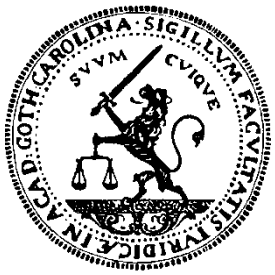

FACULTY OF LAW

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# The MASS code on autonomous shipping: Evolution and legal implications

JURM02 Graduate thesis

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# Summary

The shipping industry is currently at the beginning of a transformative shift with the introduction of Maritime Autonomous Surface Ships (MASS). With MASS, ships will function without the need for humans onboard. However, the current legal framework within maritime law is built on the premise that humans are in fact onboard ships. Therefore, legal questions and uncertainties have risen alongside this new technology.

To tackle this issue, the International Maritime Organization (IMO) set out in 2017 to develop a code, with the aim of covering the legal gaps created in the framework by the introduction of MASS. The MASS code, currently in a draft state, aims to define responsibilities and solve practical issues arising from the use of the new technology, whilst also seeing to that the risks adhering to the introduction of this new technology are mitigated. The code has been developed within the IMO's framework with input from, among other parties, states, international organisations, private companies, and experts within the field. In the development of the code, a large quantity of opinions and material concerning the legal implications of MASS has been presented. This has mainly been in connection with the sessions of the Maritime Safety Committee (MSC), which has been the main actor in driving the development of the code forward.

This thesis examines the emerging MASS code, material relevant to it, and the implications of a transition from manned to unmanned autonomous ships, specifically focusing on the compatibility of current maritime laws and the effectiveness of the code. The conclusions drawn show that the current legal framework largely accommodates autonomous vessels within their respective regulatory instruments, although certain aspects need significant clarification. Furthermore, the thesis states that the code should shape its regulations with a performance-based approach, enabling the use of various solutions and minimising the risk of obstructing the development and use of MASS. In conclusion, it is stated that the draft code should be amended before its entry into force to ensure that all aspects of autonomous and unmanned ships are handled efficiently.

# Sammanfattning

Sjöfartsindustrin står för närvarande inför ett paradigmskifte i och med framväxandet av Maritime Autonomous Surface Ships (MASS). Dessa fartyg är utformade för att verka autonomt, utan mänsklig närvaro ombord. Den nuvarande rättsliga strukturen inom sjörätten bygger emellertid på antagandet att människor befinner sig ombord på fartygen, vilket har lett till uppkomsten av rättsliga frågor och osäkerheter i samband med denna nya teknologi.

För att hantera dessa utmaningar initierade Internationella sjöfartsorganisationen (IMO) 2017 ett arbete med att utveckla en kodifikation som syftar till att fylla de rättsliga luckor som uppstår genom användandet av MASS. Denna nya kodifikation, som för närvarande endast är ett utkast, avser att definiera ansvarsområden och lösa praktiska problem som uppstår vid användningen av den nya teknologin. Kodifikationen syftar även till att säkerställa att riskerna förknippade med denna nya teknologi minimeras. Utvecklingen av kodifikationen har skett inom ramen för IMO:s struktur och har, bland annat, involverat bidrag från stater, internationella organisationer, privata företag och experter inom området. Under kodifikationens utveckling har en omfattande mängd synpunkter och material rörande de rättsliga implikationerna av MASS presenterats, främst i samband med möten i ”Maritime Safety Committe”, som har varit den primära drivkraften bakom kodifikationens framåtskridande.

Denna uppsats undersöker den framväxande MASS-kodifikationen, relevant material sammanhörande till kodifikationen samt de implikationer som övergången från bemannade till obemannade autonoma fartyg medför. Särskilt fokus är riktat på hur väl de nuvarande sjörättsliga lagarna är kompatibla med denna nya teknologi samt den kommande kodifikationens effektivitet. Slutsatserna visar att det nuvarande rättsliga ramverket i viss utsträckning kan inrymma autonoma fartyg, även om vissa aspekter kräver betydande förtydliganden. Vidare framhåller uppsatsen att kraven i den nya kodifikationen bör utformas med en prestationsbaserad utgångspunkt, vilket möjliggör användningen av olika lösningar och minimerar risken för att hämma utvecklingen och användningen av MASS. Sammanfattningsvis konstateras att utkastet till den nya kodifikationen bör ändras innan den träder ikraft för att säkerställa att alla aspekter av obemannade och autonoma fartyg hanteras effektivt.

# Preface

First and foremost, I would like to extend my sincere gratitude to my supervisor, Olena Bokareva, for guiding me throughout the entire process of writing this thesis.

I would also like to thank my family and friends for supporting me throughout my legal studies, essentially making this thesis possible.

David Milger

Lund, May 22nd, 2024.

# Abbreviations

| | |
|---|---|
| COLREGs | The 1972 International Regulations for Preventing Collisions at Sea |
| FAL | The Facilitation Committee |
| ICJ Statute | The Statute of the International Court of Justice |
| ICS | International Chamber of Shipping |
| IMO | International Maritime Organization |
| LEG | The Legal Committee |
| LiDAR | Light Detection and Ranging |
| MASS | Maritime Autonomous Surface Ships |
| MASS code | Non-mandatory goal-based mass instrument |
| MSC | Maritime Safety Committee |
| SOLAS | The International Convention for the Safety of Life at Sea |
| STCW | International Convention on Standards of Training, Certification and Watchkeeping for Seafarers |
| ISM | The International Safety Management Code |
| UNCLOS | The United Nations Convention on the Law of the Sea |

# 1 Introduction

## 1.1 Background

The development of shipping has impacted global trade and economies for centuries. Today, the industry is on the looking towards a major change with the introduction of MASS (Marine Autonomous Surface Ships). Historically, innovations such as the transition from sail to steam power or from wood to iron and steel ships have marked significant changes in the industry. The shift towards MASS is driven by new technologies like artificial intelligence-aided design, and electronic navigation that enable ships to operate with minimal or no human intervention. These developments are supported by various stakeholders including industry leaders, regulatory bodies, and academic institutions. For example, the development of the fully autonomous ship Yara Birkeland[1] demonstrates the practical application of these technologies. Alongside, regulatory frameworks are also evolving, with organisations like the IMO (International Maritime Organisation) spearheading initiatives to integrate autonomous ships safely into the current maritime system.[2]

