability, it will be difficult to establish whether the algorithm of the MASS observed the standards of good seamanship under the circumstances. In the case of a conventional vessel, the standard of good seamanship is the reasonable steps that an ordinarily competent seafarer would have taken under the circumstances. In the case of a MASS, it can similarly be argued that the standard of good seamanship is that level of care and skill which is expected of a competent programmer or developer of MASS algorithms.

It should, however, be noted that shipowners, masters, crew members and MASS programmers are expected to observe standards of good seamanship only where such standards already exist. For instance, SOLAS requires all ships to have a receiver for a global navigation satellite system (e.g. GPS) or a terrestrial radionavigation system or other means to establish and update the ship's position automatically.[852] Although SOLAS requires ships to carry one receiver, the vast majority of seagoing ships carry two sets of GPS receiver as a good seamanship practice in case one of the receivers fails. The technology of GPS already exists and it is possible for shipowners to observe the good seamanship of carrying two GPS receivers on their ships. However, interference and jamming in the GPS system have been on the rise in different parts of the world recently.[853] Carrying two GPS receivers cannot necessarily solve the problem and other methods such as radar bearings and celestial navigation should be used as a matter of good seamanship. In order to address the interference and jamming issues associated with 'satellite' positioning systems, an accurate positioning system called eLORAN is currently under development in Europe to provide a 'terrestrial' backup to satellite systems.[854] Shipowners may be expected to carry an eLORAN receiver on their ships as a matter of good seamanship only if such technology is already available. A simple risk-

[852] Chapter V, Regulation 19.2.6.

[853] 'GPS Interference and Jamming on the Increase' (*Gard*, 29 September 2020) <https://www.gard.no/web/updates/content/30454065/gps-interference-and-jamming-on-the-increase> accessed 07 February 2023.

[854] MCA, 'MGN 379 (M+F): Navigation: Use of Electronic Navigation Aids' (20 September 2019) para 4.3.

benefit analysis shows that carriage of goods by sea cannot be paused until a reliable backup to satellite positioning systems is developed.

Similarly, MASS programmers cannot be expected to programme a MASS in a way that it is able to avoid all accidents in all possible situations. Sometimes, an accident becomes inevitable and the available technology cannot prevent it even if that accident had been anticipated in advance. Good seamanship for MASS programmers means that they are expected to carry out a comprehensive risk assessment and programme the MASS to avoid accidents in light of the 'available' technology. If a certain accident under certain circumstances becomes unavoidable, the duty of seamanship is arguably discharged if the autonomous system takes the best action to minimise the consequent damage e.g. by reducing speed and/or changing the vessel's heading. MASS programmers cannot be held liable for not using a technology that has not yet been developed. Guidelines as to MASS safety design and risk assessment are currently under development by the maritime industry. For example, Maritime UK has been publishing and updating standards for design and operation of MASS, the latest (sixth) version of which was published in November 2022.[855] Classification Societies such as DNV[856] and ClassNK[857] have also recently developed such guidelines. Once the standards of reasonable care and skill for MASS design and operation have been established by regulation or by guidelines developed by the industry, then determining whether a MASS manufacturer complied with those standards will not be an issue and thus, apportioning liability based on observance of good seamanship will also be possible.

Thus, it seems that operation of MASS Degree 4 through the proposed three-stage process is unlikely to cause insurmountable safety issues, or any legal issues in the context of apportioning liability following a collision. It was shown in the previous sections that in terms of knowledge, skills and even good seamanship, autonomous systems can potentially be better than humans in the long term. Therefore, contrary to the dominant view in the literature, autonomous vessels would not fall foul of Rule 2. As the Belgian MLA pointed out in its response to the CMI questionnaire, if a MASS Degree 4 can navigate as safely or even safer than a conventional vessel, then the goal of COLREGs is achieved and there are no technical or safety issues. There are, however, two regulatory issues that need to be addressed. First, the reference to 'the owner, master or

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[855] 'Maritime Autonomous Ship Systems (MASS): UK Industry Conduct Principles and Code of Practice' <https://www.maritimeuk.org/priorities/innovation/maritime-uk-autonomous-systems-regulatory-working-group/mass-uk-industry-conduct-principles-and-code-practice-2022-v6/> accessed 20 December 2022.

[856] 'Autonomous and Remotely Operated Ships' (*DNV*, September 2018) <https://rules.dnv.com/docs/pdf/DNV/cg/2018-09/dnvgl-cg-0264.pdf> accessed 07 February 2023.

[857] 'Autonomous Ships' (*ClassNK*, August 2021) <https://www.classnk.or.jp/hp/pdf/research/rd/giho03e_2021.pdf> accessed 07 February 2023.

crew' in Rule 2(a) may be interpreted as if the Rule requires physical presence of crew members on board the vessel. The STCW Convention also requires the officer in charge of the navigational watch to be 'physically present' on the navigating bridge or in a directly associated location such as the chartroom or bridge control room 'at all times'.[858] This uncertainty is reflected in the response of the Japanese MLA where it says that the principle of good seamanship 'may be interpreted as if requiring on-board personnel',[859] and in the CMI Position Paper where it states that 'the IMO Regulations, in particular SOLAS, the STCW and the COLREG, make it clear that contemporaneous human involvement in the decision-making process is essential, even if on-board attendance is not always'.[860] The lack of clarity may well deter the potential users of MASS Degree 4 for fear of being prosecuted and criminally liable under the national legislation. For instance, the UK Merchant Shipping (Distress Signals and Prevention of Collisions) Regulations 1996 makes it clear that: 'Where any of these Regulations [the UK version of COLREGs] is contravened, the owner of the vessel, the master and any person for the time being responsible for the conduct of the vessel shall each be guilty of an offence, punishable on conviction on indictment by imprisonment for a term not exceeding two years and a fine'.[861] The second issue is that the words 'the owner, master or crew' in Rule 2(a) imply that it is a legal person (owner) or a natural person (master or crew) rather than an autonomous system who should observe the standards of good seamanship. In other words, following a collision involving a MASS Degree 4, a claimant may argue that although the MASS took the best possible avoiding action, using AI to navigate a vessel autonomously is against the standards of good seamanship and thus nothing in COLREGs can exonerate the owners of the MASS. As mentioned above, a special meaning can be given to a term used in a treaty only if the parties to the treaty so intended and there is simply no evidence to suggest that the State parties to COLREGs intended to extend the meaning of 'owner, master or crew' to AI.

It is, therefore, submitted that these two regulatory issues around Rule 2 need to be addressed through an amendment to COLREGs or another IMO legal instrument. However, since COLREGs is a public-facing convention which is referred to by different people with different knowledge and qualifications, an amendment to COLREGs will unnecessarily complicate it particularly for ordinary members of the public who just need to know and learn the rules of collision avoidance rather than details about good

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[858] Chapter VIII, Regulation VIII/2(2.1).

[859] 'CMI IWG Questionnaire on Unmanned Ships (Japan)' <https://comitemaritime.org/work/mass/> accessed 07 February 2023.

[860] Robert Veal and Henrik Ringbom, 'Unmanned Ships and the International Regulatory Framework' (2017) 23(2) Journal of International Maritime Law 100, 115.

[861] Paragraph 6(1).

seamanship for AI. In order to dispel the uncertainty, therefore, the IMO should develop a legal instrument clarifying that MASS can be operated remotely or completely autonomously with no human involvement on board or ashore and that the standards of good seamanship can be observed by AI too. Such an instrument should also set out the conditions that a MASS must meet before it can be certified for full operation. A 3-phase system i.e. simulation, cadetship and sea trial can be used as a paradigm for certification of an autonomous collision avoidance technology. As observed above, there are already instances of some MASS that have successfully met the requirements of one or more of these three phases. In order to observe the standards of good seamanship, MASS designers and operators should carry out a thorough risk assessment as to what may go wrong during an autonomous voyage and what can be done to prevent possible accidents or mitigate the consequences of such accidents. For instance, since good seamanship and departure from the Rules are often required in multi-ship situations, control of a MASS should be switched over from autonomous to manual remote control in busy coastal waters. SOLAS requires that in areas of high traffic density, in conditions of restricted visibility and in all other hazardous navigational situations it must be possible to change over the ship's steering control from automatic to manual immediately.[862] Similarly, where a MASS is expected to encounter a large number of fishing vessels in a particular area or if the MASS detects such vessels at a long range, a warning should be sent to the control centre alerting the remote controller to supervise or take over the navigation of the MASS. If, for whatever reason, the remote controller fails to do so and the MASS is trapped in an inevitable collision or allision, its autonomous system should take the best action to minimise the consequent damage e.g. by reducing speed and/or changing heading. Such risk assessment and contingency plans are not directly required by COLREGs but they can help the designers and operators of the MASS to establish that they observed the standards of good seamanship under Rule 2 if an accident does happen.

To conclude, Rule 2 does not legally 'require' owners or seafarers to exercise good seamanship not least because a test whether they can fulfil such a broad requirement in all circumstances will be extremely difficult if not impossible. Rather, it 'expects' them to do so and warns that if they do not, nothing in the Rules will exonerate them from the consequences of the failure. Similarly, Rule 2 does not in itself exclude MASS Degree 4 operations just because currently they may not be able to show good seamanship in all conceivable circumstances. In fact, from a safety and technical standpoint, AI has the potential to observe good seamanship standards and avoid collisions better than human seafarers and the potential is gradually turning into reality as the technology advances and MASS operations become more widespread. There are currently over 1,000 MASS

[862] Chapter V, Regulation 24.1.

that are operated by more than 53 organizations worldwide.[863] From a regulatory point of view, however, the meaning and application of Rule 2 need to be clarified to provide the certainty for MASS developers and operators. That clarification should be made in an instrument other than COLREGs.

4.5. Look-out Requirement and Artificial Intelligence

As observed in the previous chapter, poor look-out is recognised as the most common cause of maritime collisions. Lack of proper look-out has also, on occasion, been regarded as the sole or main cause of collision even though other faults and breaches of COLREGs also contributed to the collision.[864] Since one of the driving forces behind the autonomous ship technology is reducing collisions, it is necessary to assess whether MASS are capable of keeping a proper look-out in accordance with COLREGs.

Rule 5 of COLREGs, entitled 'Look-out' reads:

> Every vessel shall at all times maintain a proper look-out by sight as well as by 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 the risk of collision.

The main debate in the literature is focused on whether reference to 'sight and hearing' in Rule 5 requires a human being to perform the look-out duties. In light of the emerging MASS technology, the question is whether the lookout obligation may be discharged (fully or partially) by a remote controller or solely by AI rather than on-board seafarers. It has been argued that since decision competence under Rule 5 presupposes critical skills, experience, intuition and informed decision-making processes, the presence of human decision seems to be necessary.[865] Some researchers, however, suggest that while it is unclear whether a MASS Degree 3 equipped with highly sophisticated cameras and aural sensors satisfies the 'sight and hearing' requirement, a MASS Degree 4 does not satisfy

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[863] Jack Richard Dougherty, 'Autonomous Vessels are Becoming a Commercial Reality' (*The Maritime Executive*, 24 September 2021) <https://www.maritime-executive.com/editorials/autonomous-vessels-are-becoming-a-commercial-reality> accessed 07 February 2023.

[864] See, for example, *The Enif* [1991] 1 Lloyd's Rep 643.

[865] Marel Katsivela, 'Unmanned Vessels and Regulatory Concerns' (2020) 26(4) Journal of International Maritime Law 239, 244ff.

the requirement.[866] Others have taken the view that just how Rule 5 would be interpreted in a MASS Degree 4 situation is not entirely clear.[867]

4.5.1. Interpretation of Rule 5

It has been argued that this Rule does not presuppose the presence of crew members on board a ship, with the effect that no amendment to this Rule would be necessary regarding MASS Degree 4.[868] In a similar vein, the Position Paper published by Rolls Royce in 2016 also suggests that the term look-out in Rule 5 does not necessarily denote a person, but rather the systematic collection of information.[869] It has also been contended that pursuant to Rule 1(e) of COLREGs, since a MASS could be considered as a 'vessel of special construction or purpose', the MASS may be exempt from complying with Rule 5 and the flag State of the MASS may adopt its own appropriate precautionary measures to meet the requirements of the look-out rule.[870] However, it is submitted that Rule 1(e) does not empower a flag State to vary the look-out requirements according to special construction or purpose of a vessel flying its flag. As Rule 1(e) explicitly states, a vessel of special construction or purpose may comply with some other provisions (adopted by her flag State) only with respect to 'the number, position, range or arc of visibility of ***lights or shapes***, as well as to the disposition and characteristics of ***sound-signalling appliances***.'[871] In other words, Rule 1(e) permits flag States to depart only from those COLREGs rules which are related to lights, shapes or sound-signalling apparatus of the vessel. For instance, under Rule 21(a), a 'masthead light' means a white light which must be placed over the 'fore and aft centreline' of the vessel. However, an aircraft carrier due to its special construction or purpose (launching and recovery of aircraft) would not be able to have a masthead light over its 'fore and aft centreline'. The aircraft carrier can, therefore, comply with some other provision which would be 'the closest possible

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866 Robert Veal, Michael Tsimplis & Andrew Serdy, 'The Legal Status and Operation of Unmanned Maritime Vehicles' (2019) 50(1) Ocean Development & International Law 23, 39.

867 Brendan Gogarty and Meredith Hagger, 'The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air' (2008) 19 Journal of Law, Information and Science 73, 115.

868 Oliver Daum and Timo Stellpflug, 'The Implications of International Law on Unmanned Merchant Vessels' (2017) 23(5) Journal of International Maritime Law 363, 372.

869 Rolls Royce, 'Remote and Autonomous Ships: The Next Steps(AAWA Position Paper)' (2016) page 46 – available at <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 07 February 2023.

870 Oliver Daum and Timo Stellpflug, 'The Implications of International Law on Unmanned Merchant Vessels' (2017) 23(5) Journal of International Maritime Law 363, 372.

871 Emphasis added.

compliance'[872] with Rule 21(a) e.g. having the masthead light on her island as closely as possible to the fore and aft centreline. Rule 1(e), therefore, is not a licence to flag States to adopt their own rules in regard to Rule 5.

As it has been pointed out, COLREGs were drafted on the presumption that all vessels have a master on board and in control of the vessel,[873] and the second step of the Regulatory Scoping Exercise for COLREGs also took the view that COLREGs were not (in nature or application) prepared for MASS Degree 4 operations.[874] Even if the duty to maintain a proper look-out is placed on the 'vessel' rather than on human beings, the fact that 'sight and hearing' are inherently 'human qualities' suggests that Rule 5 is intended to cover human lookout functions.[875] This conclusion can be arrived at from another angle too. Rule 5 requires a proper lookout 'by sight and hearing' as well as by 'all available means' appropriate in the prevailing circumstances and conditions. Since 'all available means' includes use of electronic navigational aids such as radar equipment,[876] and because the mandate of lookout by 'all available means' is in addition to a lookout 'by sight and hearing', the wording of Rule 5 indicates that 'all' other technical means have already been considered and human senses followed by human judgment and experienced reaction are deemed by Rule 5 to be necessary as to avoid collision.[877] In other words, as pointed out by the response of the Spanish MLA to the CMI Questionnaire, if the courts consider the electronic visual and aural sensors on a MASS to be no more than 'all available means', then the requirement of a proper lookout by 'sight and hearing' would still need to be fulfilled by a human being.[878] The uncertainty surrounding the interpretation of Rule 5 is also reflected in the answers of other MLAs who responded to Question 4.3. of the CMI questionnaire that asked:

> 'As interpreted under national law, could the COLREG Rule 5 requirement to maintain a "proper lookout" be satisfied by camera and aural censoring [sensory]

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[872] COLREGs, Rule 1(e).

[873] Scott Savitz, Irv Blickstein *et al.*, *U.S. Navy Employment Options for Unmanned Surface Vehicles (USVs)* (Rand Corporation 2013) 48.

[874] IMO Doc MSC 102/5/3, para 31.

[875] Henrik Ringbom, 'Regulating Autonomous Ships—Concepts, Challenges and Precedents' (2019) 50(2-3) Ocean Development & International Law 141, 152ff.

[876] *The Maritime Harmony* [1982] 2 Lloyd's Rep 400, 406.

[877] Aristotelis Komianos, 'Autonomous Shipping Era: Operational, Regulatory, and Quality Challenges' (2018) 12(2) The International Journal on Marine Navigation and Safety of Sea Transportation 335, 342.

[878] 'CMI IWG Questionnaire on "Unmanned Ships" – AEDM Response' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-SPAIN.pdf> accessed 07 February 2023.

equipment fixed to the ship transmitting the ship's vicinity to those "navigating" the ship from the shore?'

The Irish,[879] Italian[880] and Maltese[881] MLAs answered the question in the negative stating that as interpreted under their national laws, Rule 5 requires presence of human look-outs on board the vessel. Similarly, the Singaporean MLA was also of the view that the traditional understanding of maintaining a proper look-out under Rule 5 requires that a human look-out be placed on board the vessel in accordance with the STCW Convention, and that the issue requires further technical discussions at IMO. The American MLA stated that 'the [US] law has also been uniform to the effect that technology such as radar/ARPA cannot substitute for a human lookout', but it is nevertheless possible that 'a sufficiently sophisticated on-board system that would enable "sight and hearing" for a remote human controller equivalent to that which could be attained by a lookout stationed on the bridge and/or bow of the vessel would be satisfactory under Rule 5.'[882] The British MLA opined that although the issue is yet to come before the court, Rule 5 makes reference to 'sight and hearing' which suggests that 'human perception is required' but does not specify that this must be provided by persons on board the ship.[883] According to the German MLA, the requirement to maintain a proper look-out in Rule 5 in German case law has been held to refer to the respective 'perception of the individual(s) designated to maintain lookout' and thus, 'a fully autonomous vessel does not seem to satisfy the criteria

[879] 'Replies of Irish Maritime Law Association' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-IRELAND.pdf> accessed 07 February 2023.

[880] 'CMI Questionnaire on Unmanned Ships' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-ITALY.pdf> accessed 07 February 2023.

[881] 'CMI Questionnaire' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-MALTA.pdf> accessed 07 February 2023.

[882] 'Response of MLA to CMI Questionnaire re Unmanned Ships' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-US.pdf> accessed 07 February 2023.

[883] 'CMI Questionnaire: UNMANNED SHIPS' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-UK.pdf> accessed 07 February 2023.

of Rule 5.'[884] The Indian[885] and Japanese[886] MLAs were of the view that although the duty of look-out may be performed by a remote controller through visual and aural sensors on board a MASS Degree 3, it is desirable to revise COLREGs and clarify the point as COLREGs were not designed to apply to MASS.

Noting that the above question was asked only in the context of remotely-controlled vessels (MASS Degree 3), it is clear that several States may well be of the view that autonomous operation of a MASS Degree 4 would be a clear breach of Rule 5 as interpreted under their national laws. In fact, considering the framework of the international maritime law as a whole, and interpreting international regulations in accordance with the Vienna Convention on the Law of Treaties, lead one to the conclusion that the current international maritime conventions and regulations have been adopted and ratified to be applied to the conventional manned vessels. For instance, the STCW Convention requires the officer of the navigational watch to be 'physically present' on the navigating bridge 'at all times'.[887] SOLAS also requires ships of 500 gross tonnage and upwards to have two independent means for 'communicating orders' from the physical navigation bridge to the position from which the engines are normally controlled.[888] This SOLAS requirement clearly excludes possibility of an 'electronic bridge' as it presupposes physical presence of the ship's crew members on the navigation bridge as well as the machinery space. In line with the two above-mentioned conventions, the reference to 'sight and hearing' in COLREGs should also be read to mean that the look-out obligation must be discharged by crew members on board the vessel. This view is supported by Article 31(1) of the Vienna Convention requiring that a treaty must be interpreted 'in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' There is no doubt that the 'ordinary' meaning of the term 'sight and hearing' is the ability of 'humans' to use their eyes and ears rather than the ability of cameras and aural sensors to detect objects and sounds. Pursuant to the Vienna Convention, special meaning can be given to a term of a treaty

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[884] 'CMI IWG Questionnaire "Unmanned Ships" — DVIS response' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-GERMANY.pdf> accessed 07 February 2023.