As the industry moves towards autonomous shipping, it faces challenges similar to past technological shifts. These include ensuring safety, integrating new operational methods, and managing the impact on maritime jobs. The transition to autonomous shipping is not solely concerning adopting new technologies; it also involves rethinking maritime practices and regulations to fully leverage the benefits of automation while addressing potential risks and ethical concerns.[3]

The progressive automation of ships, including potential crew reductions, poses substantial challenges to both ship operation and maritime law. Existing maritime regulations, premised on the assumption of manned ships, mandate a crew responsible for overseeing operations and responding to emergencies. This paradigm shift requires a thorough integration of autonomous or crewless ships into existing legal frameworks, which span from UNCLOS (The United Nations Convention on the Law of the Sea 1982) to detailed international safety rules enforced by the IMO. These regulations, including about 40 international conventions related to maritime safety, security, and

[1] An 80 meter long, fully electric, autonomous ship, see Yara website,< https://www.yara.com/news-and-media/media-library/press-kits/yara-birkeland-press-kit/> , (accessed 14 May 2024).

[2] G. Wright, *Unmanned and Autonomous ships: An Overview of MASS*, Abingdon: Routledge, 2020, at pp. 2 and 10–12.

[3] Ibid, pp. 15–17.

environmental protection, as well as national and regional laws, must adapt to accommodate new types of vessels. The role of the IMO is critical in this context; it sets a precedent that influences all other regulatory layers. Effective integration of autonomous ships within IMO conventions is essential for facilitating legal adjustments in correlated regulatory frameworks. Conversely, a failure to update IMO rules to reflect advancements in ship automation could impede the establishment of a legal foundation for operating such ships internationally. Thus, harmonising global maritime regulations with the capabilities of autonomous technology is imperative for legal and operational consistency.[4]

To face this challenge, the IMO aims to adopt a new, non-mandatory goal-based MASS code to take effect in 2025. This code will form the basis for a coming mandatory code, planned to enter into force in 2028.[5] However, whilst a new regulatory instrument is widely viewed as necessary, the existing regulatory framework would likely also need revision, since it has been developed with traditional, manned ships in mind.[6]

The project of creating the MASS code formally started within at the 98th session of the MSC (The Maritime Safety Committee) in 2017.[7] Following the history of the MASS code since its inception, it is clear that establishing a solid trajectory for these regulations is a complex endeavour. The creation and implementation of regulations within the MASS code present substantial challenges. For example, one significant issue is how administrations, recognised organisations, states, and the industry will handle certification and other approval processes to ensure that a MASS or its systems maintain at least the same level of safety as traditional ships.[8]

In conclusion, while the path forward includes navigating significant regulatory and operational challenges, these efforts are crucial for integrating MASS into the global shipping framework safely and effectively. The ultimate goal is to ensure that MASS can revolutionise maritime transport while maintaining the highest safety standards and gaining public trust. This

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[4] H. Ringbom, "Legalizing autonomous ships" , (2020), *Ocean Yearbook 2020*, Vol. 34, No. 1 at p. 432.

[5] IMO, *Autonomous shipping*, <https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx>, (accessed 8 May 2024).

[6] H. Ringbom, "Regulating Autonomous Ships—Concepts, Challenges and Precedents", (2019), *Ocean development & international law*, Vol. 50, at p. 163.

[7] MSC 98th session, MSC 98/20/2, Maritime Autonomous Surface Ships: Proposal for a regulatory scoping exercise, submitted by Denmark, Estonia, Finland, Japan, the Netherlands, Norway, the Republic of Korea, the United Kingdom and the United States, pp. 1–2.

[8] H. Thunfors, "Evolution of IMO's MASS: Through the prism of the chair", in T. M. Johansson et al., *Autonomous Vessels in Maritime Affairs: Law and Governance Implications*, Cham: Springer Nature Switzerland AG, 2023 at p. 55.

delicate balance will require careful consideration of all factors, including the human element, which remains central to the design, testing, and operation of these systems.[9]

As shown above and by nature of the relatively new technology of autonomous ships, and an entirely new legal instrument, legal uncertainty exists. The aim of this thesis is therefore to highlight these uncertainties and provide further legal research on the matter.

## 1.2 Scope and purpose

The purpose of this thesis is to define legal uncertainties connected to the existing legal instruments of SOLAS (The International Convention for the Safety of Life at Sea), COLREGs (The International Regulations for Preventing Collisions at Sea as amended 1972), UNCLOS, and the new MASS code. Furthermore, the thesis seeks to discuss the defined issues and possible solutions to them.

The research questions this thesis seeks to answer are the following:

- Whether current regulatory maritime law is applicable to MASS?
- Whether amendments are needed to the current regulatory maritime framework?
- What are the potential legal implications in the proposed new MASS code and could the MASS code provide viable solutions to regulate MASS?

To answer these questions, it is necessary to examine the development of the new MASS code, as to understand the reasoning, meaning and purpose behind the regulations within the codification, to fairly assess and critically discuss its implications. Furthermore, legal doctrine surrounding issues in the new MASS code in relation to existing instruments will also be examined as to further clarify uncertainties within the draft code and nuance the results of the thesis. After examining these sources parallel to each other, conclusions will be drawn in order to answer the research questions stated.

Only certain regulations within the field of public maritime law, in relation to the MASS code, will be examined in the scope of the thesis. This delimitation is made to focus the thesis on the most frequently mentioned and discussed issues, within legal doctrine, the shipping industry, and debate pertaining to

[9] Ibid, pp. 57–58.

autonomous shipping and the new MASS code. This delimitation has been done by analysing and evaluating the legislative history of the MASS code, as well as discussions pertaining to the code and selecting the chosen instruments based on the results of that analysis.

In order for the reader to grasp the technical aspects presented within the thesis, the thesis will include a concise background to relevant matters. These matters include autonomous vessels, the selected regulatory instruments, the MASS code, and the legislative history of the MASS code. By nature of the topic of the thesis, the research questions demand a fundamental level of understanding for the relevant technical aspects in order to be fairly assessed.

Furthermore, whilst amendments are possible through existing legal instruments as those mentioned in the thesis, and the research questions hypothetically could be extended to include related instruments, the thesis will focus on amendments to the emerging MASS code, as to limit the material scope of the thesis. This delimitation is made in order to for each stated research question to be given the room needed in order for it to be answered in a sufficient manner.

## 1.3 Methodology and materials

The research questions stated in this thesis will be answered through applying a theoretical legal dogmatic method. Using the legal dogmatic method, the questions stated in the thesis will be answered by analysing them in light of relevant legal sources.[10] The main relevant legal sources examined in this thesis is rooted in international conventions, as delineated by Article 38 (1) (a), of the ICJ Statute. The central instrument of the thesis is the MASS code, which will be, when it enters into force, on a voluntary basis. The MASS code is therefore to be viewed as international soft law as it lacks legal bindingness at its current state, which the thesis focuses on. Soft law falls outside the categorisation provided for in Article 38 of ICJ Statute. As the MASS code is set to become mandatory in 2028, it will evolve into international hard law, and therefore merge into the international regulatory framework.[11]

Secondary sources of international law, as listed in Article 38 of ICJ Statute, will also be included within the scope of the thesis.[12]

[10] M. Nääv and M. Zamboni, *Juridisk Metodlära*, Lund: Studentlitteratur, 2018 at pp. 27–28.

[11] C. Eggett, "Sources of International Law", in S. G. Hauck et al., *Public International Law: A Multi-Perspective Approach*, Abingdon: Routledge, 2024 at pp. 207–208.

[12] Ibid, p. 199.

Furthermore, the legal dogmatic method will be applied in a way where the research questions stated in the thesis will be answered with a *de lege lata*, analysing the current legal framework, and *de lege ferenda*, analysing the future legal framework, argumentation.[13] *De lege lata* and *de lege ferenda* adheres to the legal dogmatic method when there is legal coherence between the two.[14] In this thesis, this coherence is between the current maritime law regulating MASS and the MASS code. This serves the purpose of the research questions in the thesis by clarifying the current legal state of legal area at hand, in a critical manner, and contributing to the legal doctrine of the area.[15] Because of the absence of existing international law concerning the main questions of the thesis, the *de lege lata* argumentation will be limited to the current state of the law in focus, the MASS code draft and its legislative history.

Materially, the thesis is based on the discussions and work that lay ground to the new MASS code. In addition to this, legal doctrine, through journal articles and books, focused on the same discussions, and material provided therein, is examined. Therefore, documents provided by state delegations and legal papers submitted in relation to those during sessions of the MSC during the development of the new MASS code, lay ground for the thesis. In regard to legal doctrine, journal articles and books, complement the material provided for in the sessions to further deepen the legal analysis. Electronic resources used are from well recognised databases and websites of high relevance to the thesis.

Following the nature of MASS technology, and the current stage of the MASS code, no case law is referred to or analysed within the scope of the thesis. This is primarily because no such cases exist, relevant to MASS. It should be noted that case law exists concerning certain legal principles discussed within the scope of the thesis, but they have been omitted on the basis of their lack of relevancy concerning the purpose of the thesis.

The thesis is largely based on documents related to the development of the MASS code. This is mainly because of the lack of other academical text related to the draft code. Furthermore, this allows for the thesis to be based on first hand sources related to the draft code, and a selection of appurtenant documents, most relevant to the thesis.

[13] B. Lehrberg, *Praktisk juridisk metod*, Uppsala: Iusté, 2022 at p. 281.

[14] C. Sandgren, *Rättsvetenskap för uppsatsförfattare*, Stockholm: Norstedts Juridik AB, 2021 at p. 51.

[15] M. Nääv and M. Zamboni, *Juridisk Metodlära*, Lund: Studentlitteratur, 2018 at pp. 36–37.

The discussion, analysis, and conclusions drawn within the thesis is based upon the latest draft of the MASS code, published at the 108th MSC session, on th 13th of February 2024.[16]

## 1.4 Scheme of the thesis

Following this introductory chapter, chapter two discusses and introduces the concept of autonomous vessels and autonomous shipping. This is done to introduce the reader to the concept of autonomous vessels.

In chapter three, an introduction is given to the field of maritime law, as to introduce the reader to the legal framework of which the MASS code will take part, in order for the reader to understand the implications of, and context surrounding the MASS code.

In chapter four, the MASS code is presented. This chapter focuses on the development and legislative history of the MASS code. As the MASS code is not yet in final form, the legislative history of the code is of high value, as it gives background and context to the legal questions pertaining to it. Later in the chapter, legal doctrine and commentary pertaining to the MASS code is presented to further the readers understanding of the legal questions and uncertainties relevant to the MASS code.

Finally, in chapter five, foregoing chapters are analysed and reviewed in order to answer the questions of the thesis. By being guided through and shown the legal framework, and the technical predisposition, the reader is presented with the writer's thoughts and conclusions, built upon the information provided for in the earlier chapters. Lastly within this chapter, a concise summary is given.

[16] MSC 108th session, MSC 108/4, Report of the Correspondence Group Submitted by Marshall Islands, annex 1.