[885] 'CMI Questionnaire on Unmanned Ships' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-INDIA.pdf> accessed 07 February 2023.

[886] 'CMI Questionnaire on Unmanned Ships' – available at <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-JAPAN.pdf> accessed 07 February 2023.

[887] Chapter VIII, Regulation VIII/2(2.1).

[888] Chapter II-I, Regulation 37.

only if there is evidence that the state parties to the treaty so intended[889] and there is no evidence to indicate that the state parties to COLREGs intended to give the term 'sight and hearing' any special meaning. There are also some cases where the courts have decided that the use of electronic navigational equipment such as radar does not obviate the necessity to use an independent human look-out on the bridge.[890] Considering Rule 5 as the 'most problematic' Rule of COLREGs and arguing that a fully autonomous electronic look-out system has so far never come before courts, the MUNIN research project also took the view that Rule 5 does require a human look-out who is capable of sight and hearing.[891]

The importance of clarifying this issue goes beyond purely academic as breach of COLREGs constitutes a criminal offence in some states. For example, under the UK Merchant Shipping (Distress Signals and Prevention of Collisions) Regulations 1996, where 'any' Rule of COLREGs is contravened, the 'owner' of the vessel, the 'master' and any 'person' for the time being responsible for the conduct of the vessel will each be guilty of an offence punishable by imprisonment and a fine.[892] If a proper look-out by sight and hearing means that the look-out duties must be performed by a human who is physically present on board the vessel, then the owner of a MASS (in case of MASS Degree 4) and the remote operator (in case of MASS Degree 3) may face criminal liability for failing to comply with Rule 5. The uncertainty, therefore, may deter potential owners and operators from purchasing or operating MASS Degree 3 or 4 even if such vessels are safer than conventional vessels. Such uncertainty and deterrence would delay or curtail the benefits of MASS operations. Thus, if MASS prove that they can avoid collisions by maintaining a safe look-out, then the best way of dispelling the uncertainty will be 'amending' the COLREGs rather than developing interpretations. If a MASS Degree 3 or 4 can indeed avoid collisions by maintaining a safe look-out, then any breach of Rule 5 is only technical which will only require an amendment to the Rule.[893] Attention should, therefore, be focused on how safe an 'electronic look-out' might be when compared to a human look-out; and if MASS are safe to operate, then the required level of amendment should be determined.

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[889] The Vienna Convention on the Law of Treaties, Article 31 (4).

[890] See, for example, the judgment of the US Court of Appeals for the Fifth Circuit in *Tokio Marine & Fire Insurance v. FLORA MV* 235 F.3d 963 (5th Cir. 2001).

[891] European Commission, 'MUNIN, D9.3: Quantitative Assessment' (2015) page 67 – available at <http://www.unmanned-ship.org/munin/wp-content/uploads/2015/10/MUNIN-D9-3-Quantitative-assessment-CML-final.pdf> accessed 07 February 2023.

[892] Regulation 6.

[893] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 326.

4.5.2. Electronic Look-out vis-à-vis Human Look-out

A proper look-out under Rule 5 must be maintained by:

a) sight; and
b) hearing; and
c) all available means appropriate in the prevailing circumstances and conditions.

Collective capability of MASS to comply with these requirements with reference to the latest advancements in the technology will be assessed below. Currently, MASS Degrees 3 and 4 use 360-degree cameras and other equipment such as LIDAR to create a very accurate view of the vicinity of the MASS and avoid dangers accordingly. *The Mayflower*, for example, uses 6 AI-powered on-board cameras to provide visual input to a computer vision system which identifies hazards like vessels and even partially submerged shipping containers floating in the water.[894] It is set to cross the Atlantic Ocean again, but this time with a new 'AI Captain' that will navigate the vessel across the ocean.[895] Further, in the deployment of the world's first urban autonomous vessels which started on the canals of Amsterdam in November 2021, some autonomous vessels cleverly called 'roboats' use LIDAR (light detecting and ranging) and cameras to enable a 360-degree view.[896] These versatile autonomous vessels are used to carry people and goods, collect garbage from residents on the shore, and perform surveys of canal infrastructure and water quality.[897] Another example is Singapore's first commercial autonomous tug, *The IntelliTug*, which is the product of a collaboration between the technology provider Wartsila, the classification society Lloyd's Register and the Maritime and Port Authority of Singapore. The vessel, which is equipped with sensors, cameras and autonomous navigation systems, demonstrated the capabilities to avoid both virtual and real-life moving obstacles.[898] The fact that these vessels navigate the busy waters of Amsterdam and

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[894] 'A Ship without a Human Captain or Crew' <https://mas400.com/technology> accessed 07 February 2023.

[895] 'Silicon Sensing participates in Mayflower Autonomous Ship Quest' (*Marine Technology News*, 14 March 2022) <https://www.marinetechnologynews.com/news/silicon-sensing-participates-mayflower-618063#:~:text=The%20Mayflower%20Autonomous%20Ship%20(MAS,captain'%20that%20guides%20the%20vessel.> accessed 07 February 2023.

[896] 'Roboat ready for self-driving pilots on the Amsterdam Canals' (*AMS*, 27 Oct 2021) <https://www.ams-institute.org/news/roboat-ready-self-driving-pilots-amsterdam-canals/> accessed 07 February 2023.

[897] Carl Franzen, 'Autonomous Boats Are Using Lidar to Traverse the Canals of Amsterdam' (*Ground Truth*, 06 January 2022) <https://groundtruthautonomy.com/robotics/autonomous-boats-are-using-lidar-to-traverse-the-canals-of-amsterdam/> accessed 07 February 2023.

[898] Maritime and Port Authority of Singapore, 'Keynote Speech by Ms Quah Ley Hoon, Chief Executive, Maritime and Port Authority of Singapore at the 2nd International Ship Autonomy and Sustainability Summit' (30 November 2020) <https://www.mpa.gov.sg/web/portal/home/media-centre/news-releases/detail/f946dba5-ec9d-477d-b677-ae4f3544dc1d> accessed 07 February 2023.

Singapore safely and autonomously while avoiding other human-navigated boats and other fixed or floating objects, indicates that the autonomous vessel technology is potentially capable of maintaining a proper look out and ultimately to avoid collisions.

There are, nevertheless, some exceptional situations where a competent human look-out may be able to outperform his or her electronic counterpart. For instance, while an electronic look-out system can detect a small floating object in the screen of its radar or LIDAR, there is no evidence to show that the system is able to discern whether the target is an inanimate object (e.g. a floating log) or a human being who is swimming or seeking help in the water. If so, and if the system concludes that the relatively small size of the object poses no threat to the safety of the MASS and navigates on with the same course and speed, then MASS Degree 4 can potentially pose a danger to the life of a person who happens to be in their way. Besides, it has been confirmed that vessel-strikes pose a serious threat to the conservation status of some species of marine mammals and may even jeopardise the very survival of certain species.[899] Proliferation of MASS Degree 4 and their inability to detect such marine mammals without national and/or international mitigation strategies can exacerbate the situation and lead to the extinction of some of those species. At present, the *Sea Hunter* which is one of the (if not the) most advanced MASS Degree 4 vessels in the world, does not have the ability to perceive and understand COLREGs-defined lights or shapes of other vessels around it.[900] In fact, because of their weak radar reflectivity and surrounding noise, small objects such as marine buoys and wooden fishing boats may not even be detected by a single visual sensor.[901]

The second element of a proper look-out is 'hearing'. There are a few reasons behind the requirement to keep an aural watch. First, by constant listening, the vessel will be able to hear different sound signals of other vessels in the vicinity that may be trying to communicate a message. For instance, a vessel which is navigating in or near an area of restricted visibility, must sound a particular fog signal depending on the type of the vessel.[902] Also, when a vessel fails to understand the intentions or actions of another vessel which is in sight, or when it is in doubt whether the other vessel is taking sufficient

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[899] Richard Caddell, 'Shipping and the Conservation of Marine Biodiversity: Legal Responses to Vessel-Strikes of Marine Mammals' in: Richard Caddell (ed) and Rhidian Thomas (ed), *Shipping, Law and the Marine Environment in the 21st Century: Emerging Challenges for the Law of the Sea – Legal Implications and Liabilities* (Lawtext Publishing 2013) 107.

[900] 'DARPA Christens (Mostly) Autonomous Vessel' (*The Maritime Executive*, 19 June 2020) <https://www.maritime-executive.com/features/darpa-christens-mostly-autonomous-vessel> accessed 07 February 2023.

[901] Dalei Qiao, Guangzhong Liu, Taizhi Lv, Wei Li and Juan Zhang, 'Marine Vision-Based Situational Awareness Using Discriminative Deep Learning: A Survey' (2021) 9(4) Journal of Marine Science and Engineering 397, 399.

[902] As required by COLREGs, Rule 35.

action to avoid collision, then it must indicate its doubt by giving at least five short and rapid blasts on the whistle.[903] By listening and understanding the sound signals in the vicinity, the vessel will be able to take the appropriate action accordingly. Second, by keeping a listening watch on VHF channel 16, the look-out will also have a general understanding of the VHF conversations between different vessels and/or persons in the area as well as receiving any spoken Mayday message and acting on the message if necessary. Again, MASS Degree 4 are currently unable to detect and understand sound signals from other vessels or people;[904] not even *The Sea Hunter*.[905] Operation of a MASS Degree 4 in spite of this inability may be seen as a violation of Rule 5.

The third element of a proper look-out is the use of 'all available means' which are appropriate in the prevailing circumstances and conditions. For vessels so fitted, the term 'all available means' includes radar, sonar, infrared or electro-optical sensors, AIS receiving equipment, and sound detection and amplification equipment.[906] MASS can obviously use such available means to maintain a look-out. A proper look-out, however, may also necessitate seeking help and advice from the port authorities. In *The Nordic Ferry*, where the radars of a vessel which was leaving the port of Ipswich became completely ineffective in dense fog, Sheen J suggested that the vessel should have sought advice from the fog watch pilot on duty in the harbour because this would have been better than navigating the vessel without assistance and proceeding down the channel on the wrong side.[907] MASS Degree 4 currently are not capable of communicating with and seeking advice from port authorities.

It is clear from the foregoing paragraphs that although various equipment and sensors on MASS Degree 4 can use 'all available means' to detect vessels and objects around the MASS, they are not currently capable of receiving and understanding all visual and aural data in the environment and the MASS therefore is not capable of complying with the 'sight and hearing' elements of Rule 5 in all possible situations. The question then arises as to whether MASS Degree 4 should be exempt from complying with the 'sight and hearing' obligations.

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903 COLREGs, Rule 34(d).

904 'Autonomous and Remotely Operated Ships' (*DNV*, September 2018) page 51 <https://rules.dnv.com/docs/pdf/DNV/cg/2018-09/dnvgl-cg-0264.pdf> accessed 07 February 2023.

905 'DARPA Christens (Mostly) Autonomous Vessel' (*The Maritime Executive*, 19 June 2020) <https://www.maritime-executive.com/features/darpa-christens-mostly-autonomous-vessel> accessed 07 February 2023.

906 Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 113.

907 [1991] 2 Lloyd's Rep 591, 596.

4.5.3. Amendment to Rule 5

The US Navigation Safety Advisory Council (NAVSAC) has proposed that in order to address the issue, Rule 5 should be amended to read:

> 'Every manned 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.'[908]

This proposed amendment has also been supported by some commentators.[909] The addition of the qualifier 'manned' before the word 'vessel' in the NAVSAC recommendation would, in effect, relieve MASS Degree 3 or 4 from any look-out requirement as it would make the lookout duties compulsory for 'manned' vessels only. One could argue that such an amendment would not cause any safety issues because the purpose of a proper lookout is simply to make a full appraisal of 'the risk of collision'[910] and Rule 7 imposes the same duty on 'every vessel' to use all available means to determine if 'risk of collision' exists. And because the text of Rule 7 explicitly states that the duty applies to 'every vessel', MASS would still have to comply with Rule 7.[911] That is to say, MASS would have to use 'all available means' such as electronic equipment to determine if 'risk of collision' exists without having to comply with the 'sight and hearing' requirement to determine the risk.

However, the purpose of Rule 5 is not just determining if there is a risk of collision – the other purpose is to make a full appraisal 'of the situation'.[912] As the Admiralty Court has clarified in different cases, the term 'look-out' means not only visual and aural look-out, but also appreciation of 'what is taking place' in the wider sense.[913] For example, sometimes a visual and/or aural watch is required no to avoid collision with other vessels

[908] 'UUV Manufacturers' Concerns Regarding NAVSAC Task 08-07, Resolution 11-02 Proposed Changes to Inland and COLREGS to Address Unmanned Underwater and Unmanned Surface Vehicles' <https://www.regulations.gov/document/USCG-2012-0212-0004> accessed 07 February 2023.

[909] See, for example, Christopher C. Swain, 'Towards Greater Certainty for Unmanned Navigation, a Recommended United States Military Perspective on Application of the "Rules of the Road" to Unmanned Maritime Systems' (2018) 3(1) Georgetown Law Technology Review 119, 141.

[910] As required by Rule 5.

[911] Craig H Allen, 'The Seabots are ~~Coming~~ Here: Should they be Treated as 'Vessels'?' (2012) 65(4) The Journal of Navigation 749, 751.

[912] COLREGs, Rule 5.

[913] See, for example, *The Santander* [1966] 2 Lloyd's Rep 77, 82 and *The Golden Polydinamos* [1993] 2 Lloyd's Rep 464, 477.

but to avoid causing injury to a person in the water. In *Schumacher v Cooper*,[914] the operator of a boat who was listening to loud music could not hear the yells of a swimmer in the water who was then hit and injured by the boat. The US District Court for the District of South Carolina found the boat operator liable for the injury as he violated Rule 5 and failed to hear the yells of the swimmer. Another purpose of a proper look-out is an appreciation of not only what is taking place around the vessel, but also what is happening on board the vessel itself. In other words, a proper look-out must be both external and internal. By 'sight and hearing', the OOW will be able to notice if any equipment on board the vessel starts malfunctioning or stops working and take a proactive action. For example, a vigilant look-out may notice an outbreak of a small fire on deck well before any fire alarm is activated and this will enable the vessel's crew to extinguish the fire before it spreads or gets out of control. An autonomous look-out system, therefore, should constantly be monitoring and analysing not only the external situation around the MASS, but also the internal circumstances on board the MASS. As another example, a proper look-out includes checking the vessel's navigational equipment and ensuring that it is functioning as it should. In *The Staffordshire*, the Admiralty Court held that failing to appreciate that the ship's compass had stuck (and as a result, the vessel had fallen off to starboard), constituted a 'bad lookout'.[915] The Admiralty Court has reached the same conclusions in several cases ever since.[916] The UK Maritime and Coastguard Agency also advises watchkeepers to regularly check the performance of navigational equipment such as radar and highlights the need to cross-check the vessel's position using other available means.[917]

Furthermore, since the state of the visibility is one of the most important factors in determining a vessel's safe speed,[918] monitoring the weather conditions is another aspect of a proper look-out. If visibility deteriorates, then vessels not in sight of one another and navigating in or near an area of restricted visibility must comply with Section III (instead of Section II) of COLREGs. A proper look out may also necessitate seeking help and advice from the port authorities. In *The Nordic Ferry*, where the radars of a vessel which was leaving the port of Ipswich became completely ineffective in dense fog, Sheen J

[914] 850 F. Supp. 438 (D.S.C. 1994).

[915] (1948) Ll L Rep 141, 145.

[916] For example, *The Anna Salem* [1954] 1 Lloyd's Rep 475; *The Chusan* [1955] 2 Lloyd's Rep 685; *The Esso Plymouth* [1955] 1 Lloyd's Rep 429.

[917] MCA, 'MGN 379 (M+F): Navigation: Use of Electronic Navigation Aids' (20 September 2019) – available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833107/MGN_379.pdf> accessed 07 February 2023.

[918] As required by Rule 6 of COLREGs.

suggested that the vessel should have sought advice from the fog watch pilot on duty in the harbour because this would have been better than navigating the vessel without assistance and proceeding down the channel on the wrong side.[919] An all-encompassing look-out can also protect safety of life at sea because a listening watch allows the OOW to hear and identify various distress signals that may be communicated via VHF channel 70, MF/HF frequencies or other recognised methods.[920] Although it is still not clear whether MASS Degree 3 or 4 are or should be obliged to render assistance to persons in distress at sea under SOLAS,[921] such vessels can at the very least relay the distress signal to the relevant Rescue Co-ordination Centre (RCC) that is designated by the IMO for the geographical area in question. A proper look-out by 'sight and hearing' can also help prevent or minimise damage to the marine environment. An observant look-out can spot a trail of oil pollution in the vessel's wake and inform the engine room crew to address the issue.

The upshot, therefore, is that preventing collisions is just one aim of the COLREGs and, in particular, the look-out obligations. The overall aim of adopting the COLREGs was to maintain a high level of 'safety' at sea[922] and thus, restricting the purpose of the 'sight and hearing' obligation to merely avoidance of 'collision' will compromise safety of life and safety of the environment. For the reasons set out above, it is submitted that exempting MASS Degree 4 from 'sight and hearing' duties as suggested by the NAVSAC is likely to compromise safety of life and environment. The question then arises as to whether MASS Degree 4 should ever be permitted to operate if they are not capable of maintaining a proper look-out by 'sight and hearing' and if they are not expressly exempt from the obligation by an amendment to Rule 5.

4.5.4. The way forward

The current shortcomings of MASS Degree 4 to comply with Rule 5 include their inability to detect small targets; to distinguish a small inanimate object from a human being; to perceive lights and shapes of other vessels; to understand the meaning of sound signals; and to communicate with human beings on other vessels or ashore. A basic risk-benefit analysis, however, suggests that these shortcomings should be no bar to the operation of MASS Degree 4 due to the following reasons.

First, as observed in Chapter 3, the most common cause of maritime collisions is lack of a proper human look-out which may be a result of fatigue, distraction, apathy and so on.

[919] [1991] 2 Lloyd's Rep 591, 596.

[920] The list of recognised distress signals can be found in Annex VI of COLREGs.

[921] Chapter V, Regulation 33(1).

[922] As stated in the preamble of COLREGs.

An electronic look-out system, however, is not susceptible to any of these factors and is, therefore, able to perform the 'visual' element of the look-out duties better than humans in the vast majority of situations. Moreover, night vision cameras, LIDAR and short-range high-resolution radar provide digital vision in conditions where human look-outs are blind.[923]

Second, the aforementioned situation of a person swimming in water is extremely rare in the high seas and very unlikely to happen in coastal waters as warnings are frequently issued about the dangers of swimming in busy shipping lanes[924] and most people do not do so.

Third, the most common causes of mortality and injury to marine mammals have been identified as follows: high maritime traffic density in critical areas; excessive vessel speed in particular habitats; failure to notice the mammals in question; and general ignorance and under-reporting of the problem.[925] The first two issues can be addressed by co-operation of the relevant coastal States and the IMO through, for example, vessel routing measures and speed restriction regulations.[926] The third factor can be minimised by utilising LIDAR and requiring the control mode of MASS Degree 4 to be switched over from MASS Degree 4 to MASS Degree 3 in certain areas that are known to be critical habitat for marine mammals. The forth issue may also be addressed through vessel reporting measures.[927] Since most of the areas that are both critical habitats for marine mammals and are likely to be adversely affected by vessel traffic lie within the territorial sea and the EEZ of coastal States, the regulation and application of routeing measures should be given a higher priority in coastal waters than on the high seas.[928]

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[923] 'Extending Crews' Senses with Automation' (*Lloyd's List*, 15 March 2021) <https://lloydslist.maritimeintelligence.informa.com/LL1136060/Extending-crews-senses-with-automation> accessed 07 February 2023.