# 2 Autonomous shipping: Definitions and technical background

## 2.1 Background

The advent of autonomous shipping represents a technological leap in the maritime sector, differentiating from traditional, manned, seafaring practices towards a future where vessels navigate the oceans unmanned. This shift is not merely technological but also transformation in the maritime industry, driven by the dual aims of enhancing operational efficiency and reducing human error. As these autonomous vessels evolve from conceptual designs to operational realities, they bring a host of legal challenges and regulatory needs that mirror the industry's broader transition towards automation.[17] Despite the implications of autonomous shipping for the maritime legal framework, scholarly engagement with this subject remains relatively limited. This deficiency highlights the need for exhaustive legal research and discourse to address the complexities introduced by autonomous vessels.[18]

## 2.2 Definitions

The concept of "autonomy", and that of "vessels" or "ships" (used interchangeably within this thesis), encompasses many things. Therefore, some definitions and limitations have to be made in order for the thesis to reach necessary conclusions.

### 2.2.1 Definitions of autonomy

The concept of "autonomy" in maritime transport is central to ongoing legal, technical, and ethical discussions as technologies mature. Derived from the Greek words "autos" (self) and "nomos" (rule or regulation), "autonomy" in the context of maritime vessels refers to the capability of a ship to govern itself through self-regulating artificial intelligence. Scholarly literature

[17] R. Veal and M. Tsimplis, "The integration of unmanned ships into the lex maritim", (2017), *Lloyd's Maritime and Commercial Law Quarterly*, Vol. 303, at pp. 303–305.

[18] H. Ringbom, E. Røsæg and T. Solvang, *Autonomous ships and the law*, Abingdon: Routledge, 2021 at p. 3.

describes autonomous vessels as capable of interacting independently with their environment, making decisions, and navigating accordingly.[19]

Furthermore, an "autonomous vessel" can include many types of vessels, with many different degrees of autonomy. Many different systems exist to define to what extent a vessel is autonomous, and in extension, how it thereby should be regulated. The most commonly discussed systems for defining are IMO's MASS scale of autonomy within the MASS code, Sheridan's 10-point scale, and the six-point scale set out in the 2017 of the Danish Maritime Law Association.[20] The most commonly used, and therefore the system referred to in this thesis, is the scale used within the MASS code. [21]

The MASS code defines different levels of autonomy through a scale of one to four, degree one being non-autonomous and four being fully autonomous, in the following way.

| | |
|---|---|
| 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 and at times be unsupervised but with seafarers on board ready to take control. |
| Degree Two: | *Remotely controlled ship with seafarers on board:* The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions. |
| Degree Three | *Remotely controlled ship without seafarers on board:* The ship is controlled and operated from another location. There are no seafarers on board. |
| Degree Four: | *Fully autonomous ship*: The operating system of the ship is able to make decisions and determine actions by itself. |

[19] T. M. Johansson et al., "Introduction to Autonomous Vessels in Maritime Affairs: Law & Governance Implications", in *Autonomous Vessels in Maritime Affairs: Law and Governance Implications*, Cham: Springer Nature Switzerland AG, 2023 at p. 3.

[20] B. Soyer and A. Tettenborn, *Artificial Intelligence and Autonomous Shipping :Developing the International Legal Framework*, Oxford: Hart Publishing, 2021 at pp. 7–8.

[21] Ibid p. 8.

It is also stated that the scale does not represent a hierarchical order. Lastly, it is clarified that a vessel could be operating at multiple different degrees of the MASS scale for the duration of a single voyage.[22]

### 2.2.2 Definitions of a vessel

The terms "ship" and "vessel" are used across various maritime law texts and international conventions without a singular, universally accepted definition. This situation leads to legal interpretations that vary by jurisdiction. IMO instruments and UNCLOS offer descriptions that serve as references but allow for broad interpretation. The disparity in definitions can influence the application of maritime regulations and affect legal outcomes in matters related to maritime safety, environmental protection, and liability.

#### 2.2.2.1 UNCLOS

The UNCLOS is often referred to as the main governing regulation related to maritime and marine law. [23] UNCLOS does not contain a clear definition of what a vessel or a ship is.[24]

Under Article 94 of UNCLOS, flag States are mandated to exercise jurisdiction and control over their ships, ensuring safety at sea. This includes obligations regarding the construction, equipment, seaworthiness, and importantly, the manning of ships. States must ensure ships are manned by qualified masters, officers, and crews considering the type, size, and equipment of the vessel. This requirement calls for personnel in maintaining safety, preventing collisions, and ensuring effective communication at sea, in adherence to international safety and environmental protection standards.[25]

Article 94 of UNCLOS employs terminology such as "manning," "seamanship," "master," "officers," and "crew," which are traditionally associated with the presence of human personnel. However, UNCLOS does not stipulate the mandatory physical presence of seafarers on board a vessel. Consequently, the language used in Article 94 does not preclude the possibility of ships operated remotely, assuming the availability of technologies that can navigate a ship with a level of safety comparable to that achieved with human

[22] MSC, Outcome of the regulatory scoping exercise for the use of mass, MSC.1/Circ.1638 Annex, p. 3–4.

[23] J. Barret and R. Barnes, *Unclos as a living treaty*, London: British Institute of International & Comparative Law, 2016 at p. 5.

[24] J. Kraska and Y. Park, *Emerging technologies and the law of the sea*, Cambridge: Cambridge University Press, 2022 at p. 223.

[25] Ibid pp. 218–219 and 226.

oversight. This interpretation hinges on the technological capacity of systems like cameras, sensors, and radars to maintain operational standards equivalent to those of manned ships. Thus, the provisions of UNCLOS allow for the potential adoption of remotely operated vessels, contingent upon the efficacy and reliability of the necessary technology.[26]

#### 2.2.2.2 SOLAS

SOLAS (The International Convention for the Safety of Life at Sea), adopted in 1914 and amended in 1974, represents an international legislation aimed at ensuring the safety of, and on board, merchant ships. It establishes minimum safety standards for the construction, equipment, and operation of ships, under the jurisdiction of flag states. SOLAS includes comprehensive measures for fire safety, life-saving appliances, radiocommunications, and navigation safety, among others, across its detailed chapters. Each chapter addresses specific aspects of maritime safety, from construction and fire protection to emergency management and cargo handling.[27]

SOLAS contains definitions of ships based on the intended purpose and use of the ship, further clarified within each chapter of the regulation.[28] Some guidelines are given, for example, concerning passenger ships, "A passenger ship is a ship which carries more than twelve passengers."[29]. Furthermore, regarding cargo ships, "A cargo ship is any ship which is not a passenger ship."[30]

#### 2.2.2.3 COLREGs

COLREGs (The 1972 International Regulations for Preventing Collisions at Sea), was established to update and replace the 1960 Collision Regulations, concurrently adopted with the 1960 SOLAS Convention. The COLREGs articulate rules spanning various navigational scenarios, emphasising safe speed, proper lookout, and the conduct of vessels in diverse conditions, including in proximity to traffic separation schemes. These regulations are divided into parts covering general provisions, steering, navigation and sailing

[26] I. Parlov, "Can the International Regulatory Framework on Ships' Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?", (2023), *Ocean Development & International Law*, Vol. 54. at p. 168.

[27] IMO, *International Convention for the Safety of Life at Sea (SOLAS), 1974*, <https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx>, (accessed 10 May 2024).

[28] SOLAS Chapter 1, Regulation 1, (b).

[29] SOLAS Chapter 1, Regulation 2, (f).

[30] Ibid, (g).

rules, lights and shapes, sound and light signals, exemptions, and compliance verification, accompanied by annexes detailing technical requirements.[31]

COLREGs provides a broad definition of a "vessel" to encompass a wide range of watercraft. This rule categorises vessels as including every description of watercraft, such as non-displacement craft and seaplanes, that are used or capable of being used as a means of transportation on water. This inclusive definition ensures that the regulations apply to a diverse array of maritime vehicles, promoting safety and clarity in navigation practices across global waters.[32]

As seen in this chapter, autonomous vessels fit into the definition of vessels or ships within the relevant legal framework. In the following chapter, the legal framework which the MASS code will be incorporated into will be presented, as to give the reader an understanding of the legal premises for the code.

[31] IMO, *Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs),* <https://www.imo.org/en/About/Conventions/Pages/COLREG.aspx>, (accessed 15 April 2024).

[32] R. Pedrozo, "Advent of a New Era in Naval Warfare: Autonomous and Unmanned Systems", in T. M. Johansson et al., *Autonomous Vessels in Maritime Affairs: Law and Governance Implications*, Cham: Springer Nature Switzerland AG, 2023 at p. 68.

# 3 International maritime legislation: Principles and framework for the MASS code

Following the nature of the thesis, a short background must be given to the field of maritime legislation, given its unique nature. Since the thesis is focused on international law, with the MASS code being defined as international soft law and given its non-mandatory nature up until its revision and transformation into international hard law in 2028, a short background will also be given to hard and soft international law. Furthermore, the legislative process behind the MASS code will also be discussed and presented to give the reader a more nuanced understanding of the material presented concerning the legislative process of the code.

## 3.1 Introduction to maritime legislation

Maritime legislation stems at its earliest recording from the Babylonian Code of Hammarubi, dating back to the period between 2000 and 1600 B.C. At this stage, the code contained rules regulating leasing of ships, marine collisions, and more. These rules are viewed as a codification of the customs and practices that were most relevant at the time.[33] Throughout history, maritime legislation has evolved based on customs, practices and usage surrounding the legislation, giving it a very practical nature. As maritime legislations have evolved, they have been influenced by the marine venturers themselves, alongside judges, dispute settlements, and other influencers characterised by a practical standpoint.[34]

Modern maritime legislation is to a large extent based on maritime operations involving the movement of goods from one point to another. As approximately 90% of the tonnage of goods is transported by sea, the focus is apparent. The modern field of maritime law involves many different actors and many different subfields, all with the similarity of practicality and adaptability to the contemporary that is maritime law.[35]

## 3.2 The IMO and the legislative process

[33] P. K. Mukherjee, *Mukherjee on Maritime Legislation*, Malmö: WMU Publications, 2021 at p. 13.

[34] Ibid, p. 31.

[35] P. Todd, *Advanced Introduction to Maritime Law*, Cheltenham: Edward Elgar Publishing Limited, 2021 at pp. 1–3.

The IMO was established in the aftermath of the Second World War, initially as the United Maritime Consultative Council. Its role was narrowly defined due to concerns from some states regarding potential interference in domestic and commercial matters. This body was to be temporary, but its final session in October 1946 recommended creating a more permanent intergovernmental consultative organisation. This led to the establishment of the IMO, which was formally adopted under the United Nations Economic and Social Council in 1948 in Geneva. The IMO's mandate, as outlined in Article 1 of its Convention, is;[36]

> To provide machinery for co-operation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting international shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters of 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.

Originally conceived as a consultative body, the IMO's scope has expanded significantly over time. By 1975, the IMO had evolved into a regulatory authority, a change formalised by the IMO Assembly in Resolution A.358(IX), recognising its capacity to develop and adopt regulations ensuring the safety of international shipping and environmental protection.[37]

Today, the IMO has developed over fifty conventions that regulate a wide array of safety, environmental, and security aspects of maritime operations. These conventions, which are mostly in force, cover the majority of the world's commercial shipping by tonnage. Besides these binding treaties, the IMO has also created numerous non-binding 'soft law' instruments like codes, guidelines, and best practices that have significantly contributed to global ocean governance. The IMO's regulatory activities are specifically targeted at international shipping involved in international trade, explicitly excluding warships, government vessels not engaged in commercial activities, and vessels operating within internal waters, which remain under national jurisdiction. However, states can choose to apply IMO conventions more broadly in alignment with their national policies. Additionally, the IMO conducts assessments at member states' requests to enhance maritime safety within national waters. The IMO's role is further supported by UNCLOS (the United Nations Convention on the Law of the Sea), which directs states to engage with the

[36] R. P. Balkin, "The IMO and Global Ocean Governance: Past, Present, and Future", in D. J. Attard, *The IMLI Treatise on Global Ocean Governance: Volume III: The IMO and Global Ocean Governance*, Oxford: Oxford University Press, 2018 at pp. 1–2.