[924] See, for example, Sarah Elmes, 'Wild Swimmers Warned to Keep out of Plymouth Shipping Lanes' (*PlymouthLive*, 17 December 2020) <https://www.plymouthherald.co.uk/news/plymouth-news/wild-swimmers-warned-keep-out-4805579> accessed 07 February 2023.

[925] Richard Caddell, 'Shipping and the Conservation of Marine Biodiversity: Legal Responses to Vessel-Strikes of Marine Mammals' in: Richard Caddell (ed) and Rhidian Thomas (ed), *Shipping, Law and the Marine Environment in the 21st Century: Emerging Challenges for the Law of the Sea – Legal Implications and Liabilities* (Lawtext Publishing 2013) 112.

[926] Ibid 124-129.

[927] Ibid 129-131.

[928] Ibid 121.

Fourth, in case of a ‘man overboard’, the crew of the relevant vessel or other vessels in the vicinity will immediately start a search and rescue operation to recover the person in the water and the possibility of a MASS Degree 4 hitting that person is thus minimal.

Fifth, as demonstrated in Chapter 3, if MASS Degree 4 are required to keep out of the way of other vessels and take early action, then their inability to perceive other vessels’ lights and shapes become irrelevant. In other words, as soon as a MASS Degree 4 detects a target by its radar, AIS or cameras and if risk of collision exists, then it should take the appropriate avoiding action regardless of whether it can ‘see’ or ‘understand’ the lights of that target. In fact, there are very few situations in which a MASS Degree 4 may be a stand-on vessel[929] and even then, the MASS Degree 4 may eventually have to take avoiding action if the give-way vessel does not do so.[930]

Finally, as discussed earlier, good seamanship would mean that the control mode of a MASS Degree 4 should be switched over from MASS Degree 4 to MASS Degree 3 (or at least supervised) in congested or coastal waters. This means that the remote operator or supervisor will be able to (remotely) see the environment around the MASS and take the required action if a person does appear in the waters ahead of the MASS, or if there are lights and/or shapes that the MASS may not be able to understand, or if the remote operator needs to seek help or advice from the port authorities. Moreover, visual perception of the marine environment is still a new area of research and it is likely that future research will greatly improve visual perception of a MASS Degree 4 of its surrounding environment. For example, multi-modal fusion e.g. fusing data provided by a monocular vision technology with data provided by a LIDAR sensor will significantly increase the perception capability of MASS Degree 4 navigational systems.[931]

As to verbal communications, the attitude of the courts towards the use of VHF has fluctuated over the years between approving the use of radiotelephone communications as a useful tool for collision avoidance and criticising it as a source of distraction, confusion and misunderstanding, and a review of relevant cases lends support to both views.[932] For instance, in *The Bovenkerk*, the Admiralty Court found that a vessel was at fault for ‘bad look-out in the broadest sense; namely, faulty appreciation of V.H.F.

[929] Under Rule 18.

[930] For example, under COLREGs, Rule 17(b).

[931] Dalei Qiao, Guangzhong Liu, Taizhi Lv, Wei Li and Juan Zhang, ‘Marine Vision-Based Situational Awareness Using Discriminative Deep Learning: A Survey’ (2021) 9(4) Journal of Marine Science and Engineering 397, 410.

[932] Craig H Allen Sr and Craig H Allen Jr, *Farwell’s Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 128.

information and total absence of radar look-out.'[933] In contrast, in *Aleksandr Marinesko and Quint Star*, the Admiralty Court emphasised that 'vessels should be navigated in accordance with the Collision Regulations and not by agreement on the VHF.'[934] The risks associated with the use of VHF are that, it is currently impossible to identify the vessel calling or answering a VHF call; there may be language difficulties depending on the nationalities of the watch officers involved; and precious time may be wasted trying to contact another vessel instead of taking avoiding action. Moreover, only ships of 300 gross tonnage and upwards are required to carry VHF radiotelephone apparatus under international regulations[935] and thus, not all vessels will have VHF on board. Carriage and use of VHF radiotelephone, however, is compulsory for certain vessels navigating in the territorial waters of the United States. For example, watch officers must, when necessary, transmit and confirm the intentions of their vessels and any other information necessary for the safe navigation of vessels.[936] The US inland version of COLREGs also permits vessels to reach a passing agreement in a head-on, crossing, or overtaking situation by using the radiotelephone as prescribed by the Vessel Bridge-to-Bridge Radiotelephone Act.[937] Although there is no similar express provision under UK legislation or regulations, a failure to use the on-board VHF radiotelephone may, under certain circumstances, amount to violation of Rule 5 or 7 of COLREGs that require the use of 'all available means'. In any case, vessels in the open sea very rarely recourse to bridge-to-bridge radiotelephone for collision avoidance as there is sufficient sea room between them for collision avoidance manoeuvres. In busy waters where the use of VHF may become useful or necessary, the control of a MASS Degree 4 can be switched over from MASS Degree 4 to MASS Degree 3 and the remote controller therefore can maintain a VHF listening watch and respond if necessary. The current shortcomings of MASS Degree 4, therefore, are not insurmountable and the benefits of a fully autonomous look-out system greatly outweigh its possible risks. Furthermore, if MASS outnumber the conventional vessels in the future, then the necessity for MASS Degree 4 to be able to understand and communicate with conventional vessels will decrease as technology will enable MASS to communicate with each other electronically rather than verbally or through light or sound signals.

The first step, it is submitted, is that the SOLAS or STCW Convention should clarify that the 'sight and hearing' obligation under Rule 5 can be discharged by remote human look-

[933] [1973] 1 Lloyd's Rep 63, 70.

[934] [1998] 1 Lloyd's Rep 265, 278.

[935] SOLAS, Chapter III, Regulation 6 (2.1.1).

[936] Vessel Bridge-to-Bridge Radiotelephone Regulations (33 CFR 26) § 26.04(b) – available at <https://www.navcen.uscg.gov/pdf/navRules/Insert_Page208.pdf> accessed 07 February 2023.

[937] Inland Rule 34(h).

outs and on-board autonomous electronic systems. There is already a precedent for clarifying and extending the meaning of Rule 5 to cover the use of new technologies. As it was difficult for watch officers in an enclosed bridge or on a high-speed craft to hear or understand the sound signals around the vessel, SOLAS solved the problem by requiring ships with a totally enclosed bridge to be fitted with 'a sound reception system, or other means, to enable the officer in charge of the navigational watch to hear sound signals and determine their direction'.[938] Another example of amendments to IMO instruments to accommodate new technologies is the optional replacement of the watchkeeping crew in the engine room by various sensors and alarms through guidelines and standards which eventually ended up as a new section in SOLAS[939] on 'periodically unattended machinery spaces'.[940] Most large ships today meet the SOLAS requirements for unattended machinery spaces with the effect that their engine crew members can work 'office hours' with the automated systems keeping a watch in the engine room for the remaining 16 hours of the day.[941] Similar provisions can pave the way for the use of cameras and aural sensors on a MASS Degree 4 instead of an on-board look-out, and on a MASS Degree 3 in conjunction with a remote look-out. Such a clarification will go a long way to dispel the uncertainty around the interpretation of Rule 5 and thereby the fear of potential MASS owners and operators of becoming criminally liable for violation of Rule 5. Any proposed amendment to SOLAS must be adopted by a two-thirds majority of the Contracting States present and voting in the Maritime Safety Committee provided that at least one third of the Contracting States are present at the time of voting.[942] The same conditions must also be met for an amendment to the STCW Convention.[943] Given that countries with a large number of seafarers may not find such clarification (which will pave the way for MASS Degrees 3 and 4 operations) in their interest, amending SOLAS or the STCW Convention may prove difficult. However, IMO Member States who support MASS operations can formally pronounce that the 'sight and hearing' obligation may be discharged remotely or autonomously. Even though such an endorsement may take the form of a non-binding government statement or an IMO circular, it can amount to 'subsequent agreement' between the parties regarding the interpretation of Rule 5.[944] Those States can then operate MASS Degree 3 and/or 4 on the high seas with special attention to Rule 2 and

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[938] Regulation V/19.2.1.8.

[939] Chapter II-1, Part E.

[940] Henrik Ringbom, 'Regulating Autonomous Ships—Concepts, Challenges and Precedents' (2019) 50(2-3) Ocean Development & International Law 141, 152.

[941] Ibid.

[942] SOLAS, Article VIII, paragraph b(iv).

[943] STCW Convention, Article XII, paragraph a(iv).

[944] Vienna Convention on the Law of Treaties, Article 31(3)(a).

such operations can constitute 'subsequent practice' in the application of the treaty which establishes the agreement of the parties regarding the interpretation of Rule 5.[945] Thus, even if a formal amendment to SOLAS or the STCW Convention proves to be difficult, subsequent agreements between States and subsequent State practice will clarify the meaning of Rule 5 over time.

Nevertheless, considering the rapid advances in the MASS technology, and given that a customary international rule may take a long time to be established, in the absence of a clarification by the IMO i.e. if the matter is left to be determined by customary international law, there is a danger that the regulatory framework may fall behind and inconsistent standards may develop in different States or by different organisations. The IMO should develop a set of guidelines for the second phase of MASS trials (as discussed above), invites flag States to submit the result of trials, and use the results to determine the standards for the third phase of MASS trials. The IMO could, for example, first develop guidelines for MASS Degree 2 operations and determine the circumstances under which the bridge of a MASS Degree 2 may be left unattended temporarily. Such guidelines would, essentially, pave the way for a 'periodically unattended bridge' and would be similar to the guidelines for 'periodically unattended machinery spaces' under SOLAS. The industry has already taken the initiative to move towards a 'periodically unattended bridge'. ABB, for example, is currently working on a concept of B0 where the bridge of a vessel may be conditionally and periodically unmanned in order to enable more efficient utilisation of the crew members, reduce fatigue, and increases safety.[946] In order to understand the concept of B0, it is necessary to know the number of certified crew members who must be present on the bridge under the current international regulations. Under special circumstances e.g. in areas of high traffic density or in conditions of restricted visibility, SOLAS requires that the officer in charge of the navigational watch (OOW) must have available without delay the services of a qualified helmsperson who shall be ready at all times to take over steering control of the vessel.[947] In addition to a helmsperson, the OWW must also post a proper lookout in conditions of restricted visibility under the STCW Code.[948] ABB categorises the bridge status under such circumstances as B3 since the bridge team comprises at least three certified crew members. In hours of darkness and good weather conditions, the number of bridge team

[945] Ibid Article 31(3)(b).

[946] Captain Eero Lehtovaara and Dr Kalevi Tervo, 'B0 – A Conditionally and Periodically Unmanned Bridge' (*ABB*, 31 May 2019) <https://new.abb.com/news/detail/24651/b0-a-conditionally-and-periodically-unmanned-bridge> accessed 07 February 2023.

[947] Regulation V/24.

[948] Regulation VIII/45.

may be reduced to two, namely, the OOW and a look-out[949] and hence, the bridge status is categorised as B2 by ABB. When certain conditions are met, the OOW may be the sole lookout in daylight hours which is why the bridge status is labelled by ABB as B1 in this situation. ABB is developing the concept of B0 on the basis that where visibility and the weather conditions are good, no vessel is visible with a CPA and TCPA[950] above certain values and so on, then the OOW and the look-out could leave the bridge unmanned.[951] The B0 concept garnered the support of many maritime nations who responded to a questionnaire that was sent to more than 60 States during the MUNIN project and agreed that bridge crews on certain vessels in the future could only work during daylight hours similar to engine crews on some vessels today.[952]

Although the B0 concept is a great intermediate step towards actualisation of MASS Degrees 3 and 4, the required conditions for a B0 status as described by ABB are rather general and lack detail. Even if ABB determines the conditions in greater detail in the future, such conditions should still be determined by the IMO for two reasons. First, guidelines adopted by the IMO (which is the international regulatory body) are more likely to be followed by different vessels flying the flag of different States and thereby harmonising the practice around the world. Second, in the interests of safety, determining, updating and finalising the prerequisites for a B0 status need to be based on factual data derived from MASS trials in real sea conditions over a long period of time. The concept of 'periodically unattended machinery spaces' was discussed at the IMO in the mid-1960s and took about two decades to be finally introduced into SOLAS in 1988.[953] Gathering and analysing data achieved through MASS trials on such a large scale and over a potentially long time, and subsequently developing guidelines expected to be followed world-wide can only be achievable by the IMO.

In summary, there is currently no factual reason to assume that a MASS Degree 3 or 4 will be a less reliable vessel for the flag state to comply with the COLREGs than traditional

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[949] The STCW Code, Regulation VIII/46.

[950] Time to closest point of approach.

[951] Captain Eero Lehtovaara and Dr Kalevi Tervo, 'B0 – A Conditionally and Periodically Unmanned Bridge' (*ABB*, 31 May 2019) <https://new.abb.com/news/detail/24651/b0-a-conditionally-and-periodically-unmanned-bridge> accessed 07 February 2023.

[952] MUNIN, 'D9.2: Qualitative Assessment' (2015) para 4.2.2.4. – available at <http://www.unmanned-ship.org/munin/wp-content/uploads/2015/10/MUNIN-D9-2-Qualitative-assessment-CML-final.pdf> accessed 07 February 2023.

[953] Henrik Ringbom, 'Regulating Autonomous Ships—Concepts, Challenges and Precedents' (2019) 50(2-3) Ocean Development & International Law 141, 152.

manned vessels.[954] In fact, various projects such as MUNIN have demonstrated that MASS Degrees 3 and 4 can operate at least as safely as conventional manned vessels. The MUNIN questionnaire that was sent to more than 60 States, asked, *inter alia*, whether the human look-out could be replaced with 24/7 autonomous look-out systems, and none of the States answered the question in the negative.[955] About three quarters of the participants of the survey stated that electronic sensors can work as well as or better than a human look-out and that they may take over the human look-out function if proven to work reliably.[956] Furthermore, circumstances where an autonomous look-out system cannot currently substitute a human look-out are rare and can be dealt with by switching over the control of the vessel from MASS Degree 4 to MASS Degree 3 in congested waters, for example. MASS owners and operators will have to do so under Rule 2(a) even if there is no regulatory provision to that effect. Making an amendment to Rule 5 similar to the one suggested by the NAVSAC, would exempt MASS Degree 4 from 'sight and hearing' obligations which, as noted above, can threaten safety at sea under certain circumstances. Moreover, such an exemption is likely to stifle potential advances in fully autonomous look-out systems. However, if the 'sight and hearing' obligations are kept in force and clarified by the IMO to be applicable to all vessels including MASS, then MASS owners will be able to carry out a risk-benefit analysis and decide whether the autonomous look-out system on their MASS can comply with the 'sight and hearing' duties to a reasonable degree. Such risk analysis and decision can be made during the second and the third phase of MASS trials and tests that were discussed in the preceding sections.

4.6. MASS and Restricted Visibility

Restricted visibility at sea poses a great threat to vessels as well as the persons and/or cargo on board vessels. However, although fog has been labelled as the ancient terror of mariners, the advent of electronic navigational equipment such as radar, AIS and GPS has ameliorated some of that terror.[957] Conduct of vessels in restricted visibility is governed by Rule 19 which applies to vessels 'not in sight of one another when navigating

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954 Oliver Daum and Timo Stellpflug, 'The Implications of International Law on Unmanned Merchant Vessels' (2017) 23(5) Journal of International Maritime Law 363, 372.

955 MUNIN, 'D9.2: Qualitative Assessment' (2015) para 3.2. – available at <http://www.unmanned-ship.org/munin/wp-content/uploads/2015/10/MUNIN-D9-2-Qualitative-assessment-CML-final.pdf> accessed 07 February 2023.

956 Ibid.

957 Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 365.

in or near an area of restricted visibility'.[958] The Rule applies to all vessels even if there is no risk of collision,[959] and in most cases of collision in fog, one or both of the vessels are cited for proceeding at an excessive speed.[960]

Rule 19, however, has been the source of confusion for some seafarers for a long time as different provisions of this Rule apply in different situations. Paragraphs (b) and (c) apply to all vessels navigating in or near an area of restricted visibility even if they are in sight of one another. Paragraphs (d) and (e), however, apply to vessels navigating in or near an area of restricted visibility only if they are not in sight of one another. It follows that three conditions must be met for Rule 19(d) and (e) to be applicable:

1) vessels must be 'navigating';
2) vessels must be 'in or near' an area of restricted visibility; and
3) vessels must 'not be in sight' of one another.

4.6.1. Vessels Must be 'Navigating'

COLREGs do not provide a definition of navigating. However, it is reasonable to conclude that a vessel must be 'underway'[961] before it can be deemed to be navigating within the meaning of Rule 19(a).[962] A vessel which is underway but not making way through the water is, nevertheless, required to comply with the Steering and Sailing Rules as this point has been clarified by the MSC as follows: 'When applying the definition of the term "underway" mariners should also have regard to Rule 35(b) where it is indicated that a vessel may be underway but stopped and making no way through the water.'[963] It seems, therefore, that the only condition for a vessel to be deemed as 'navigating' under Rule 19 (a) is that it must be 'underway' i.e. it must not be at anchor, or made fast to the shore, or aground.[964] For MASS Degrees 1, 2 and 3, it is straightforward for the on-board or remote watch officer to determine whether the vessel is navigating or not. As to MASS Degree 4, the vessel can be programmed such that it knows whether it is navigating (e.g. its engines are operating) or not (e.g. it is made fast to the shore).

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958 COLREGs, Rule 19(a).

959 *The Da Ye* [1993] 1 Lloyd's Rep 30, 38.

960 BA Fransworth, Larry C Young and Steven D Browne, *Nautical Rules of the Road* (4th edn, Cornell Maritime Press 2010) 55.

961 COLREGs, Rule 3(i).

962 Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 374.

963 AN Cockcroft and JNF Lameijer, *A Guide to the Collision Avoidance Rules* (7th edn, Butterworth Heinemann 2012) 9.

964 As defined by Rule 3(i).

4.6.2. Vessels Must be 'in or Near' an Area of Restricted Visibility

COLREGs provide a rather circular definition for the term 'restricted visibility' and defines it as 'any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms or any other similar causes.'[965] Visibility is a measure of the transparency of the atmosphere and may be defined as 'the greatest horizontal distance at which an object of specified characteristics can be seen by a person of normal vision under conditions of average daylight illumination'.[966] COLREGs do not quantify the term 'restricted' i.e. there is no provision as to how restricted the visibility must be in order for vessels to start to comply with Rule 19. However, it is clear that 'restricted' visibility must surely lie somewhere between perfect visibility and the kind of thick fog that obscures the jackstaff.[967]

It seems that there are good reasons for the omission of such quantification. Perfect visibility is when there are no suspended particles in the air and visibility through the atmosphere is about 130 nautical miles.[968] However, in order to avoid collision, watch officers do not need to see vessels 130 nautical miles away, nor would they ever be able to do so with naked eyes even if they needed to do so. But at the very least, the vessel needs to be able to see as far away as it would offer sufficient sea room and time to the vessel in order to perform a safe collision avoidance manoeuvre. An action to avoid collision may be an alteration of course, or speed, or a combination of both. However, every vessel has different manoeuvring characteristics depending on its size, hull shape, speed and loading conditions. Two paramount manoeuvring capabilities of a vessel are its 'stopping distance' and 'turning ability' which are important factors in determining the vessel's safe speed under COLREGs.[969] The minimum distance that a vessel needs to come to rest over the ground is called the stopping distance of that vessel.[970] The higher the weight and/or speed of the vessel, the greater its stopping distance will be due to higher inertia. As a typical example, for an oil tanker of 220,000 tonnes of deadweight travelling at a full speed of 10 knots, from the moment its telegraph is put from full ahead to the stop position (known as inertia stop manoeuvre), it may continue to travel for about

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[965] Rule 3(l).

[966] The Met Office, *Meteorology for Mariners* (3rd edn, Met Office 1978) 59.

[967] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 376.

[968] Captain H Subramaniam, *Marine Meteorology* (3rd edn, Vijaya Publications 2002) 27.

[969] Rule 6(a)(iii).

[970] David J House, *Seamanship Techniques: Shipboard and Marine Operations* (5th edn, Routledge 2019) 667.

4.5 nautical miles before it comes to a full stop.[971] In contrast, for a medium-sized ship of a deadweight of 18,000 tonnes travelling at a full speed of 15 knots, from the moment the telegraph is put from full ahead to full astern (known as crash stop manoeuvre), the ship will take about 10 minutes and 10 cables[972] to come to rest.[973] Another manoeuvring characteristic of a vessel is its 'advance' which is the distance travelled by the vessel in the direction of the original course from starting the turn to completing the turn.[974] For instance, a container ship with a deadweight of about 20,000 tonnes (normal ballast condition) and proceeding at about 24 knots, when its rudder is turned hard a-starboard, will travel about 0.5 nautical miles ahead before its turn is completed.[975]

It is, therefore, obvious that vessels with a greater stopping distance and/or advance will need more sea room around themselves to perform a safe collision-avoidance manoeuvre. To allow for a safety margin, a large oil tanker with a stopping distance of 5 nautical miles, should be able to visually see vessels which are, for example, 7 nautical miles away. Thus, if meteorological visibility drops below 7 nautical miles, then the oil tanker may treat it as 'restricted' visibility simply because it cannot visually see the full area of water within which it can complete its collision avoidance manoeuvres. By way of contrast, a small and manoeuvrable boat with a stopping distance of 0.5 nautical miles may well not treat the same meteorological visibility as 'restricted' as it can visually see the full area of water within which it may perform its collision avoidance manoeuvres. For such a boat, 'restricted' may mean 2 or 3 nautical miles depending on the prevailing circumstances. It is submitted, therefore, that the term 'restricted' is a relative term that depends on manoeuvring characteristics of the vessel concerned and that is why it has not been quantified in COLREGs. The upshot, therefore, is that the boundary of restricted visibility cannot be determined by formula or by any law and that watch officers on different vessels will make different judgements based on their own observations.[976]

The term 'restricted' may, nevertheless, be approximately quantified for large vessels i.e. vessels of 50 metres or more in length. COLREGs require that the masthead light of such

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[971] 'Stopping Distance, Turning Circle, Ships Manoeuvring' (*Knowledge of Sea*, 02 January 2020) <https://knowledgeofsea.com/stopping-distance-turning-circle-ships-manoeuvring/> accessed 07 February 2023.

[972] 'Cable' is a unit of length of 200 yards or approximately a tenth of a nautical mile i.e. 183 metres.

[973] David J House, *Seamanship Techniques: Shipboard and Marine Operations* (5th edn, Routledge 2019) 668.

[974] Ibid 685.

[975] Ibid 686.

[976] William P Crawford, *Mariner's Rules of the Road* (Norton & Co 1983) 100.

vessels must be visible at a minimum range of 6 miles.[977] This COLREGs provision suggests that as a general rule of thumb, large vessels may treat a meteorological visibility of less than 6 miles as restricted visibility. In practice, visibility of less than 5 miles should cause enough concern to at least put the engine spaces on alert and test the vessel's navigation lights even though it would not warrant the sounding of fog signals.[978] Determining the range of visibility during the daytime can be carried out by radar. The range at which a radar target can first be seen with naked eyes is the range of visibility for the present meteorological conditions in that area. If the range is less than 5 miles, then prudent watch officers will comply with Rules 19 and 35. MASS can utilise the same method for calculating visibility range during the daytime. Determining the range of visibility during hours of darkness, however, is not as straightforward because, for example, where visibility is 3 miles, high intensity lights of a particular vessel may be seen from 10 miles away which can be misleading. The presence of a 'loom' around the vessel's navigation lights is often used by mariners as a guide to deteriorating visibility.[979] A MASS Degree 4 can use its cameras to determine whether visibility is deteriorating based on the loom around its navigation lights. High relative humidity is another sign of deteriorating visibility. For example, a relative humidity of more than 95% is a sign of mist i.e. when visibility is between 1,000 and 2,000 metres.[980] By using a hygrometer, a MASS Degree 4 should be able to estimate the range of visibility and determine whether it should sound the fog signal as required by COLREGs. Even when visibility is impaired due to solid particles (rather than water droplets or vapour) in the air, a MASS Degree 4 can still use visibility sensors that can measure visibility from a few tens of metres to a few tens of kilometres reasonably accurately by simulating human perception of visibility.[981] MASS Degree 4 can utilise of the above-mentioned methods or instruments to determine the range of visibility and use the 5-mile guide as a general rule of thumb in order to ascertain whether it should comply with the Rules in Section II or Section III.

In addition to complying with navigational rules 'in' an area of restricted visibility, a vessel which is 'near' an area of restricted visibility such as fog must still sound a particular sound signal (as required by Rule 35) so that other vessels that are about to emerge from the fog bank will have an advance warning of its presence. Before the advent of radar, vessels

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[977] Rule 22(a).

[978] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 376.

[979] The Met Office, *Meteorology for Mariners* (3rd edn, Met Office 1978) 60.

[980] Elaine Ives and Maurice Cornish, *Reeds Maritime Meteorology* (4th edn, Reeds 2019) 41.

[981] 'How we measure visibility' (*The Met Office*) <https://www.metoffice.gov.uk/weather/guides/observations/how-we-measure-visibility> accessed 07 February 2023.

mainly depended on a regime of fog signals (under the previous collision regulations) for detecting other vessels and thereby avoiding collision by reducing speed or stopping.[982] Even though the use of radar, ARPA and AIS has ever since made risk detection considerably easier, vessels must still sound a particular fog signal under Rule 35 when they are 'in or near an area of restricted visibility'. The question then arises as to how 'near' a vessel must be to an area of restricted visibility in order for Rule 35 to apply. Although the regulations are silent on this point, some guidance can be derived from Annex III of COLREGs. The range of audibility of a vessel 200 metres or more in length must be at least 2 nautical miles[983] and this leaves no doubt that if visibility is less than 2 nautical miles, then vessels must sound their particular fog signal as required by Rule 35. However, since fog may increase the range of audibility of a vessel's sound signal[984], it can be argued that even if a vessel is more than 2 (e.g. 3) nautical miles away from a fog bank, fog signals should still be sounded by that vessel.

4.6.3. Vessels Must 'not be in Sight' of One Another

The third and last condition is that the vessels must not be in sight of one another. In other words, if two vessels are in or near an area of restricted visibility but they can visually observe one another, then their collision avoidance responsibilities will be governed by Section II instead of Section III of COLREGs. It should, however, be noted that such vessels must still comply with paragraphs (b) and (c) of Rule 19 i.e. they must proceed at a safe speed which is adapted to the prevailing circumstances and conditions of restricted visibility, must have her engines ready for immediate manoeuvre, and must have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the Rules of Section I.

However, the question arises as to which Rules will apply when two vessels are not initially in sight of one another but then come within sight as they approach each other. It goes without saying that Section III will apply to both vessels before they come in sight of one another. It is, however, not entirely clear whether the encounter is to be governed by Section II or III 'after' the two vessels come within sight. For example, in an encounter between an ordinary power-driven vessel and a vessel restricted in her ability to manoeuvre, both vessels must take avoiding action under Section III when they are not in sight.[985] However, when the two vessels first sight each other and risk of collision exists,

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[982] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 370.

[983] COLREGs, Annex III, paragraph (c).

[984] Elaine Ives and Maurice Cornish, *Reeds Maritime Meteorology* (4th edn, Reeds 2019) 41.

[985] Rule 19(d).

the vessel restricted in her ability to manoeuvre would be obliged to keep her course and speed if the Rules in Section II apply to the encounter.[986]

Historically, English and US courts have taken two different approaches as to what Rules should govern such a situation. There are two decisions where the Admiralty Court and the Court of Appeal have taken the view that when the two vessels first come within sight, they must comply with the Rules in Section II irrespective of the distance between the two vessels. In the case of *Maloja II*[987] where visibility had reduced below one nautical mile, the two vessels first visually sighted each other when they were about six to seven cables apart and the Admiralty Court held that the vessels should have complied with Section II when they first came within sight. Similarly, in *The Mineral Dampier–Hanjin Madras*[988] where all 27 crewmembers of *The Mineral Dampier* lost their lives due to the collision, the two vessels first visually observed each other at a range of about three nautical miles, and the Court of Appeal took the view that the two vessels had to comply only with the Crossing Rule[989] applicable to vessels in sight of one another and not with Rule 19. According to decisions of the US courts, however, when the two vessels come in sight, they must comply with the Rules in Section II only if the closing speed and the distance between the two vessels are such that they provide ample time for both vessels to re-assess the situation and comply with the Rules that would be applicable to vessels in sight of one another.[990] It is submitted that the approach of the US courts provides a higher degree of safety and consistency for two reasons. First, it guards against abrupt and last-minute manoeuvres that may lead to conflicting actions and collision.[991] Second, it restrains any tendency that either of the two vessels may have to delay her avoiding action under Rule 19(d) with the hope that when the two vessels eventually come in sight, she becomes a stand-on vessels under Section II and can therefore avoid the bother of taking any action.[992]

Since pre-programmed or AI-lead MASS cannot adopt both English and US courts' approaches simultaneously, and because MASS owners and operators would want to avoid any collision or criminal liability under any jurisdiction, it is desirable for all MASS

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[986] Rule 18(a)(ii).

[987] [1993] 1 Lloyd's Rep 48.

[988] [2001] 2 Lloyd's Rep 419.

[989] Rule 15.

[990] See, for example, *Cusamona v The Curlew*, 105 F, Supp 428, 1952 AMC 508 (D Mass 1952) and *The New Hamshire*, 136 F 769 (2nd Cir 1905).

[991] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 377.

[992] Ibid.

(and all other vessels for that matter) to avoid getting into such a situation in the first place. This is another reason why MASS should be required to take early avoiding action and avoid impeding other vessels' navigation in any condition of visibility. As concluded at the end of Chapter 3 (section 3.10), this issue can also be addressed by adding the following paragraph to the existing Rule 8 of COLREGs:

> *(g) Except where Rules 9 and 10 otherwise require, a fully autonomous MASS shall not impede the passage of any other vessel at any time.*

4.7. MASS and their Navigational Status and Identification Signals

The last question that this thesis attempts to answer is whether MASS should have a particular navigational status, light or signal. Some researchers suggest that MASS should or could generally be categorised as vessels 'not under command' (NUC), or vessels 'restricted in their ability to manoeuvre' (RAM) and these proposals will be analysed below.

4.7.1. Not Under Command (NUC)

Under Rule 18, certain vessels, when in sight of one another, have a navigational right of way over others based on a hierarchy of categories. For example, a vessel 'not under command'[993] and a vessel 'restricted in her ability to manoeuvre'[994] have a right of way over an ordinary power-driven vessel, a vessel engaged in fishing, and a sailing vessel.[995] The question then arises as to whether a MASS Degree 3 (with no crew members on board and operated remotely) or a MASS Degree 4 (with no crew members on board and navigated autonomously) could generally be regarded as a vessel 'not under command' or a vessel 'restricted in her ability to manoeuvre' for the purposes of Rule 18. Gogarty and Hagger submit that that the current version of COLREGs regime seems to provide autonomous vessels with a navigable right-of-way over any other vessel directly under command, and that autonomous vessels would be obliged to signal their status as being NUC or as being under restricted manoeuvrability.[996] They further comment that if an autonomous vessel fails to do so, their operators might be held liable for any subsequent

[993] As defined by Rule 3(f).

[994] As defined by Rule 3(g).

[995] Rule 18 (a) to (c).

[996] Brendan Gogarty and Meredith Hagger, 'The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air' (2008) 19 Journal of Law, Information and Science 73, 115.

collision with another vessel regardless of whether the other vessel was complying with the relevant rules.[997]

Also, in August 2018, before the start of the IMO's Regulatory Scoping Exercise and in its initial review of IMO instruments under the purview of the Maritime Safety Committee (MSC), the MSC published a consolidated report to review the work undertaken by several organizations and IMO Member States that had considered regulatory issues and solutions for the use of MASS. The report stated that MASS Degree 4 could hardly meet the requirements for human control and simultaneous decision competence as required by COLREGs.[998] It then mentions that, as a possible solution, it has been considered by some Member States and organisations whether MASS Degree 4 could be considered 'not under command' or 'restricted in her ability to manoeuvre' in accordance with Rule 3 and that all other ships would consequently be obliged to 'keep out of her way'.[999] The report, however, rightly concludes that a MASS Degree 4 capable of navigating, cannot be considered as a vessel 'not under command'.[1000]

COLREGs define the term 'vessel not under command' as a vessel which 'through some *exceptional circumstance* is unable to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel'.[1001] The definition makes it clear that in order for a vessel to qualify as a vessel NUC, the cause of the inability of the vessel to comply with the Rules must be some 'exceptional circumstance' and not the vessel's ordinary mode of operation. The courts have also interpreted the term 'not under command' as referring to a vessel that has, exceptionally, lost her ability to manoeuvre as required by the Rules due to some failure of equipment or damage rather than the absence of a crew as a normal or routine feature of the ship itself.[1002] Circumstances in which a vessel may be recognised as NUC include:

a) breakdown of the vessel's engines or steering gear;
b) loss of the vessel's propeller or rudder;
c) a sailing vessel which is becalmed (as long as she does not have an engine);
d) a vessel with her anchor down but not holding; and

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[997] Ibid.

[998] IMO Doc MSC 100/INF.3, 'Initial Review of IMO Instruments under the Purview of MSC: Note by the Secretariat' (9 August 2018) Annex, page 50.

[999] Ibid.

[1000] Ibid.

[1001] Rule 3(f) (emphasis added).

[1002] Luci Carey, 'All Hands off Deck: The Legal Barriers to Autonomous Ships' (2017) 23(3) JIML 202, 209.

e) exceptional weather conditions.[1003]

In other words, a vessel not under command cannot be navigated in accordance with COLREGs due to some cause beyond her control and is therefore 'at the mercy of winds and seas'.[1004] If a MASS is designed to be operated with no crew on board on a permanent basis, this is a 'design feature'[1005] rather than an 'exceptional circumstance' and the MASS therefore cannot be considered 'not under command'. Thus, a MASS Degree 3 or 4 that cannot, in its ordinary mode of operation, manoeuvre as required by COLREGs cannot be considered a vessel 'not under command' and thus enjoys no navigational rights over other vessels. Moreover, as observed in Chapter 3, for various reasons, it is autonomous vessels that should keep out of the way of other vessels and not the other way round. The argument that autonomous vessels are generally 'not under command' can potentially be counter-productive to the development and promotion of autonomous shipping as it may imply that such vessels are unseaworthy.[1006] As pointed out by the Finnish Maritime Law Association in response to Question 4.4 of the CMI Questionnaire, such categorisation would not resolve the problem of a navigational encounter between two autonomous vessels and it may be questioned as a matter of principle whether the introduction of new shipping technologies should confer a right of way to autonomous vessels that would essentially leave the collision avoidance responsibility to all the other vessels.[1007]

MASS, nonetheless, may become 'not under command' if, for example, the communication link between a MASS Degree 3 and the remote operator breaks down or the autonomous navigation system of a MASS Degree 4 fails. This is because breakdown of the communication link can constitute an 'exceptional circumstance' that may make compliance of the MASS with COLREGs extremely difficult if not impossible. In short, the 'not under command' status should only be saved for exceptional and genuine situations where a MASS (or any other vessel for that matter) temporarily loses its ability to comply

[1003] Carlos F Salinas, Victoria Peña, Gonzalo Pérez and Tricia L Horton, 'Not Under command' (2012) 65(4) The Journal of Navigation 753, 754ff.

[1004] Ibid 753.

[1005] As pointed out by the South African Maritime Law Association: 'CMI Questionnaire on Unmanned Ships: Response by Maritime Law Association of South Africa' <https://comitemaritime.org/wp-content/uploads/2018/05/South-africa.pdf> accessed 07 February 2023.

[1006] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 329.

[1007] 'CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-FINLAND.pdf> accessed 07 February 2023.

with COLREGs rather than a permanent navigational status for a MASS that due to its inherent technical shortcomings cannot follow the Rules of COLREGs.

4.7.2. Restricted in her Ability to Manoeuvre (RAM)

Under COLREGs, the term ‘vessel restricted in her ability to manoeuvre’ means a vessel which ‘from the *nature* of her work is restricted in her ability to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel.’[1008] Rule 3(g) provides that the term ‘vessels restricted in their ability to manoeuvre’ includes but is not limited to:

(i) a vessel engaged in laying, servicing or picking up a navigation mark, submarine cable or pipeline;
(ii) a vessel engaged in dredging, surveying or underwater operations;
(iii) a vessel engaged in replenishment or transferring persons, provisions or cargo while underway;
(iv) a vessel engaged in the launching or recovery of aircraft;
(v) a vessel engaged in mine clearance operations; and
(vi) a vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course.

Some researchers suggest that it is more conceivable that an autonomous vessel could be considered as a vessel ‘restricted in her ability to manoeuvre’ rather than a vessel ‘not under command’.[1009] The US Navigation Safety Advisory Council (NAVSAC) which is a group of experts who advise and make recommendations to the US Coast Guard on various matters including COLREGs, also suggests that Rule 3(g) should be amended to add a new subparagraph to read:

(vii) a self-propelled vessel while unmanned and operating autonomously.[1010]

It has similarly been argued that since the above-mentioned list of activities that qualify a vessel as RAM is not exclusive, COLREGs would not necessarily prevent ‘autonomous operation’ from being considered as a category of work that restricts the ability of a MASS to manoeuvre as required by COLREGs.[1011] However, as defined by Rule 3(g), a RAM

[1008] Rule 3(g) (emphasis added).

[1009] See, for example, Michael R Benjamin and Joseph A Curcio, ‘COLREGS-Based Navigation of Autonomous Marine Vehicles’ (2004) IEEE/OES Autonomous Underwater Vehicles (IEEE Cat. No. 04CH37578) 32, 33.

[1010] NAVSAC, Resolution 12-08, para II(B).

[1011] Christopher C. Swain, ‘Towards Greater Certainty for Unmanned Navigation, a Recommended United States Military Perspective on Application of the “Rules of the Road” to Unmanned Maritime Systems’ (2018) 3(1) Georgetown Law Technology Review 119, 148.

vessel is a vessel which from the 'nature' of her work is restricted in her ability to manoeuvre as required by COLREGs. It can be argued that autonomous navigation of a MASS Degree 4 is merely a 'mode of operation' rather than the 'nature' of its work that restricts its ability to manoeuvre as required by the Rules. All of the vessels introduced by Rule 3(g) as RAM have one factor in common: they are all engaged in a 'particular activity' and it is the 'nature' of that activity that restricts their manoeuvrability. None of the vessels listed in Rule 3(g) would be considered as restricted in her ability to manoeuvre when she stops her particular activity and simply starts to navigate in her ordinary mode of operation. For example, if a dredger is sailing from A to B without actually carrying out any dredging operations, then such a dredger under COLREGs is only considered to be an ordinary power-driven vessel, not a RAM vessel.[1012] Put differently, while a NUC vessel has to stay NUC until the problem is solved, a RAM vessel can freely 'choose' when she wants to operate as RAM and, if necessary, she can delay or even cancel the commencement of her operation e.g., in the case of adverse weather conditions. By the same token, an autonomous dredger that is engaged in dredging operations, may claim the RAM status and enjoy the accompanied right of way under Rule 18. However, as soon as the vessel stops her dredging operations and starts to navigate from A to B, it becomes an ordinary power-driven vessel and loses its navigational privilege under Rule 18. That is to say, a MASS Degree 3 or 4 which is being navigated remotely or autonomously as its routine mode of operation is not engaged in any particular activity and any inability to follow COLREGs would be due to her design defects or shortcomings rather than the 'nature of her work'. Remote or autonomous operation of a MASS does not restrict manoeuvrability of the vessel in the same way that the activities listed in Rule 3(g) would.