[37] Ibid.

IMO as the competent international organisation for setting maritime standards. Although UNCLOS rarely mentions the IMO explicitly, it is viewed that the provisions were intended to empower the IMO's regulatory role in international maritime governance.[38]

## 3.3 Sources of international law

Sources of international law, within the scope of this thesis, derive from one of four sources, namely, Conventions and treaties, international custom, general principles of law, and subsidiary sources.[39] Article 38 of the ICJ Statute is the point of departure for scholarly examination of the sources of international law. Historically, Article 38 has been referred to as an authoritative articulation of the sources of international law, underscoring the predominant role of States in the formation of international rules. This provision suggests that States are generally not bound by international rules unless they have expressly consented to them. However, the contemporary legal discourse challenges the notion that States are the sole architects of international law, suggesting a more nuanced interaction among various actors in the international legal system, and within the four sources in relation to each other.[40]

Conventions and treaties lay on the basis of the binding principle of *pacta sunt servanda*, by nature of the parties to the convention or treaty, obligating themselves to what is set forth in the agreement between them. Furthermore, the 1969 Vienna Convention on the Law of Treaties, states in Article 26, "Pacta sunt servanda*"*, that "Every treaty is binding upon the parties to it and must be performed by them in good faith.".[41]

International custom derives from the practices of the given legal environment.[42] In the field of international law, the given legal field relates to the practices of, and within, states. Moreover, the creation of customary international law involves two elements: State practice and the belief that such practice is legally obligatory, known as *opinio juris*. Customary international law is notably flexible, allowing it to adapt to various legal contexts. It can be regional or global in scope, may be affirmed by treaties or exist

[38] R. P. Balkin, "The IMO and Global Ocean Governance: Past, Present, and Future", in D. J. Attard, *The IMLI Treatise on Global Ocean Governance: Volume III: The IMO and Global Ocean Governance*, Oxford: Oxford University Press, 2018 at pp. 1–2.

[39] H. Thirlway, "The Sources of International Law", in M. D. Evans, *International Law*, Oxford: Oxford University Press, 2010 at p. 95.

[40] C. Eggett, "Sources of International Law", in S. G. Hauck et al., *Public International Law: A Multi-Perspective Approach*, Abingdon: Routledge, 2024 at pp. 157–158.

[41] H. Thirlway, "The Sources of International Law", in M. D. Evans, *International Law*, Oxford: Oxford University Press, 2010 at p. 101.

[42] Ibid.

independently, and can apply generally or be specifically tailored. This flexibility allows customary law to evolve in response to ongoing changes in international law and policy.[43]

Concerning general principles of law, the source was originally established within Article 38 of the ICJ Statute to cover a hypothetical scenario where the issue in a given dispute would not be governed by any treaty or established customary law. Therefore, to avoid a *non liquet* situation, the source of general principles of law was established within the Article.[44] Moreover, general principles of law provide legal function where the law is unclear and enhance the coherence of the international legal system. Furthermore, the general principles support interpretation and supplement other rules of international law and form the basis for establishing primary rights and obligations, as well as secondary and procedural rules. Specifically, general principles are often used in developing procedural norms and are linked with "international due process". This role is confirmed in Article 31(3)(c) of the 1969 Vienna Convention on the Law of Treaties, indicating that general principles are integral to the "rules of international law" and essential in legal interpretations and filling legislative gaps.[45]

Subsidiary sources of law, most commonly further defined as judicial decisions and teachings, refers to rules of international law stemming from deriving from aforementioned sources but furthered developed and materialised in a second source. As defined in Article 38 paragraph 1 (d) of the ICJ Statute, "subsidiary" gives it meaning in the determination of the applicable law at hand, necessitating its use only in cases where the given source needs further definition in order to be applied.[46]

In cases where two, or more, sources of law are deemed applicable, *prima facie*, a hierarchy within the sources decides which source of law shall be applied. The hierarchy between the sources is either decided by the principle of *lex specialis derogate generali*, or *lex posterior derogate priori*. The former prioritising the further specialised rule over the general rule, relevant to the subject, and the latter stating that the newer rule shall override the older rule.[47] Moreover, instruments may contain regulations concerning hierarchy,

[43] S. Victor, "Customary International Law", in S. G. Hauck et al*., Public International Law: A Multi-Perspective Approach*, Abingdon: Routledge, 2024 at p. 188.

[44] H. Thirlway, "The Sources of International Law", in M. D. Evans, *International Law*, Oxford: Oxford University Press, 2010 at p. 108.

[45] C. Eggett, "Sources of International Law", in S. G. Hauck et al., *Public International Law: A Multi-Perspective Approach*, Abingdon: Routledge, 2024 at p. 197.

[46] H. Thirlway, "The Sources of International Law", in M. D. Evans, *International Law*, Oxford: Oxford University Press, 2010 at p. 110.

[47] Ibid, p. 113.

expressively determining what should be applied in a situation of regulatory conflict.[48]

## 3.4 Hard law and soft law

Soft law describes non-binding legal instruments, containing norms, standards, principles, or other descriptions of excepted behaviour. used in contemporary international legal settings. Furthermore, whilst not law per se, soft law instrument possesses value in possibly describing *opinion juris*, contributing to asserting customary law, or contributing to the corpus in developing international law. Examples of soft law includes the 1948 Universal Declaration of Human Rights, and the 2007 Declaration on the Rights of Indigenous Peoples.[49]