Swain argues that, in the alternative, MASS operators could adopt an 'expansive interpretation' of RAM status and thereby assert that autonomous operation is a nature of work that restricts the ability of a MASS to manoeuvre in accordance with COLREGs.[1013] However, the question of whether a vessel is restricted in its ability to manoeuvre is a question of 'fact' and is not based on the 'belief' of the vessel's operator.[1014] In other words, the vessel must in fact be restricted in her ability to manoeuvre; the manoeuvrability must be restricted from the nature of her work; the restriction must render the vessel unable to keep out of the way of another vessel; and

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[1012] Carlos F Salinas, Victoria Peña, Gonzalo Pérez and Tricia L Horton, 'Not Under command' (2012) 65(4) The Journal of Navigation 753, 756.

[1013] Christopher C. Swain, 'Towards Greater Certainty for Unmanned Navigation, a Recommended United States Military Perspective on Application of the "Rules of the Road" to Unmanned Maritime Systems' (2018) 3(1) Georgetown Law Technology Review 119, 149.

[1014] Robert Veal *et al*., 'Liability for operations in Unmanned Maritime Vehicles with Differing Levels of Autonomy' (European Defence Agency, Brussels, 2016) 70ff.

restrictions from other causes will not qualify the vessel as a RAM vessel.[1015] A MASS Degree 3 or 4 which is being operated remotely or autonomously but is nevertheless (at least potentially) able to alter her course and/or speed, cannot claim a RAM status simply because she is not unable to keep out of the way of other vessels. The owner of a MASS Degree 4 cannot claim the RAM status by arguing that the autonomous navigation system of the MASS is not advanced enough to determine and execute the required manoeuvre for the same reason that an incompetent watch officer on a conventional vessel cannot claim the RAM status for his/her vessel just because he/she does not know what manoeuvre might be required by COLREGs and how to carry out such a manoeuvre.

Thus, if a MASS Degree 3 or 4 which is engaged in carrying goods or persons cannot follow COLREGs due to certain technical shortcomings in its design, then such a vessel cannot claim the privilege of being categorised as a RAM vessel simply because her inability to adhere to the Rules stems from her technical shortcomings rather than the nature of her work. Nevertheless, as discussed in Chapter 3, MASS Degrees 3 and 4 being recognised as RAM may be a reasonable approach to increase the safety of MASS trials in the interim period when there is no amended COLREGs or definitive and comprehensive guidance on MASS operations. There is also no doubt that a MASS Degree 3 or 4 which is engaged in an activity (e.g. underwater operations) the nature of which restricts her ability to comply with COLREGs, will qualify as a RAM vessel and will therefore enjoy the navigational priority under Rule 18.

The upshot is that, after the interim period, categorising MASS Degree 3 or 4 in their ordinary mode of operation as vessels not under command or vessels restricted in their ability to manoeuvre will stifle the autonomous ship technology which would otherwise develop to be fully COLREGs compliant and take seaman-like collision avoidance actions. Moreover, since the most common cause of collisions at sea is lack of situational awareness (on conventional vessels), such categorisation combined with technical shortcomings are apt to exacerbate the current situation. It is submitted, therefore, that notwithstanding the above-mentioned proposals put forward by individuals, organisations, or States, autonomous vessels should not have the status of a vessel 'not under command' or 'restricted in her ability to manoeuvre', but should bear the highest level of responsibility to catalyse further development of the autonomous ship technology and ultimately to ensure safety at sea.

[1015] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 58.

4.7.3. Special Lights, Signs and AIS Signals

A power-driven vessel under COLREGs means any vessel which is 'propelled by machinery'[1016] and a sailing vessel means any vessel which is 'under sail' provided that propelling machinery, if fitted, is not being used.[1017] It is clear from these two definitions that virtually all MASS fall under the category of a power-driven vessel. All power-driven vessels when underway must display a white masthead light,[1018] a green starboard sidelight, a red port sidelight, and a white stern light.[1019] However, when a power-driven vessel has a special navigational character or is engaged in a particular activity, it must exhibit additional lights to highlight its character and/or activity to other vessels in the area. For instance, an air-cushion vessel is a power-driven vessel and thus must display the said lights for a power-driven vessel. However, when operating in the non-displacement mode, the hovercraft must additionally exhibit an all-round flashing yellow light.[1020] The purpose of the additional (flashing yellow) light is not to indicate a high-speed vessel, but to warn other vessel of its particular manoeuvring characteristics such as a tendency to side-slip when it is turning.[1021] As a second example, when taking off, landing or in flight near the surface, a WIG craft must in addition to the lights displayed by a power-driven vessel, display a high intensity all-round flashing red light.[1022] Given the high speed and unique operating characteristics of such vessels, there is a need for an identifying special high intensity light,[1023] and hence the high intensity flashing red light which can be seen and distinguished from long distances.

It can be argued that since a MASS also has particular characteristics, it should be required to show a unique identification signal to alert seafarers on other vessels of its presence. For example, a MASS Degree 3 which is being navigated by a remote operator may at any moment lose its communication link to the remote control-centre due to a technical issue and thus may not be able to take avoiding action in a collision situation. In a similar vein, the autonomous navigation system of a MASS Degree 4 may fail or

[1016] Rule 3(b).

[1017] Rule 3(c).

[1018] Two masthead lights, if the vessel is 50 metres or more in length (Rule 23(a)(ii)).

[1019] Rule 23(a).

[1020] Rule 23(b).

[1021] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 7-449.

[1022] Rule 23(c).

[1023] Craig H Allen Sr and Craig H Allen Jr, *Farwell's Rules of the Nautical Road* (9th edn, Naval Institute Press 2020) 420.

(even worse) perform a sudden and unexpected manoeuvre which will catch other vessels by surprise.

Porathe suggests that a MASS operating in fully autonomous mode (MASS Degree 4) could display a purple all-round masthead light during hours of darkness because purple is a colour that is not already used for other purposes in COLREGs.[1024] In a recent survey the result of which was published in April 2022, over 560 licenced deck officers answered several MASS-related questions one of which was whether MASS should exhibit an all-round light of a colour that is not currently used as another identification light within COLREGs and if so, whether such a light should be purple or turquoise.[1025] The majority of the participants answered that MASS should display an all-round identifying light and the colour of such a light should be purple.[1026] The autonomous car industry, however, has proposed a turquoise light for identification of autonomous cars. Taking into account physiological and psychological factors such as human chromatic sensitivity, colour vision deficiencies, attractiveness and expected uniqueness, a recent study used the following criteria for the evaluation of most suitable colour for identification of autonomous cars:

1) visibility/saliency;
2) discriminability against other light signals emitted by the car and traffic environment;
3) visibility and discriminability considering colour vision deficiencies;
4) attractiveness; and
5) uniqueness.[1027]

The study concludes that turquoise receives higher ratings in most criteria than yellow, green, and purple and is therefore best suited for the identification of autonomous cars.[1028] The car maker Ford also concluded through a trial in 2019 that turquoise was the colour that people most reacted to as it was more noticeable than white and that turquoise was confused less with red than purple was confused with red.[1029] The German

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1024 Thomas Porathe, 'Maritime Autonomous Surface Ships (MASS) and the COLREGS: Do We Need Quantified Rules or is "the Ordinary Practice of Seamen" Specific Enough?' (2019) 13(3) The International Journal on Marine Navigation and Safety of Sea Transportation 511, 515 ff.

1025 Elspeth Hannaford, Pieter Maes and Edwin Van Hassel, 'Autonomous Ships and the Collision Avoidance Regulations: A Licensed Deck Officer Survey' (2022) WMU Journal of Maritime Affairs 1, 25.

1026 Ibid.

1027 Annette Werner, 'New Colours for Autonomous Driving: An Evaluation of Chromaticities for the External Lighting Equipment of Autonomous Vehicles' (2018) III Colour Turn III-1, III-5.

1028 Ibid III-13.

1029 James Billington, 'Ford Uses Light-based Communication for Autonomous Cars' (*Autonomous Vehicle International*, 08 February 2019) car maker Mercedes similarly uses turquoise light for its autonomous cars based on the results of several studies.[1030]

Although it is now established that in road conditions, turquoise lights used by autonomous vehicles provide more visibility, distinguishability, sense of safety and trust amongst other road users, there is no scientific or empirical study to reach the same conclusion for autonomous vessels in sea conditions and in relation to sea users. One conclusion, nonetheless, can be reached: it is crucial for MASS to be readily distinguishable from other vessels through an identification light at night. Whether the colour of such a light should be turquoise, purple or some other colour, and whether a different number of lights should be used for different categories of MASS are matters of further research. It is, nonetheless, submitted that such a light should be a 'flashing' light in order to attract attention of the other vessels in the area quicker and easier. As discussed above, the identification light for both WIG craft and air-cushion vessels is a 'flashing' light i.e. the light must flash with a rate of 120 flashes or more per minute[1031] so that other vessels can easily notice the light. Submarines, when navigating on the surface, are not obliged under COLREGs to exhibit any particular lights other than those of ordinary power-driven vessels. It is, nevertheless, common that some submarines display a very quick-flashing amber anti-collision light above or below the masthead light.[1032] Since such a light is not required or recognised as an identification light for submarines by COLREGs, the purpose of displaying the quick-flashing amber light is indicating to an approaching vessel the need for extra caution rather than giving immediate identification of the type of the vessel displaying the light.[1033] Given that MASS Degree 3 or 4 may face a technical issue with no crew on board to deal with it, their identification light should be a quick-flashing light so that they give quick and conspicuous warning to all other vessels in the vicinity. In sum, COLREGs should require MASS to display a unique identification light during hours of darkness and such a light should be a 'flashing' light – a paragraph should be added to Rule 23 to address the issue. For daytime identification, special letters or signs on the hull of a MASS could be used for identification purposes.

However, lights at night and letters or signs at daytime may not always be readily visible to all other vessels especially from long distances or in restricted visibility. There should,

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<https://www.autonomousvehicleinternational.com/news/adas/ford-uses-light-based-communication-for-autonomous-cars.html> accessed 07 February 2023.

1030 Daniel Patrascu, 'Self-Driving Mercedes-Benz S-Class Puts on a Turquoise Light Show' (*autoevolution*, 01 February 2019) <https://www.autoevolution.com/news/self-driving-mercedes-benz-s-class-puts-on-a-turquoise-light-show-132111.html> accessed 07 February 2023.

1031 COLREGs, Rule 21(f).

1032 UKHO, *NP100: The Mariner's Handbook* (8th edn, The UK Hydrographic Office 2004) 54.

1033 Ibid.

therefore, be an additional method of identification of MASS. Under SOLAS, all passenger ships irrespective of size and all ships of 300 gross tonnage and upwards engaged on international voyages must be fitted with an automatic identification system (AIS).[1034] Even cargo ships not engaged on international voyages must carry an AIS if they are of 500 gross tonnage or upwards[1035] and all ships fitted with an AIS must operate it at all times subject to international agreements, rules or standards.[1036] It is submitted that 'all' MASS should be required to be fitted with an AIS regardless of their size, type or application so that other vessels will have an early notice of the presence of the MASS in the area. The information that an AIS must provide includes the 'type' of the vessel[1037] e.g. whether the vessel is a cargo ship, an oil tanker, or a container ship. The 'mode of operation' of a MASS should be required to be added to AIS transmitted information to indicate whether the MASS is being operated remotely (i.e. as a MASS Degree 3) or fully autonomously (i.e. as a MASS Degree 4) and so on. It can, thus, be argued that SOLAS (or any other IMO instrument that may be relevant in the future) should be amended to require all MASS, if practicable, to be fitted with an AIS and transmit the mode of operation of the MASS (and update it if necessary) at all times.

[1034] Chapter V, Regulation 19.2.4.

[1035] Ibid.

[1036] Ibid Regulation 19.2.4.7.

[1037] Ibid Regulation 19.2.4.5.1.

Chapter 5: Conclusions and Recommendations

This thesis has determined the most appropriate way of integrating MASS into two particular conventions, namely, UNCLOS and COLREGs. The aim of this final chapter is to consolidate the main findings of previous chapters and highlight their importance and the original contribution of the thesis to knowledge. To this end, Chapter 5 will provide normative suggestions as to how the current collision regulations should be amended to ensure safety of navigation at sea. This chapter will also analyse the methodological challenges of the research and will highlight the resultant limitations or gaps in the research. Finally, an agenda will be suggested for further research in the field of MASS and their compliance with collision regulations.

5.1. Legal Status of MASS under UNCLOS

The first issue that this study dealt with was the legal status of MASS under UNCLOS. The rationale behind this approach is that UNCLOS is often regarded as a framework or an umbrella Convention that sets out general principles the details of which can be found in other instruments.[1038] Since the navigational rights in different maritime zones under UNCLOS are granted to 'ships' or 'vessels', Chapter 2 attempted to determine whether MASS constitute 'ships' or 'vessels' for the purposes of UNCLOS. The significance of addressing this issue is that, if MASS do not constitute 'ships' under UNCLOS, then they may not be entitled to the navigational rights or prospective owners or operators may be deterred from operating MASS in different maritime zones. In order to address the issue, the following five different approaches were analysed.

5.1.1. National Law Interpretation Approach

UNCLOS does not provide a definition of 'ship' or 'vessel', but obliges every State to 'fix the conditions for the grant of its nationality to *ships*, for the registration of *ships* in its territory, and for the right to fly its flag.'[1039] This means that States have exclusive discretion as to whether or not to register a particular watercraft as a 'ship'. It has,

[1038] 'Marine Environment from the Conclusion of the United Nations Convention on the Law of the Sea to the World Summit on Sustainable Development' <https://www.un.org/Depts/los/convention_agreements/convention_20years/PresentationG_GoettscheWanli.pdf> accessed 07 February 2023.

[1039] Article 91(1) (emphasis added).

therefore, been suggested that it is better to assume that it is left to each State to decide whether a given watercraft e.g. a MASS is a 'ship' under its national laws.[1040]

Under UK legislation, the term 'ship' includes every description of vessel used in navigation.[1041] It follows that a 'ship' must be a 'vessel' i.e. resemble a 'hollow receptacle'[1042] and must also be 'used in navigation'. However, the Court of Appeal has held in a recent case that the capability to carry people or goods is not an essential characteristic so long as 'navigation' is a significant part of the function of the watercraft.[1043] It has been held that 'navigation' simply means 'movement across water'[1044] and some unmanned barges have therefore been held to be 'ships'.[1045] Thus, there is no reason to conclude that MASS cannot be considered 'ships' under English law. Moreover, English case law does not present any direct barrier to considering MASS as 'ships'. As a matter of fact, the first ever autonomous vessel called *C-Worker 7* was registered by the UK Ship Register in November 2017.[1046] The legal status of MASS under UK law, therefore, is determined as 'ships'.

The position, however, is not entirely clear under domestic laws of some States. For instance, in response to the CMI Questionnaire, the Croatian Maritime Law Association stated that MASS Degree 3 or 4 would not constitute 'ships' under Croatian law.[1047] Chapter 2 demonstrated that the national law interpretation approach would be problematic for two reasons. First, it can potentially lead to inconsistencies and contradictory practices amongst States simply because a given watercraft may be considered a 'ship' under domestic laws of one State, but not a 'ship' under those of another State. The inconsistency can, in turn, result in conflicts between States as it did in the China/US incident in 2016. Second, the 1952 Arrest Convention does not define the term 'ship', but provides that the rules of procedure relating to the arrest of a ship and

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[1040] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 309.

[1041] Section 313(1) of the UK Merchant Shipping Act 1995.

[1042] *Steedman v Scofield* [1992] 2 Lloyd's Rep 163, 165.

[1043] *Perks v Clark* [2001] EWCA Civ 1228; [2001] 2 Lloyd's Rep 431.

[1044] Ibid [2001] 2 Lloyd's Rep 431 [42].

[1045] See, for example, *The Mudlark* [1922] P 116.

[1046] 'UK Ship Register Signs its First Unmanned Vessel' (*UK Ship Register*, 13 November 2017) <https://www.ukshipregister.co.uk/news/uk-ship-register-signs-its-first-unmanned-vessel/> accessed 07 February 2023.

[1047] 'CMI Questionnaire on Unmanned Ships' <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-CROATIA.pdf> accessed 07 February 2023.

to all matters of procedure which the arrest may entail, must be governed 'by the law of the Contracting State in which the arrest was made or applied for.'[1048] In other words, all matters regarding the arrest of a 'ship' are governed by the law of the Contracting State in which the arrest was made or applied for. Since ship arrest plays such an important role for potential claimants to secure their claims in cases such as collision and pollution, leaving the decision of whether MASS are 'ships' to each individual State may, in effect, render the Convention useless in relation to MASS arrest. Accordingly, Chapter 2 introduced the following four alternative approaches.

5.1.2. Treaty Interpretation Approach

UNCLOS provides that 'ships' of all States enjoy the right of innocent passage through the territorial sea;[1049] that all 'ships' and aircraft enjoy the right of transit passage;[1050] and that all States are entitled to sail 'ships' on the high seas.[1051] It appears, therefore, that UNCLOS grants all navigational rights to 'ships'. But since UNCLOS also makes reference to 'vessels', Chapter 2 first dealt with the question of whether 'vessels' can equally enjoy the navigational rights which are given to 'ships'. According to the VCLT, the 'preparatory work' of a treaty may be used to interpret the meaning of an ambiguous or obscured term of that treaty.[1052] The *travaux préparatoires* of UNCLOS indicates that there is no meaningful difference between the terms 'ship' and 'vessels simply because different committees were responsible for drafting different Articles of UNCLOS and while one of the committees showed a preference for 'ship', the other committee opted for 'vessel'.[1053] Moreover, the VCLT also clarifies that when a treaty has been written in two or more languages, the text is equally authoritative in each language, unless the treaty expressly provides otherwise. Since the Spanish and French versions of UNCLOS use only one word to mean ship or vessel, the words 'ship' and 'vessel' are not interpreted as meaning different things in the English version of UNCLOS.[1054]

[1048] Article 4.

[1049] Article 17.

[1050] Article 38.

[1051] Article 87(1)(a).

[1052] Article 32.

[1053] Satya N Nandan (ed) and Shabtai Rosenne, *United Nations Conventions on the Law of the Sea 1982: A Commentary*, Volume II (Martinus Nijhoff Publishers 1993) para 1.28.

[1054] Ibid.

It was then demonstrated that the 'manning of ships' requirement imposed on flag States by UNCLOS[1055] does not mean that unmanned watercraft are not 'ships' under UNCLOS just because they are not manned. In manning a ship, UNCLOS requires the flag State to take into account the 'applicable international instruments'.[1056] The only applicable international instrument that currently deals with 'manning of ships' is the SOLAS convention which merely states that all ships must be 'sufficiently and efficiently manned'[1057] and that in doing so, flag Sates must take into account the IMO's Principles of Minimum Safe Manning. This IMO instrument does not determine a minimum number of on-board crew members, but provides that the level of 'ship automation' and degree of 'shoreside support' provided to the ship should be taken into account.[1058] Given that the average crew size for cargo ships has significantly reduced over the course of past decades as a result of rapid advancements in 'ship automation', there is no reason to think that the crew size cannot or should not be reduced to zero on MASS. In fact, the purpose of the UNCLOS manning requirement is ensuring 'safety at sea'[1059] and not determining the ship status of a watercraft based on whether there is a crew on board. Furthermore, nothing in UNCLOS, SOLAS, or the IMO's Principles of Minimum Safe Manning prevents a MASS from being operated without an on-board crew if it is safe to do so.

Moreover, a significant finding of Chapter 2 is that the term 'ship' does not have a single ordinary meaning under UNCLOS and that the precise meaning of the term will depend on the context in which it has been used. Under treaty interpretation rules, the terms of a treaty must be interpreted 'in their context' and in light of the 'object and purpose' of the treaty.[1060] For example, every 'ship' must have on board 'such charts, nautical publications and navigational equipment and instruments as are appropriate for the safe navigation of the ship'.[1061] Since the 'object and purpose' of this provision is 'safe navigation of the ship', a fixed platform cannot be considered a 'ship' under this provision and is therefore not obliged to have nautical publications or navigational equipment simply because fixed platforms are not used for navigation. On the other hand, UNCLOS prohibits the transport of slaves in 'ships'[1062] and empowers warships to board a 'ship'

[1055] Article 94(3)(b).

[1056] Ibid.

[1057] Chapter V, Regulation 14.

[1058] Resolution A.1047(27), Annex 2, para 1.1.

[1059] As stated in Article 94(3).

[1060] VCLT, Article 31(1).

[1061] Article 94(4)(a).

[1062] Article 99.

which is suspected to be engaged in slave trade.[1063] Bearing in mind the 'object and purpose' of these provisions i.e. prohibition of slave trade in all possible forms, it can be argued that the very same fixed platform can be construed as a 'ship' under the provisions that prohibit slave trade. Similarly, by adopting a purposive interpretation approach, it is clear that the purpose of the UNCLOS manning requirement is 'to ensure safety at sea'.[1064] Thus, a MASS that can be operated safely, does not have to be manned under the UNCLOS manning requirement simply because such a MASS has been designed to operate safely without a crew on board in the first place. That is to say, just because a given structure is considered to be a 'ship' under some UNCLOS provisions, does not mean that it must comply with all other UNCLOS provisions that apply to 'ships'. The term 'ship' may be construed differently under different UNCLOS provisions depending on the purpose of the provision in question.

5.1.3. Evolutionary Interpretation Approach

According to the VCLT, a treaty must be interpreted 'in good faith in accordance with the ordinary meaning to be given to the terms of the treaty'.[1065] Thus, some may argue that since the ordinary meaning of the term 'ship' at the time of UNCLOS negotiations did not include MASS Degree 3 or 4, the term 'ship' does not cover such watercraft under UNCLOS. The International Court of Justice, however, has recently ruled that it is the 'present meaning' of the terms of a treaty which must be accepted for purposes of applying the treaty, and not necessarily their original meaning.[1066] The VCLT also states that 'any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation' must also be taken into consideration.[1067] Furthermore, UNCLOS itself also provides an open-ended list of 'freedoms of the high seas'[1068] in order to accommodate the use of new technologies in the high seas. There is, therefore, evidence of an 'evolutionary approach' to treaty interpretation adopted by the ICJ, the VCLT, and UNCLOS itself. For instance, today many States use the high seas to send satellites into space even though this right is not expressly listed by UNCLOS as a freedom of the high seas. Under this evolutionary interpretation approach, the fact that some States have registered MASS Degrees 3 and

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[1063] Article 110.

[1064] Article 94(3).

[1065] Article 31(1).

[1066] *Dispute Regarding Navigational and Related Rights* (*Costa Rica v Nicaragua*) [2009] ICJ 213 [70].

[1067] Article 31(3)(b).

[1068] In Article 87.

4 as ‘ships’, indicates that the present meaning of the term ‘ship’ under UNCLOS may be extended to cover such watercraft too.

In light of this evolutionary interpretation approach, even if the term ‘ship’ at the time of UNCLOS negotiations did not cover MASS, there is no evidence to suggest that the parties intended to confine the concept of ‘ship’ solely to conventional manned watercraft. In fact, the preparatory work and the text of UNCLOS show that the drafters of UNCLOS gave an evolutionary nature to the Convention so as to accommodate the use of new technologies in the high seas. MASS is one of those new technologies which under the above-mentioned evolutionary approach can be used in the high seas.

5.1.4. Comparison with the Aviation Industry

Unlike the shipping industry, the law surrounding autonomous systems has been more responsive and has kept pace with the technology in the aviation industry. This is mainly due to the express text of Article 8 of the Chicago Convention that entitles ‘pilotless aircraft’ to fly in the international airspace. The ICAO has also clarified that ‘pilotless aircraft’ includes all unmanned aircraft whether remotely controlled, fully autonomous, or combinations of both and thus they are all subject to Article 8. Thus, under ‘civil’ aviation law, UAVs are considered to be unmanned ‘aircraft’ and enjoy navigational rights in the international airspace. Under ‘military’ aviation law, long-standing use of different military UAVs in the international airspace has also established their status as ‘aircraft’ with the right to fly in the international airspace.

Two main factors contributed to the success of the aviation industry in recognising UAVs as ‘aircraft’. The first factor is the all-encompassing definition of ‘aircraft’. The definition of ‘aircraft’ in the Chicago Convention is so inclusive that, in effect, covers ‘any’ human-made object that operates in the air. The lack of a definition for ‘ship’ in UNCLOS and its evolutionary provisions regarding freedoms of the high seas pave the way for a liberal interpretation of the term ‘ship’. That is to say, an expansive interpretation should be adopted so that ‘any’ artificial object that operates in the marine environment may be considered as a ‘ship’ under the UNCLOS provision in question. Having a national character or being properly manned should be consequences (rather than prerequisites) for an object that is recognised as a ship. The second success factor was the customary international law i.e. the fact that pilotless aircraft have been used since the First World War led to the recognition of UAVs as ‘aircraft’. Thus, customary international law may also ultimately establish the legal status of MASS as ‘ships’ under UNCLOS.

5.1.5. Customary International Law Approach

A new rule of customary international law may be established if there is sufficient ‘state practice’ together with ‘*opinio juris*’. It was shown that these two elements are reaching the sufficient level in relation to MASS and thus, are establishing a new rule of customary international law that MASS are 'ships' and have navigational rights under UNCLOS. Examples of State practice include the UK Ship Register signing a MASS Degree 4 (*C-Worker 7*) to the flag in 2017; completion of an autonomous voyage by *SEA-KIT Maxlimer* between British and Belgian ports in 2019; and the autonomous crossing of the Atlantic Ocean between UK, Canadian and US ports by *The Mayflower* in 2022. The State practice is also accompanied by *opinio juris* i.e. public statements made by or on behalf of those States that operate MASS. State practice does not need to be universal but it should be 'sufficiently widespread' i.e. those States that had the 'opportunity or possibility' to apply the alleged rule, have done so. Given that MASS is a relatively new technology that is not currently available in many States, even a small number of States operating MASS on the high seas can satisfy the objective element of the emerging rule of customary international law. Moreover, the US has maintained its position over a decade that MASS are ships and enjoy navigational rights and no State has officially objected to that position. The lack of objection can itself serve as evidence of *opinio juris* by the States that had the opportunity to protest against the position, but did not do so.[1069]

It is apparent from the above that MASS have operated and will continue to operate in national and international waters and the practice of treating MASS as ships that enjoy freedom of navigation is not only accompanied by *opinio juris* but also will soon be 'sufficiently widespread' which will ultimately give rise to a new rule of customary international law: MASS are ships that enjoy UNCLOS navigational rights.

The practice of an international organisation may also contribute to the formation or expression of a rule of customary international law[1070] if the practice is attributed to the international organisation itself and if the subject matter of the rule falls within the mandate of that organisation. The Regulatory Scoping Exercise carried out by the IMO amounts to the practice of a competent international organisation that treats MASS as ships (or vessels) that enjoy navigational rights on the high seas. Although it is not within the IMO's competence to determine the ship status of MASS under 'UNCLOSL', the IMO's practice can, nonetheless, contribute to the formation of the emerging rule that MASS are ships under 'customary international law'.

Additionally, although activities or statements of non-governmental organisations do not count as practice of 'States', they may, nevertheless, 'shape' the practice of States who react to such activities or statements and therefore may contribute to the formation or expression of customary international law. For instance, since 2013, the classification

[1069] The ILC, 'Draft Conclusions on Identification of Customary International Law' (2018) Conclusion 10(3) – available at <https://legal.un.org/ilc/texts/instruments/english/draft_articles/1_13_2018.pdf> accessed 07 February 2023.

[1070] Ibid Conclusion 4(2).

society DNV has been developing a concept for a MASS Degree 4 called *The Revolt* and also published design criteria and guidelines for MASS in 2018. These activities in turn have shaped Norway's position and practice regarding MASS in the following ways. Firstly, in September 2017, the Norwegian Government provided a grant of about 30% of the total cost of constructing a MASS Degree 4 called *Yara Birkeland*. Secondly, it established the Norwegian Forum for Autonomous Ships (NFAS) to promote the concept of MASS and designated a test area for MASS trials. Third, together with BIMCO, Norway also prepared the draft interim guidelines for MASS trials that was submitted to the IMO in September 2018. All these activities of DNV influenced and shaped Norway's practice which in turn will contribute to the development of a rule of customary international law in relation to MASS.

Thus, it appears that a new rule of customary international law is developing that MASS are 'ships' that are entitled to the UNCLOS navigational rights. Although it has been suggested that the required state practice may introduce long delays in establishing the ship status of MASS,[1071] the International Law Commission has recently concluded that if the practice is sufficiently widespread, then no particular period of time is required in order for the rule to be established.[1072]

5.1.6. Different MASS Activities in Different Maritime Zones

Since a coastal State has sovereignty over its territorial waters, the State has exclusive power to establish requirements for operation of MASS in its territorial waters as long as such requirements are not contrary to established rules of international law. Thus, MASS can operate in the territorial waters of the flag State and engage in activities such as carriage of goods or people, fishing and scientific research. They can also carry out the same activities in the EEZ of the flag State.[1073]

All types of MASS have the right to operate in the high seas even if they are labelled as 'devices' rather than 'ships'. UNCLOS grants the right of innocent passage in the territorial sea to submarines and 'other underwater vehicles' which arguably include all types of unmanned underwater vehicles. If all types of underwater vehicles are entitled to operate in the territorial waters of a foreign State where the State has sovereignty, they must surely have the right to operate in the high seas where no State enjoys sovereignty. This view is supported by the fact that oil platforms (which may be labelled as devices rather than ships) have been enjoying the freedom of navigation on the high seas over the

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[1071] Robert Veal and Michael Tsimplis, 'The Integration of Unmanned Ships into the *Lex Maritima*' [2017] LMCLQ 303, 309.

[1072] The ILC, 'Draft Conclusions on Identification of Customary International Law' (2018) Conclusion 8(2).

[1073] Under Article 56 of UNCLOS.

course of past decades. Moreover, the freedom of navigation on the high seas is given to 'States' rather than 'ships'.[1074] In addition to conventional ships, therefore, States can use any other watercraft to exercise their freedom of navigation. Depriving MASS of the freedom of navigation on the high seas would also be contrary to the spirit of Article 87 of UNCLOS that permits States to use the high seas for all types of peaceful activities. In light of the China/US incident in 2016 and in the interest of peace and order in the high seas, every watercraft regardless of its type, size, or purpose, should be entitled to operate in the high seas provided that it is registered by a State.

The freedom of navigation enjoyed by States in the high seas extends to the EEZ of a coastal State too.[1075] Thus, since MASS enjoy the freedom of navigation on the high seas, they enjoy the same right in the EEZ of a foreign State too. However, the freedom of navigation in the EEZ is not absolute, but is subject to the relevant provisions of UNCLOS.[1076] For example, UNCLOS empowers the coastal State to adopt laws and regulations applicable in its EEZ in relation to the protection of the marine environment,[1077] marine scientific research,[1078] and economic activities.[1079] It follows that as long as MASS adhere to such laws and regulations, they are entitled to navigate in the EEZ of foreign States. Military activities of MASS (or any other type of watercraft for that matter) in the EEZ of a foreign State remains a debatable issue.

Ships of all States are entitled to the right of innocent passage through the territorial waters of a coastal State.[1080] Although the coastal State can adopt laws and regulations in relation to innocent passage in its territorial waters,[1081] it cannot prevent the innocent passage of a ship solely on the basis of the manning status of the ship unless such prevention is supported by 'generally accepted international rules or standards'.[1082] However, such international standards do not specify a minimum number of crew for safe manning of each type of ship and thus, MASS should enjoy the innocent passage in territorial waters of foreign States. Moreover, it is the 'activity' of a ship rather than its manning status that may render the passage of the ship non-innocent. Since transit

[1074] UNCLOS, Articles 87(1) and 90.

[1075] UNCLOS, Article 58(1).

[1076] Ibid.

[1077] Article 211(5).

[1078] Articles 56(1)(b)(ii) and 246(1).

[1079] Article 56(1)(a).

[1080] UNCLOS, Article 17.

[1081] UNCLOS, Article 21(1).

[1082] UNCLOS, Article 21(2).

passage is a more inclusive regime where the States bordering the strait have less power to interfere with operation of ships or to suspend the regime, MASS are entitled to transit passage too.

The internal waters and ports of a foreign State is the only area where a MASS may potentially not have the right to operate as the coastal State has the right to lay down conditions for admission of ships to its internal waters and ports.[1083] For example, States that supply a large number of seafarers may deny access of MASS Degrees 3 and 4 to their ports in order to support their seafarers. However, denying access of a MASS to a port must not constitute an 'abuse of rights'.[1084] Whether some States will actually ban MASS in their ports and whether such banning would amount to an abuse of rights under UNCLOS remain to be seen.

5.1.7. MASS and Sovereign Immunity

If a costal State finds a foreign MASS in breach of applicable national or international regulations, or if the coastal State does not recognise any navigational rights for the MASS, it may decide to seize the MASS in its territorial sea. Although ship arrest is a powerful tool for a potential claimant to secure their claim after a collision, a ship involved in a collision cannot be arrested if it enjoys sovereign immunity. This is where the question of sovereign immunity arises. Under UNCLOS, 'warships' and other 'government ships operated for non-commercial purposes' enjoy sovereign immunity.[1085] Given that being recognised as a 'warship' confers considerable advantages on a watercraft, it is essential to determine whether a given watercraft is a 'warship'. Although it has been argued that MASS Degrees 3 and 4 do not qualify as 'warships',[1086] it was demonstrated that such non-recognition would result in absurdities during international armed conflicts. Thus, if a MASS qualifies as a 'warship', then a coastal State is not entitled to stop, board, arrest or seize the MASS and can only require the MASS to leave its territorial waters immediately.

5.1.8. Main Findings of Chapter 2

The overall conclusion of Chapter 2 is that, under both UNCLOS and customary international law, MASS can be recognised as 'ships' that enjoy navigational rights in the high seas, the EEZ, and the territorial sea. Such recognition can help to protect human life, to save the marine environment, and to reduce the cost of carriage of goods by sea.

[1083] UNCLOS, Article 25(2).

[1084] UNCLOS, Article 300.

[1085] Article 31.

[1086] Michael N Schmitt and David S Goddard, 'International Law and the Military Use of Unmanned Maritime Systems' (2016) 98(902) International Review of the Red Cross 567, 579.

Given that some States have already started operating MASS in different maritime zones, if MASS are not considered as ships and do not enjoy freedom of navigation, then it is not clear which State or what authority is entitled to stop or prevent MASS operations in the high seas. Non-recognition of MASS as ships will deprive the international community of the benefits of autonomous shipping and can potentially lead to chaos in the high seas.

5.2. Analysis of COLREGs at Convention Level

Just because MASS can be considered as ships and enjoy freedom of navigation in different maritime zones does not necessarily mean that their operation will be safe and the current version of COLREGs can address their collision avoidance responsibilities. After the advent of steamships, new rules were added to collision regulations to address collision avoidance responsibilities between sailing vessels and steamships. Collision regulations have also been revised and updated after the introduction of new technologies such as radar and WIG craft so that the regulations can keep pace with new technologies. The advent of MASS raises the question of how collision regulations should once again change to cope with this new technology. There are generally three ways in which MASS collision avoidance duties and their interaction with conventional vessels may be addressed:

1) a new qualitative convention
2) a new quantitative convention
3) amending the current COLREGs

5.2.1. A New Qualitative Convention

Developing a totally new convention to make integration of MASS into a collision avoidance regime easier would be problematic for three reasons. First, it would stifle the autonomous ship technology that would otherwise have to develop to comply with the current or an amended version of collision regulations. Second, it would be confusing and unsafe to require thousands of vessels to start to comply with completely new rules from a specific date onwards. There are many small vessels which are navigated by individuals to whom the standards of the STCW or STCW-F Convention do not apply. Such individuals, therefore, may have a limited knowledge of COLREGs and adopting a totally new set of collision regulations has the potential to confuse such individuals and compromise the safety of navigation. Third, one of the issues associated with the existing collision regulations is that since they are ‘qualitative’, they are open to interpretation and thus, difficult to follow for a MASS Degree 4. A new qualitative convention, however much different from the current version of COLREGs, would still be ‘qualitative’ i.e. it would still be difficult to interpret by AI. Developing yet another qualitative convention, therefore, would not solve the said problem.

5.2.2. A New Quantitative Convention

In the aviation industry, there are ‘quantitative’ collision avoidance rules that are codified into the collision avoidance system of aircraft and take precedence over the pilot or the air traffic controllers. Such quantitative rules were developed after several mid-air collisions between aircraft that had to follow qualitative rules which are open to interpretation. The classification society DNV, therefore, has suggested that the shipping industry also should develop and adopt ‘quantitative’ collision avoidance rules for MASS Degree 4 to eliminate the issue of interpretation.[1087]

However, shifting the whole collision avoidance responsibility from humans to collision avoidance systems is unreasonable simply because there are many vessels which cannot be equipped with such systems and many individuals who want to navigate the vessel themselves as a recreational activity. Furthermore, when such a collision avoidance system malfunctions, a human should take over the control and navigate the vessel in accordance with collision avoidance rules. And if the rules are ‘quantitative’, then remembering, understanding and applying such rules can be extremely difficult especially for people who do not have professional seafaring qualifications. Moreover, certain collision avoidance rules simply cannot be quantified. For example, a give-way vessel must generally take ‘early and substantial’ action to keep well clear.[1088] However, the variables ‘early’ and ‘substantial’ will have different values depending on the traffic density and the course and speed of other vessels in the vicinity. From a pragmatic point of view, the Council and the Committees of the IMO will consider a proposal for a new convention only if the proposal proves that there is a ‘compelling need’ for such a new convention and also addresses the cost to the maritime industry and the relevant legislative burdens.[1089] There is simply nothing to show that there is a ‘compelling need’ for developing and adopting a set of quantitative collision avoidance rules. New quantitative rules (which would require installation of collision avoidance systems on board) would also impose unreasonable costs on many (especially smaller and non-commercial) vessels and a huge legislative burden on the IMO for developing a radically different set of collision avoidance rules.

5.2.3. Amending the Current COLREGs

This thesis has concluded that the most reasonable way of addressing MASS navigation is identifying potential issues in the existing COLREGs and amending the Convention

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[1087] Bjørn Johan Vartdal, Rolf Skjong and Asun Lera St Clair, ‘Remote-controlled and Autonomous Ships in the Maritime Industry’ (*DNV GL-Maritime*, 2018) <https://www.dnvgl.com/maritime/publications/remote-controlled-autonomous-ships-paper-download.html> accessed 07 February 2023.

[1088] COLREGs, Rule 16.