Hard law, distinguished from soft law by the consequences of a hypothetical breach, where a breach of soft law leads to political consequences, and a breach of hard law giving rise to legal consequences. Furthermore, differentiating between the two is not always clear, as soft law seldom appears in isolation. Hard law and soft law often make part of the same instrument, in supplement to each other, or as complimentary parts to the other serving top clarify the rule at hand. Moreover, soft law instruments often evolve into hard law, either expressively, by stating how and when rules within a soft law instrument transforms from optional to mandatory, or by way of adaptation into customary law.[50] Binding force of soft law instruments can also be attained by incorporating their terms into hard law instruments. An example of this legal phenomenon is found UNCLOS, where resolutions and recommendations of the IMO, and various treaties, are prescribed to be apply "generally accepted rules and standards established through competent international organisation or general diplomatic conference".[51] Therefore, whilst the IMO possesses no power to adopt binding resolutions, UNCLOS can indirectly provide their resolutions obligatory status.[52]

In 2017, the IMO initiated an effort to incorporate MASS into its regulatory framework through the MASS code, focusing on safety, security, and environmental sustainability. Led by the MSC (Maritime Safety Committee), the initiative established a regulatory scoping exercise to integrate MASS within

[48] D. Shelton, "International Law and 'Relative Normativity'", in M. D. Evans, *International Law*, Oxford: Oxford University Press, 2010 at p. 157.

[49] Ibid, p. 123 and pp. 164–165.

[50] Ibid, p. 166.

[51] UNCLOS 1982, Articles 207–212.

[52] A. Boyle, "Soft Law in International Law-Making", in M. D. Evans, *International Law*, Oxford: Oxford University Press, 2010 at p. 129.

existing IMO instruments and address operational challenges. The exercise involved evaluating current IMO regulations to determine their applicability to MASS and identify regulatory gaps. Preliminary definitions and classifications of maritime autonomy were established, ranging from partially automated ships to fully autonomous vessels. The methodology encompassed identifying relevant regulatory provisions, followed by analysis to propose regulatory adaptations. This ensured comprehensive consideration of MASS operations, including technology, operational factors, and the human element.[53]

As shown in the chapter, the MASS code will further broaden the field of maritime law through the introduction of the instrument as soft law, which will later evolve into hard law. Pending its finalisation as well as interpretation by judiciary organs, the MASS code will most likely become *lex specialis derogate generali* concerning what is regulated within it regarding MASS. Having in this and the previous chapter asserted that MASS and the MASS code fits into the legal framework of maritime law, as well as how it fits in, the following chapters will focus on more specific issues related to the code.

[53] IMO, *IMO takes first steps to address autonomous ships*, https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx, (accessed 7 May 2024).

# 4 MASS: Legislative history and legal implications

## 4.1 Evolution of the MASS code

### 4.1.1 MSC sessions

The MSC is the principal technical body of the IMO, comprising all Member States. The MSC's responsibilities encompass a broad range of maritime safety matters. These include, but are not limited to, navigation aids, vessel construction and equipment, safety-related manning, collision prevention rules, handling of hazardous cargoes, maritime safety protocols, hydrographic data, logbooks, navigational records, marine casualty investigations, and salvage and rescue operations. Additionally, the MSC executes duties mandated by the IMO Convention and responsibilities assigned under any relevant international instruments approved by the organisation. It also develops and proposes safety recommendations and guidelines for potential adoption by the IMO Assembly. The committee's role extends to amending conventions like SOLAS, involving not only IMO Member States but also non-member States that are parties to such conventions.[54]

Whilst other committees of the IMO, such as the FAL (The Facilitation Committee) and LEG (The Legal Committee) committees, have contributed to the evolution of the MASS code, the MSC has been the driving committee. It is therefore of most relevancy to describe the evolution and work surrounding the MASS code based on those meetings.

#### 4.1.1.1 The 98th to 102nd sessions

During the 98th session of the MSC, a proposal was put forward for a regulatory scoping exercise aimed at integrating MASS within the existing IMO framework. This proposal was submitted by several countries, including Denmark, Estonia, Finland, Japan, the Netherlands, Norway, the Republic of Korea, the United Kingdom, and the United States. The proposal outlined the necessity for a regulatory framework that could adapt to the operational realities of MASS, which vary in their level of autonomy from partially automated ships to fully autonomous systems that require no human intervention. The document emphasised the lack of clarity regarding the application of

[54] IMO, *Structure of IMO*, <https://www.imo.org/en/About/Pages/Structure.aspx#3>, (accessed 7 May 2024).

current IMO instruments to MASS operations, highlighting the need for a clear regulatory framework to ensure compliance with IMO standards. [55]

The regulatory scoping exercise was proposed to identify specific IMO regulations that currently prevent unmanned operations, have no applicability to unmanned operations due to their reliance on human presence, and do not prohibit unmanned operations but might require amendments to guarantee that MASS operations are conducted safely, securely, and in an environmentally responsible manner. This initiative was seen as critical to maintaining the safety, security, and environmental protection standards of shipping while accommodating the growth and innovation in MASS technology. The document suggested that the exercise would help the IMO to proactively address the emerging trends in autonomous shipping technology, ensuring that international trade could continue to benefit from advancements in maritime operations. Furthermore, the MSC was invited to consider including this new output in its work program, aiming to complete the regulatory scoping exercise within the next biennium.[56]

During the 99th session of the MSC, the ICS (International Chamber of Shipping) submitted a document responding to the call for proposals regarding the regulatory scoping exercise for MASS. This submission was part of the ongoing discussion to integrate MASS into the existing regulatory framework of the IMO.[57]

The document expressed ICS's cautious stance on the rapid adoption of MASS, highlighting varying levels of support and scepticism among Member States and international organisations regarding autonomy in shipping. ICS emphasised that any advancements toward autonomy in shipping should not compromise the safety, security, and environmental standards set by the IMO. The proposal put forth by ICS suggested the development of a work plan for the regulatory scoping exercise that included two possible approaches: one focusing on removing specific regulatory barriers to autonomy and another, considering the broader implications of autonomous technologies on all aspects of the regulatory framework. The broader approach was recommended, as it would allow for a comprehensive evaluation of how autonomous systems could fit within the current and future regulatory landscapes without undermining the effectiveness of the regulations. ICS also highlighted the importance of considering the human element in the deployment of autonomous

[55] MSC 98th session, MSC 98/20/2, Proposal for a regulatory scoping exercise, submitted by Denmark, Estonia, Finland, Japan, the Netherlands, Norway, the Republic of Korea, the United Kingdom and the United States, pp. 1–2.