[1089] IMO Resolution A.500(XII), ‘Objectives of the Organization in the 1980s’ (20 November 1981).

accordingly. In order to address MASS navigation through the current Convention, it is first necessary to ensure that the Convention applies to MASS i.e. MASS can be considered 'vessels' under the Convention. There are two issues with the definition of 'vessel' provided by the Convention. First, the watercraft in question must be used or 'capable' of being used as a means of 'transportation'. The US Supreme Court has ruled in a recent case that the term 'capable' must be applied in a practical, not a theoretical way.[1090] In other words, the watercraft must have been designed to a 'practical degree' for carrying people or things over water.[1091] Under this interpretation, therefore, a small MASS with no carriage capability would not constitute a 'vessel' and would not be obliged to comply with COLREGs. A MASS not considered as a 'vessel' under COLREGs will be a potential hazard to other vessels. The second issue in relation to the definition of 'vessel' is that, a watercraft constitutes a 'vessel' only if it is used 'on' water. This definition excludes submarines that navigate 'below' but close to the water surface. The following amendment to Rule 3(a) of COLREGs will eliminate all these uncertainties and issues:

> *The term 'vessel' includes any craft including non-displacement craft, WIG craft, seaplanes and MASS, used or capable of being used on or in close proximity to water surface.*

5.2.4. Analysis of COLREGs at Framework Level

Another finding of this research is that the general framework of COLREGs should be retained. COLREGs at framework level consist of two separate regimes of collision avoidance, namely, rules that apply to vessels 'in sight of one another' and rules that apply to vessels in 'restricted visibility'. When in sight of one another, the more manoeuvrable vessel is required to keep out of the way of the less manoeuvrable vessel, and when in restricted visibility, both vessels must take avoiding action. During the IMO Regulatory Scoping Exercise on MASS, China proposed that for MASS Degree 4, these two regimes should be merged into one set of rules that apply in all conditions of visibility. Such a merged regime would inevitably be one of the following:

1) all vessels must take avoiding in all conditions of visibility
2) the more manoeuvrable vessel must take avoiding action in all conditions of visibility

The problems with the first option are as follows. Firstly, it would be impractical or even unsafe to require all vessels regardless of their manoeuvrability to take action simply because some vessels may not be able to take the required avoiding action due to their

[1090] *Lozman v City of Riviera Beach, Florida* [2013] 1 Lloyd's Rep Plus 17, 22.

[1091] Ibid.

restricted manoeuvrability.[1092] Secondly, if all vessels regardless of their manoeuvrability were required to take action, then the more manoeuvrable vessel might be tempted to delay her action until it may become too late to avoid collision by her action alone. There are three reasons why the second option would also be problematic. First, when visibility is restricted, it is difficult or impossible for vessels to establish the navigational status and manoeuvrability of all other vessels in the area. This is because vessels indicate their navigational status by exhibiting particular lights or shapes which cannot be observed by other vessels when visibility is restricted. Although AIS may sometimes be used to determine other vessels' navigational status, not all vessels are required to have AIS and the AIS information may not always be accurate or reliable. Second, some vessels are not obliged under SOLAS to be fitted with AIS or radar and these vessels may only detect the presence of other vessels by the fog signal that they sound in restricted visibility. There should be a set of particular rules for such vessels that cannot see other vessels in the area which is why a second regime of collision avoidance rules[1093] is currently in place. Third, even if all vessels were obliged to be fitted with AIS and radar, thick fog and heavy precipitation can dramatically decrease the detection ranges of all targets or even render small vessels totally undetectable. Thus, under such circumstances the more manoeuvrable vessel cannot take avoiding action if it cannot detect other vessels and their position. This radar limitation means that a separate regime of collision avoidance rules should apply in restricted visibility. Thus, the current framework of COLREGs i.e. the two regimes of collision rules based on the state of visibility should be retained.

The central finding of this study, however, is that COLREGs should be amended to require MASS Degree 4 not to impede the passage of all other vessels and keep well clear of them in all conditions of visibility. This finding is supported by technical, safety, societal, and ethical arguments.

5.3.1. Technical Argument

In order to be 'in sight of one another', vessels must be able to observe each other 'visually' i.e. with human eyes and requiring optical sensors to be made in accordance with seafarers' eyesight standards would unnecessarily complicate COLREGs. Furthermore, there may be situations in which a vessel is neither in sight nor in restricted visibility and a MASS Degree 4 may not know what action to take in such a situation. Although seafarers would have to comply with Rule 2 in such unspecified situations, codifying every possible situation into a MASS Degree 4 would be impossible and adding a specific provision to the Rules would complicate them even more. Another issue is that if the visual information received from a vessel's navigation lights is not complete, then it

[1092] For example, a vessel engaged in towing operation.

[1093] Section III of COLREGs.

will be impossible to specify the situation and know which Rules must be followed. Finally, MASS Degree 4 are currently incapable of perceiving other vessels' navigation lights and thus, they are not able to determine other vessels' navigational status or know what action to take when there is a risk of collision. Because of all these issues, MASS Degree 4 should be required to keep clear of all other vessels in all conditions of visibility.

5.3.2. Safety Argument

Since at least two decades ago, various studies have established that lack of situational awareness is the most common cause of maritime collisions around the world. The importance of proper lookout has been emphasised to shipowners and seafarers by the IMO, by P&I clubs and other professional maritime organisations such as the Nautical Institute. Yet, lack of proper lookout continues to cause collisions more than any other factor. In fact, the ever-increasing use of mobile phones by seafarers on the bridge of ships may exacerbate the situation and bring about 'modern times' collisions. Thus, the regulations should require MASS Degree 4 to keep clear of all other vessels so that risk of collision does not develop in the first place. And when risk of collision does develop in an encounter between a MASS Degree 4 and any other type of vessel, regulations should place the prime responsibility to avoid collision on MASS Degree 4 which are not prone to fatigue, apathy, distraction and other factors that contribute to watch officers' lack of situational awareness. This objective can be achieved by obliging MASS Degree 4 'not impede' the passage of any other vessel in any condition of visibility.

Some may argue that MASS Degree 4 should be treated as ordinary power-driven vessels and when risk of collision develops, MASS Degree 4 can ultimately avoid collision by their own avoiding action alone. Such an approach, however, will increase the risk of close-quarters situations, conflicting actions, and hydrodynamic interactions. Even if the watch officer maintains a proper look-out, the task of collision avoidance is becoming more difficult as the world's waters are becoming busier, ships are becoming faster and electronic navigational aids on ships' bridges are becoming more complex. A combination of these factors can, in turn, make the watch officer cognitively overloaded or impose high levels of stress on them that may affect their cognitive ability to deal with the collision situation. Because MASS Degree 4 can process large amounts of data and multi-task without suffering from information overload or stress, it stands to reason to require them not to impede navigation of all other vessels so that watch officers (on board or ashore) will have to process a lesser amount of information.

5.3.3. Societal Approach

Not obliging MASS Degree 4 to avoid impeding navigation of other vessels would, in effect, confer a navigational privilege on MASS Degree 4. This thesis, therefore, analysed whether robots do or should have any rights of their own. The dominant view is the instrumentalist theory that states technology is something which is used by humans merely as a means to an end.[1094] The *prima facie* result of applying the instrumentalist theory to MASS Degree 4 is that they are not moral subjects and do not have any right of their own. Hence, it has been argued that not only do not robots have any rights, they are not something that could be granted any right in the first place.[1095] It is submitted, nevertheless, that the moral status of robots should not be determined on the basis of their internal properties, but on the basis of our relationships with them. Put differently, the issue should be resolved from the positive (instead of natural) law perspective i.e. although robots do not have rights of their own, we may grant rights to a robot not for the sake of the robot itself, but for our own sake. For example, if being violent towards humanoid robots desensitises human beings, then we may grant legal protection to such robots. The question, therefore, is not whether robots have any inherent right, but whether our society is prepared to grant them any right equal to or higher than that of humans. In 2016, the European Parliament's Committee on Legal Affairs proposed to grant the most advanced autonomous robots the legal status of 'electronic persons' who enjoy specific 'rights'. In 2018, however, after a group of robotics, industry leaders, law, medical and ethics experts rejected and criticised the proposal as non-sensical and non-pragmatic, the European Commission withdrew its proposal. This is indicative of the fact that our society is not prepared to grant any right to even sophisticated humanoid robots let alone autonomous vessels. Moreover, in recent years, robotics, law, and ethics experts have reached a consensus that AI should be designed and operated for the benefit of humanity and it should not be granted any rights and privileges equal to those of humans.[1096] Requiring MASS Degree 4 not to impede navigation of other vessels will benefit watch officers in that it will reduce their navigational workload so that they can focus their attention on avoiding collision with MASS Degrees 1, 2 or 3.

5.3.4. Ethical Approach

Autonomous collision avoidance systems are not always flawless and the recent collisions involving autonomous cars and conventional vehicles and also pedestrians demonstrate this fact. Similar latent technical flaws may exist in the autonomous collision avoidance system of a MASS Degree 4 and if the MASS collides with another vessel, the

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[1094] Martin Heidegger, 'The Question Concerning Technology' (1977) Environmental Ethics 1, 1.

[1095] Abeba Birhane and Jelle van Dijk, 'Robot Rights? Let's Talk about Human Welfare Instead' (2020) Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society.

[1096] See, for example, IEEE, 'Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems' (2019) page 19 – available at <https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead1e.pdf?utm_medium=undefined&utm_source=undefined&utm_campaign=undefined&utm_content=undefined&utm_term=undefined> accessed 07 February 2023.

consequences can be far more serious than those of an autonomous car. A case, therefore, can be made that a MASS Degree 4 should take 'early action' so that it does not end up in a situation where the correct judgement and/or collision avoidance action may be difficult for the MASS. In addition to technical flaws, a MASS Degree 4 that faces risk of collision in a close-quarters situation, may also have to deal with the 'trolley problem'. In an inevitable collision situation where a MASS Degree 4 has to decide between colliding with two different vessels with different number of people on board, if the MASS is programmed to collide with either of the two vessels and casualty follows, it is likely that the MASS programmers and/or owners may face a criminal liability. Although programming the MASS Degree 4 to try to avoid collision with both vessels may minimise the liability of the programmers and/or owners of the MASS, it may result in harming or killing all people on board both vessels which is unethical and undesirable. Some may argue that the issue should be resolved through adopting a convention that provides immunity from liability for implementing a utilitarian approach i.e. taking an action that will result in fewer loss of life. However, since the nature of the trolley problem is controversial, reaching an international consensus can be rather difficult. This is another reason that supports the proposal of adding the following paragraph to Rule 8 of COLREGs:

> *(g) Except where Rules 9 and 10 otherwise require, a fully autonomous MASS shall not impede the passage of any other vessel at any time*.

Three points need to be clarified. First, since there is a human agency in navigation of MASS Degrees 1, 2 and 3, all the above arguments apply only to MASS Degree 4 i.e. 'fully autonomous' vessels. Second, because Rule 8 is situated in Section I of COLREGs, the above proposed rule would apply to MASS Degree 4 in 'any conditions of visibility'. Third, due to lack of enough sea-room, a MASS Degree 4 that is navigating within a narrow channel (under Rule 9) or a TSS (under Rule 10), cannot be expected not to impede navigation of a vessel crossing the narrow channel or TSS. Quite the contrary, it is the crossing vessel that should avoid impeding the passage of the MASS Degree 4 that can safely navigate only within the narrow channel or TSS. That is why the proposed rule should be subject to the provisions of Rules 9 and 10.

5.3.5. Main Findings of Chapter 3

Chapter 3 contains three important conclusions. First, although some organisations have suggested otherwise, the safest way of addressing MASS collision avoidance is through amending the existing COLREGs rather than developing a totally new qualitative or quantitative convention. Second, despite the proposal put forward by some IMO Member States, the two collision avoidance regimes under the current version of COLREGs[1097] should not be disturbed. Third, for technical, safety, societal and ethical reasons, MASS

[1097] That is, collision avoidance rules based on whether vessels are in sight or in restricted visibility.

Degree 4 should generally be obliged to take early avoiding action so that risk of collision does not arise in the first place. Some shipping companies are already working on developing such autonomous collision avoidance systems with no existing regulation in place to that effect.[1098]

5.4. Analysis of COLREGs at Rule Level

One of the conclusions of the IMO Regulatory Scoping Exercise was that in order to integrate MASS Degrees 1, 2 and 3 into COLREGs, no actual amendment is required and the IMO may just use 'equivalences' under COLREGs or develop 'interpretations'. This thesis, however, argued that there are only two equivalent provisions under COLREGs, namely, Rule 1(e)[1099] and Rule 38[1100] and both of these rules apply only to lighting and sound-signalling requirements and do not exempt any vessel from complying with the Steering and Sailing Rules. Also, 'unified interpretations' that are developed and published by the IMO are not binding on Member States. It was, thus, concluded that amending COLREGs should take precedence over using equivalences or developing interpretations where necessary.

5.5. Interim Guidelines for MASS Trials

Four issues were identified and addressed in the IMO Interim Guidelines for MASS Trials. First, given that the Guidelines apply to trials over a 'limited period', it is not clear whether MASS can engage in full-scale operations in the absence of international guidelines or regulations during the interim period. The next version of Guidelines should clarify this point. Second, since the Guidelines do not clarify 'where' MASS trials may be carried out, it was suggested that they should initially take place in designated test areas which are segregated from high-risk areas. And if certain safety criteria are met, then trials can move from sheltered waters to busier waters. Third, the requirement that MASS should comply with the *intent* of mandatory instruments is a vague one and can potentially compromise safety. Thus, interim guidelines should oblige MASS to comply with all provisions of mandatory instruments as closely as possible. Fourth, the Guidelines do not specify the method of communication of trials to third parties. It was argued that MASS ought to display internationally recognised identification day and night signals.

[1098] See, for example, 'MOL Steps up Research Aimed at Autonomous Collision Avoidance' (*Mitsui O.S.K. Lines*, 19 October 2020) <https://www.mol.co.jp/en/pr/2020/20067.html> accessed 07 February 2023.

[1099] Exempting vessels of special construction or purpose to fully comply with requirements relating to lighting and sound-signalling appliances.

[1100] Temporarily exempting vessels the keel of which was laid before COLREGs came into force to comply with the lighting and sound-signalling requirements.

5.6. MASS and Good Seamanship (Rule 2)

Case law indicates that the concept of good seamanship evolves over time and in light of new technologies. For instance, the advent of marine radar on ships gradually changed the requirement of good seamanship regarding the look-out position i.e. it became acceptable and in line with principles of good seamanship to move the position of the look-out from crow's nest to navigation bridge. In light of the MASS Degree 3 technology, the position of the look-out and watch officer can be moved from bridge to a remote control-centre on shore.

Although the CMI Position Paper states that MASS Degree 4 would fall foul of the requirements of good seamanship, the thesis concluded otherwise by arguing that good seamanship as stated in Rule 2, is neither an express obligation nor a prerequisite element for seafarers' certification. It is just *a solemn warning* that compliance with COLREGs may not be enough in certain situations,[1101] and a *cautious reminder* of the legal consequences of negligence.[1102] Some may argue that since fully autonomous collision avoidance systems do not have the common sense of human beings, they may not be able to determine what action to take in situations not specified by COLREGs and hence, operation of MASS Degree 4 should be banned. Be that as it may, this research proposed a three-stage system to evaluate whether a given MASS Degree 4 is safe to operate. In stage 1 (simulations), the software of MASS Degree 4 is tested in various collision encounters and is then rectified or improved if necessary. It is obvious that AI can pass this stage as it can retain and recall large amounts of various information better than humans. Once stage 1 is successfully completed, then in stage 2 (interim trials), the performance of the software is tested on a MASS Degree 4 by the MASS owners or operators in a controlled way. The IMO should develop guidelines as to the minimum criteria to be met by the vessel and then update the guidelines to address any emerging issues. After a MASS Degree 4 has met the required criteria in the interim trials, then it should go through the third stage (sea trials) where the flag State tests, *inter alia*, the vessel's compliance with COLREGs (including Rule 2) and certifies the vessel upon successful completion of the test. Again, the IMO should adopt guidelines for such sea trials as well. Although such comprehensive guidelines for stage 2 or 3 currently do not exist, there are some indications that MASS Degree 4 have the potential to comply with Rule 2.

An objection against the three-stage assessment may be that it cannot cover all possible situations and a MASS Degree 4 (even if it passes all three stages) may fail to take the required avoiding action due to a sudden technical failure. Safety, however, is not absolute and international trade cannot be stopped until all ships and aircraft are completely safe with zero accidents. Humans and machines are not perfect and we

[1101] *The Queen Mary* (1949) 82 Ll L Rep 303, 341 (emphasis added).

[1102] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 7-074.

accept some level of risk in most human activities and then improve the technology over time to reduce the risk level. Even the most experienced shipmasters and Admiralty judges may sometimes have a different conclusion of what rule of COLREGs must be applied in a given situation.[1103]

Opponents of autonomous vessels may also reason that even if we accept a reasonable risk associated with operation of MASS Degree 4, courts are likely to face issues in apportioning liability in a collision involving a MASS Degree 4 due to the lack of standards of good seamanship applicable to MASS Degree 4. Such standards, however, are currently being developed by different organisations. Even the courts themselves can establish such standards in light of the available technology.

Although MASS Degree 4 are capable of complying with Rule 2, the wording of Rule 2 implies physical presence of crew on board the vessel and that it is a legal person (the vessel's owner) or a natural person (the vessel's master or crew) who must observe the principles of good seamanship. This uncertainty can deter potential users of MASS Degrees 3 and 4 due to possible civil and criminal liabilities. Thus, Rule 2 should be amended or clarified in a separate instrument in order to ovoid overcomplicating COLREGs.

5.7. MASS and Proper Look-out (Rule 5)

Interpretation of Rule 5 in light of the VCLT, relevant judicial cases, and the responses of the MLAs to the CMI Questionnaire all go some way towards establishing that even if under liberal interpretations MASS Degree 3 meet the look-out requirements, MASS Degree 4 do not. Thus, Rule 5 should be amended to allow electronic equipment to substitute human look-out. However, it is vital to ensure that electronic equipment can maintain a proper look-out as required by Rule 5. It was observed that MASS Degree 4 currently cannot detect small objects or understand other vessels' navigation lights. Nor can they understand sound signals or verbal communications on the VHF or seek advice from port control. This means MASS Degree 4 cannot comply with Rule 5 in all possible situations. Some argue that there should be a moratorium on operation of MASS Degree 4 until they can fully comply with Rule 5, and others posit that MASS Degree 4 should be exempt from the 'sight and hearing' requirement.[1104] This thesis, however, demonstrated that the benefits of using MASS outweigh their possible risks and thus their operation should not be banned. Exempting MASS from compliance with Rule 5 would also

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[1103] As observed in the case of *Nautical Challenge Ltd v Evergreen Marine (UK) Ltd* [2021] 1 Lloyd's Rep 299.

[1104] See, for example, 'UUV Manufacturers' Concerns Regarding NAVSAC Task 08-07, Resolution 11-02 Proposed Changes to Inland and COLREGS to Address Unmanned Underwater and Unmanned Surface Vehicles' <https://www.regulations.gov/document/USCG-2012-0212-0004> accessed 07 February 2023.

compromise safety at sea. Instead, the SOLAS or STCW Convention should make it clear that the 'sight and hearing' duty can be performed remotely on a MASS Degree 3 or by autonomous systems on a MASS Degree 4[1105] and specify the minimum requirements. In case amending SOLAS or the STCW Convention proves to be difficult, 'subsequent agreements'[1106] and 'subsequent practice'[1107] amongst pro-MASS States can over time extend the meaning of Rule 5 to cover MASS Degrees 3 and 4. However, since a new rule of customary international law may take a long time to be established, and given that the MASS technology is rapidly advancing, inconsistent standards may develop in different States and the regulations may fall behind the technology. The best way forward is that the IMO should invite flag States to submit the results of their interim trials and use the results to determine minimum standards for compliance of MASS Degrees 3 and 4 with Rule 5. Such standards would be developed on the analysis of a large amount of data gathered from trials of many MASS over a long period of time and thus, they would be comprehensive. The standards may remain guidelines or ultimately find their way into an amended version of the SOLAS or the STCW Convention. Although the concept of B0 developed by ABB can be a good starting point, such guidelines are not likely to be followed by all flag States or be as comprehensive as IMO standards (as discussed above) would be.

5.8. MASS and Restricted Visibility (Rule 19)

Although the COLREGs definition of 'restricted visibility' is rather circular, case law suggests that 5 nautical miles can be considered as the threshold for 'restricted visibility'. Accordingly, a MASS Degree 4 can use visibility sensors, cameras and hygrometers to determine whether it is in restricted visibility or not. It was also shown that fog signals should be sounded when visibility has dropped to less than 3 miles. A particular situation to pay attention to is where two vessels not initially in sight, ultimately come within sight. There is a dichotomy between the views of the US and UK courts as to what action each vessel must take. This thesis concludes that when vessels come in sight, they must continue to comply with the rules applicable in restricted visibility unless the speed and distance between the vessels gives them ample time to reassess the situation. However, the owners of a MASS Degree 4 that is programmed to comply with the opinion of the US courts, may be found liable by the UK courts for a collision that takes place in UK waters. This is another reason that supports the overarching normative framework of this thesis:

[1105] There is already a precedent for extending the meaning of Rule 5 to cover the use of new technologies. For example, SOLAS allowed watch officers on high-speed craft to use a 'sound reception system' in order to hear sound signals around the high-speed craft.

[1106] Vienna Convention on the Law of Treaties, Article 31(3)(a).

[1107] Ibid Article 31(3)(b).

MASS Degree 4 should be obliged to take ‘early’ action so that the risk of getting into close-quarters situations with other vessels is minimised.

5.9. Navigational Status and Identification Signals for MASS (Rules 3 and 23)

This research argued that MASS Degree 3 or 4 cannot and should not be recognised as NUC or RAM vessels under COLREGs. Such a navigational status would be counter-productive to development of MASS,[1108] would not address the issue of MASS-MASS encounters,[1109] and would be contrary to the principle that it is conventional vessels that should have navigational rights, not MASS.[1110]

There are also compelling reasons for requiring MASS to display or transmit a unique identification signal. For example, a MASS Degree 3 may lose its communication link with the remote control-centre ashore and a MASS Degree 4 may fail to take action or execute a sudden and unexpected manoeuvre. Vessels with particular manoeuvring characteristics (such as air-cushion vessels and WIG craft) are obliged to exhibit their own unique identification lights so as to alert the maritime traffic of their presence in the area. In a recent survey in which 130 professional seafarers and maritime pilots from Japan and other countries participated, 96% of the respondents expected that transmission of an electronic signal[1111] will become compulsory for MASS and 68% stated that MASS should exhibit some identification shapes or lights.[1112] These statistics indicate that seafarers may exhibit an unease about trusting MASS in manoeuvring situations.[1113] The number, colour, position and other characteristics of the lights and signals, however, should be determined by science-led studies.

5.10. Main Findings of Chapter 4

Chapter 4 has shown the importance of clarifying the meaning and application of Rules 2 and 5 through SOLAS or the STCW Convention. It has also identified potential shortcomings of the IMO Interim Guidelines for MASS Trials and how they can be improved. A 3-phase system was proposed for interim MASS trials and the IMO should

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1108 Because it may imply that they are ‘unseaworthy’.

1109 That is, it is not clear which MASS must take avoiding action as they both are NUC or RAM and by definition, unable or restricted to take action.

1110 As established in Chapter 3.

1111 Such as AIS signal.

1112 Toshiyuki Miyoshi, Shoji Fujimoto, Matthew Rooks, Tsukasa Konishi, and Rika Suzuki, ‘Rules Required for Operating Maritime Autonomous Surface Ships from the Viewpoint of Seafarers’ (2022) 75(2) The Journal of Navigation 384, 391.

1113 Ibid 389.

analyse the results of the trials in order to revise and improve its current Interim Guidelines. The Interim Guidelines can then be used for MASS certification and amendments to COLREGs.

5.11. Limitations and Methodological Challenges

This study took a comprehensive approach in determining the legal status of MASS under UNCLOS. Detailed analysis of MASS under UNCLOS was necessary because if MASS did not have navigational rights in the high seas, then analysis of COLREGs would be pointless without first addressing the issues under UNCLOS. However, when it comes to COLREGs, due to the magnitude of work that analysing every single Rule of COLREGs would require, this study adopted a primarily macroscopic analysis of COLREGs. That is to say, the study analysed whether the advent of MASS on the high seas warrants a new collision convention, whether the two-regime structure of the existing COLREGs ought to be amended, and whether MASS Degree 4 should be treated as ordinary power-driven vessels under COLREGs for the purposes of navigational rights. In addition, this study also adopted an in-depth assessment of some of the most problematic Rules of COLREGs in the context of MASS i.e. Rules 2, 3, 5 and 19. The scope of this study and its conclusions regarding specific collision regulations, therefore, is mainly limited to the said Rules.

From a methodological point of view, there are two factors that can affect the analyses and conclusions of this research. First, given that MASS is a new technology and no collision case involving a MASS has so far come before any court, the findings that are the outcome of the text-based methodology employed in some parts of the thesis are open to debate.[1114] Put another way, the ultimate validity of such findings has to be established through court decisions or developing a consensus amongst the legal community. For example, the finding in Chapter 3 that some MASS may not constitute 'vessels' for the purposes of COLREGs is open to debate. The text-based methodology, however, is justified by the nature of the relevant research questions. Second, in order to answer the normative research questions, a normative framework had to be adopted and the author decided to select 'safety' as the internal normative framework, and 'serving humanity' as the external normative framework in Chapter 3. Thus, the normative framework that is used in this thesis to analyse the data is the second factor that may affect the conclusions of the thesis. This means that adopting a significantly different pair of normative frameworks may have resulted in different conclusions regarding collision avoidance of MASS. For instance, by adopting a purely economic approach to MASS collision avoidance, one may have concluded that placing the prime collision avoidance responsibility on MASS Degree 4 would impose extra cost and delay on the autonomous

[1114] For example, interpretation of Rule 3(a) and whether MASS Degree 4 are 'vessels' under this rule.

shipping industry. The corollary of this conclusion would then be that regulations should require conventional vessels not to impede navigation of MASS Degree 4 and not the other way round. However, the author's choice of normative frameworks is supported by the overarching principle that safety of life should always be the highest priority in adopting or amending laws and regulations.

Furthermore, this research concluded that when it comes to collision avoidance responsibilities, the regulations should treat MASS Degree 3 as ordinary power-driven vessels. In other words, MASS Degree 3 should not be required to avoid impeding navigation of conventional vessels simply because there is a human who is in fact navigating and monitoring the MASS Degree 3 remotely. Humans are more or less susceptible to the factors that contribute to the lack of proper look-out and this is the most common cause of maritime collisions. This conclusion, however, is reached based on the premise that remote (on-shore) navigators of MASS Degree 3 will equally be prone to lack of situational awareness and cognitive overload as onboard navigators are. If remote navigators turn out to be much less prone to lack of situational awareness[1115] and cognitive overload,[1116] then a case may be made for a change in the regulations to require MASS Degree 3 to avoid impeding navigation of MASS Degrees 1 and 2. To date (07 February 2023), there is simply not sufficient data about the performance of MASS Degree 3 remote operators. Hence, the author's premise that remote navigators are currently susceptible to the same factors as on-board navigators are. As the number of MASS Degree 3 and remote navigators increases, more data from collision avoidance performance of those navigators will become available and further research can then be carried out to re-evaluate collision avoidance responsibilities of MASS Degree 3.

5.12. Areas for Further Research

Given that this thesis did not deal with all Rules of COLREGs, there are certain aspects of MASS collision avoidance that would benefit from further research. Some of these aspects are directly related to COLREGs and others relate to other laws or regulations related to navigation. First and foremost, navigation of MASS Degree 4 in 'narrow channels' should be analysed as there are many risks associated with sailing in a narrow channel. To name a few, some of such risks include frequent encounters between vessels that have to pass at close quarters, cross-channel and converging traffic patterns, dredging, fishing and barge fleeting operations, and the increasing presence of recreational boats, many of which are navigated by people who are unfamiliar with

[1115] For example, because they do not live or work in the harsh environment of the sea for prolonged periods of time.

[1116] For example, because there is always an emergency backup team on standby, and advanced electronic equipment in the on-shore control room that will assist the remote controller when necessary.

COLREGs.[1117] Although Rule 9 of COLREGs does regulate navigation of vessels in narrow channels, the issue is that there is currently no authoritative definition of 'narrow channel' for the purposes of this Rule. In fact, defining a narrow channel is so difficult that the IMO deliberately avoided a definition in drafting the 1972 COLREGs.[1118] In its investigation into a collision between two vessels in 1981, the US NTSB observed that it does operators 'little good to learn months after an accident that a court has ruled that a particular portion of a waterway, under a particular set of circumstances was or was not a 'narrow channel' under the rules, and that the narrow channel rule should or should not have been applied by the parties involved in the accident.'[1119] To examine the issues relating to narrow channels and to present draft recommendations, the US NAVSAC formed the Rule 9 Working Group in 2009.[1120] The group concluded that the effectiveness of Rule 9 is undermined as it is often unclear to the mariner when the rule applies.[1121] The group also highlighted that the multi-factor analysis of Rule 9 adopted by courts is complicated and that mariners' collision avoidance action will be delayed if they have to analyse all the relevant factors on a case-by-case basis.[1122] There is also a risk that two or more approaching vessels may reach conflicting conclusions as to whether Rule 9 applies to the situation.[1123] Where it is difficult for mariners to determine whether a particular waterway constitutes a 'narrow channel' under Rule 9, it goes without saying that it can be even more difficult for a MASS Degree 4 to do so. In the absence of authoritative definition or guidance as to what constitutes a 'narrow channel', there is a clear need for research to address collision avoidance of MASS Degree 4 in waterways that might be narrow channels. In addition to navigation in international waterways, such research will also promote safety of navigation in inland waterways of countries that are more likely to operate MASS in their inland waterways. One such country is the US that has over 25,000 miles of commercially navigable waterways.[1124]

[1117] Craig H Allen, 'Taking Narrow Channel Collision Prevention Seriously to More Effectively Manage Marine Transportation System Risk' (2010) 41(1) Journal of Maritime Law & Commerce 1, 7.

[1118] Andrew Tettenborn (ed) and John Kimbell (ed), *Marsden and Gault on Collisions at Sea* (15th edn, Sweet & Maxwell 2021) para 7-218.

[1119] Craig H Allen, 'How Narrow is "Narrow"?' in: 'Waterways Management' (2011) 68(1) Proceedings (The Coastguard Journal of Safety & Security at Sea) page 16 – available at <https://www.dco.uscg.mil/Portals/9/DCO%20Documents/Proceedings%20Magazine/Archive/2011/Vol68_No1_Spr2011.pdf?ver=2017-05-31-120645-040> accessed 07 February 2023.

[1120] Ibid.

[1121] Ibid.

[1122] Ibid.

[1123] Ibid.

[1124] The US Committee on the Marine Transportation System, 'Marine Transportation System Fact Sheet' (2021) – available at

‘Visual’ MASS identification signal is another area for research. Even though this research demonstrated that MASS should be required to exhibit particular lights (during darkness) or shapes (during daylight), the number, colour and disposition of such lights and shapes should be determined. Although some deck officers have opined in a recent survey that the colour of MASS identification light should be purple,[1125] a multi-disciplinary study is needed to determine the colour, intensity and disposition of the lights. It is also necessary to assess whether all four degrees of MASS should have exactly the same identification lights, or whether each degree of MASS should have its own unique and distinguishable identification lights. Furthermore, all vessels in or near an area of restricted visibility should make their presence known by a particular sound signal depending on their type and activity.[1126] For similar reasons as to why MASS should display visual identification signals when in sight of other vessels, MASS should also be required to sound a particular ‘sound’ signal under Rule 35. This thesis, however, did not analyse Rule 35 in the context of MASS. Thus, it is submitted that Rule 35 warrants further research into ‘aural’ ‘MASS identification signals.

The meaning of ‘distress’ under COLREGs is another issue which is open to further investigation. There is a long-standing maritime tradition that the master of a ship has a duty to render assistance to ‘persons’ in distress at sea. This obligation is also enshrined in international law. For instance, under UNCLOS, the shipmaster must render assistance to any ‘person’ found at sea in danger of being lost and to proceed with all possible speed to the rescue of ‘persons’ in distress.[1127] Similarly, SOLAS requires shipmasters to provide assistance to ‘persons’ who are in distress at sea.[1128] The Search and Rescue (SAR) Convention, 1979, also requires the State Parties to render assistance to any ‘person’ in distress at sea regardless of the ‘nationality or status of such a person’ or the circumstances in which that ‘person’ is found.[1129] It is, therefore, clear that international law requires shipmasters to provide assistance to ‘persons’ who are in distress. There is no ‘obligation’ to rescue a ‘ship’ or ‘vessel’ if there is no ‘person’ on board that ship to be rescued. Rescuing a ‘ship’ which is in danger of being lost at sea, is a ‘voluntary’ act that may constitute a maritime ‘salvage’ and entitle the salvor to a salvage reward. That being said, Rule 37 of COLREGs provides that when a ‘vessel’ is in distress, she must use or

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<https://www.cmts.gov/assets/uploads/documents/MTS_Fact_Sheet_2021_01_28.pdf> accessed 07 February 2023.

[1125] Elspeth Hannaford, Pieter Maes and Edwin Van Hassel, ‘Autonomous Ships and the Collision Avoidance Regulations: A Licensed Deck Officer Survey’ (2022) WMU Journal of Maritime Affairs 1, 25.

[1126] As prescribed in Rule 35 of COLREGs.

[1127] Article 98(1).

[1128] Regulation V/33(1).

[1129] Paragraph 2.1.10.

exhibit the distress signals described in Annex IV to COLREGs. The question then arises whether a MASS Degree 3 or 4 i.e. a ‘vessel’ with no human on board must or is entitled under Rule 37 to send out such distress signals. In a recent guide regarding autonomous and remote-control functions, ABS[1130] suggests that situations in which a vessel installed with autonomous or remote-control functions is required to communicate distress includes ‘loss of communication with shore control station’ and that the vessel should be capable of communicating distress signals to both shore control station and the surrounding vessels.[1131] The guide, however, clarifies that the autonomous functions covered in the guide focus on the functional capabilities and do not imply ‘unmanned’ operations.[1132] If this issue is not clarified, then a MASS Degree 3 or 4 which is in danger of being lost (e.g. by dint of the loss of its propeller), may send out a distress signal which must then be acted upon by any conventional vessel in the vicinity that receives the signal. Although owners of MASS Degree 3 and 4 would be in support of an expansive interpretation of Rule 37, there will be an objection from owners of conventional vessels for obvious reasons. Since sending out the same distress signals by a MASS Degree 3 or 4 may confuse mariners and disrupt other vessels’ navigation, it should be clarified whether Rule 37 applies to MASS Degrees 3 and 4. In addition, a MASS Degree 4 which is in danger, should be able to communicate its need for assistance to potential salvors not least because the MASS may harm the marine environment and/or cause accidents involving other vessels around it. Thus, a particular signal e.g. a ‘salvage signal’ may need to be introduced by COLREGs or other conventions for such situations.

In addition to COLREGs, analysis of the STCW Convention will also be beneficial to enhancing the safety of MASS operations. For example, the STCW Convention sets out the training standards and certification for seafarers who serve ‘on board’ seagoing ships.[1133] Thus, it is currently not clear what training or qualifications a remote operator of MASS Degree 3 must have in order to operate a MASS Degree 3 from a remote control-centre. An important question is whether a remote controller must be a former OOW with on-board experience. Research must also be carried out on the necessity of presence of a master and crew on board a MASS that carries non-crew human beings. For example, it has been argued that in order to protect lives at sea, any vessel carrying humans at sea

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[1130] An American maritime classification society.

[1131] ABS, ‘Guide for Autonomous and Remote Control Functions’ (2021) at paragraph 2.5. – available at <https://ww2.eagle.org/content/dam/eagle/rules-and-guides/current/other/323_gn_autonomous/autonomous-guide-july21.pdf> accessed 07 February 2023.

[1132] Ibid para 1.2.

[1133] Article III.

must also carry a master and crew unless explicitly exempted by the relevant competent authorities.[1134]

Another research area concerning safety of MASS navigation is compulsory maritime pilotage in certain waters around the world. For instance, under domestic legislation of Egypt, pilotage is compulsory for all vessels transiting the Suez Canal.[1135] In order to highlight the importance of safety of navigation in the Suez Canal, suffice to say that the one-week blockage of the Canal caused by the grounding of *The Ever Given* in March 2021 cost the world trade about 54 billion US dollars.[1136] It is, therefore, crucial to analyse whether a MASS Degree 3 can safely be piloted remotely, or whether a MASS Degree 4 can be safely navigated without a pilot at all.

5.13. Original Contribution to Knowledge

The original contributions of this thesis to knowledge are as follows. First, this researcher has established by adopting various approaches that operation of all degrees of MASS in the high seas and in the EEZ and territorial sea of foreign States is not, *per se*, against the provisions of UNCLOS. In other words, in the above-mentioned maritime zones, MASS collectively enjoy the same navigational rights that conventional vessels are entitled to under UNCLOS.[1137]

The second original contribution to knowledge is analysis of COLREGs at convention level, framework level and rule level. At convention level, the thesis has shown that the safest way of regulating MASS navigation is through piecemeal amendments to the existing COLREGs rather than developing a completely new set of collision regulations. It has also demonstrated, at framework level, that the current dual framework of COLREGs should be retained i.e. all vessels including MASS should still be required to follow two regimes of collision avoidance depending on the state of visibility. At rule level, the thesis has identified and addressed issues in the most important Rules of COLREGs and demonstrated that the most important amendment that COLREGs will need in the foreseeable future is requiring MASS Degree 4 not to impede navigation of all other vessels.

[1134] Aly Elsayed, 'MASS: Where is the Master?' in: 'Seaways' (February 2023) The International Journal of The Nautical Institute 1, 6ff.

[1135] Rules of Navigation (2020 Edition), Article 6(1).

[1136] Koustav Das, 'Explained: How Much did Suez Canal Blockage Cost World Trade' (*India Today*, 30 March 2021) <https://www.indiatoday.in/business/story/explained-how-much-did-suez-canal-blockage-cost-world-trade-1785062-2021-03-30> accessed 07 February 2023.

[1137] Such navigational rights in the EEZ and territorial sea of a coastal State are subject to the legitimate laws and/or regulations of the coastal State in question.

The third original contribution is devising a system to determine the right balance between MASS safety and MASS regulation. The history of automobiles, aircraft and ships shows that tough restrictions on a new technology will stifle development of the technology and will delay its benefits. In other words, new technologies, in the long run, will improve safety and will benefit human societies at large. The MASS technology can likewise improve the safety of navigation and regulations should, therefore, foster this technological innovation within the shipping industry rather than banning it. That is, nevertheless, not to say that MASS operations collision avoidance should be left to self-regulation or custom – a balance must surely be maintained between safety and fostering innovation. Given the novelty of MASS technology and importance of ship navigation, the absence of regulations specifically dealing with potential issues associated with MASS may well jeopardise safety of life, safety of environment and safety of property. In order to highlight the importance of safe navigation and effective regulations, suffice it to quote the famous phrase that 'no ship is more than twenty seconds away from disaster'.[1138] On the other hand, too restrictive regulations can also decelerate or halt further development of the MASS technology. The issue, however, is that it is not always easy to strike the right balance between safety and regulation. This difficulty in finding the right balance manifests itself in the literature in two extreme views about MASS operations: imposing a blanket ban on MASS operations, or exempting MASS from the existing collision regulations. This is where the third contribution of this study comes in by showing a third and more pragmatic way. The author has suggested a three-stage process over a period of time at the end of which the right balance between safety and regulation will emerge. The process will provide a solid foundation on which interim guidelines can be developed and improved and the guidelines can ultimately lead to adoption of a new code to certify MASS operations. It is submitted that implementing the findings of this research will greatly improve the safety of navigation in an environment where MASS and conventional vessels operate alongside each other.

[1138] John AC Cartner, Richard P Fiske and Tara L Leiter, *The International Law of the Shipmaster* (Informa Law 2009) 13.

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The Anna Salem [1954] 1 Lloyd's Rep 475

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