[56] Ibid, pp. 2–4.

[57] MSC 99th session, MSC 99/5/2, Proposals for the development of a work plan, submitted by ICS, p. 1.

systems, acknowledging the complexities of integrating these technologies with human oversight and decision-making. This includes addressing how autonomous systems interact with crew, shore-based operators, and other ships, ensuring that human factors are considered in the development of any new regulations.[58]

Additionally, the proposal included the need for an extensive collection and analysis of data on the performance of autonomous systems to inform the committee's decision-making process. This data collection, according to the proposal, would help establish a solid evidence base to assess the safety and efficacy of autonomous technologies and their impact on the current regulatory framework.[59]

Furthermore, a document was submitted by a group of countries including Australia, Canada, Denmark, Estonia, Finland, Japan, the Netherlands, Norway, Singapore, Sweden, the United Kingdom, and the United States, along with the Institute of Marine Engineering, Science and Technology and the International Marine Contractors Association. This submission outlined a proposed plan of approach for the regulatory scoping exercise concerning MASS. The document defined a structured plan to identify necessary amendments or additions to existing IMO regulations to accommodate the safe, secure, and environmentally sound operation of MASS, either fully or partially unmanned. The proposal highlighted the complexities involved in the scoping exercise, which would impact various aspects of the IMO's remit, including safety, security, ship/shore interactions, pilotage, and incident response. It also noted the significant effects that increased automation could have on the human element in maritime operations, both at sea and ashore.[60]

Moreover, the document proposed developing a preliminary vocabulary to define MASS and autonomy. The plan also called for the establishment of working groups and intersessional correspondence groups, scheduled to report progressively across several MSC sessions. The final output of the scoping exercise was expected to include a comprehensive list of applicable IMO instruments, a refined description of MASS operations, and recommendations for future work at the IMO to continue adapting to advancements in autonomous maritime technologies.[61]

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[58] Ibid, pp. 2–4.

[59] Ibid, pp. 4–6.

[60] MSC 99th session, MSC 99/5/5, Plan of approach for the scoping exercise, submitted by Australia, Canada, Denmark, Estonia, Finland, Japan, the Netherlands, Norway, Singapore, Sweden, the United Kingdom, the United States, IMarEST and IMCA, pp. 2–4.

[61] Ibid.

During the 100th session of the MSC, the committee approved framework and methodology for the regulatory scoping exercise on MASS. The exercise would in two steps evaluate IMO instruments to identify provisions that apply to MASS and prevent MASS operations, apply to MASS, and do not prevent operations, requiring no further action, apply to MASS, do not prevent operations but may need amendments or clarifications, or have no application to MASS operations. Furthermore, the degrees of autonomy were set out on a scale from one to four, as defined in previous chapters. Once the initial step of the regulatory scoping exercise is to be completed, the second step involves analysing and determining the most suitable approach for addressing MASS operations, considering the human element, technology, and operational factors.[62]

The initial review of instruments under the MSC would be undertaken by volunteering Member States, supported by interested international organisations. The list of instruments included in the MSC's scoping exercise for MASS covers safety (SOLAS); collision regulations (COLREGs); loading and stability (Load Lines); training of seafarers and fishers (STCW, STCW-F); search and rescue (SAR); tonnage measurement (Tonnage Convention); Safe Containers (CSC); and special trade passenger ship instruments (SPACE STP, STP).[63]

Furthermore, a document was submitted by China providing a preliminary analysis of COLREGs, particularly in the context of MASS. The document outlined a systematic examination of the implications of MASS on the applicability of COLREGs , focusing on areas such as the general impact of MASS operations, the two regimes of collision avoidance, the give-way/stand-on rule, and considerations of the human element in collision situations. China's analysis suggested that the current COLREGs framework, primarily designed for manned vessels, may not fully address the unique characteristics of fully autonomous ships. These include the capability of autonomous systems to perform tasks based on electronic detection and decision-making processes that differ fundamentally from human judgments based on visual cues.[64]

Furthermore, the Republic of Korea submitted a document detailing the results of a technology assessment on MASS. The document discussed how the introduction of autonomous technology would redefine roles within maritime transport systems, affecting matters from ship operation to port management.

[62] MSC 100th session, MSC 100/5, Report of the Correspondence Group on MASS, submitted by Finland, pp. 2–4.

[63] Ibid, pp. 6–8.

[64] MSC 100th session, MSC 100/INF.6 Annex, Preliminary analysis of the International Regulations for Preventing Collisions at Sea, 1972, submitted by China, pp. 1-7.

Korea highlighted that this shift would require a significant overhaul of training and education systems to equip the workforce with the necessary skills. [65]

Moreover, the assessment in the document provides an analysis of the anticipated changes in risk factors associated with maritime operations due to the adoption of MASS. It notes that while human error, currently accounting for a significant percentage of maritime accidents, might decrease, new risks associated with technology failures, such as malfunctions in autonomous navigation systems or cybersecurity breaches, could emerge and increase.[66] Furthermore, the analysis raises several hypothetical questions to explore potential conflicts within existing frameworks, such as: How will international conventions like SOLAS and COLREGs apply to unmanned vessels? What jurisdictional challenges could arise under UNCLOS when enforcing laws against autonomous ships without crews? How should liability be assigned in accidents involving autonomous ships, especially when considering the integration of complex automation technologies that might fail?[67] Additionally, the document discusses how the traditional liability structure might evolve, suggesting that manufacturers of autonomous systems could face increased liability in the event of malfunctions. [68]

During the 101st session, China highlighted that COLREGs Part B delineates vessel conduct based on visibility, with Section II applying in good visibility and Section III in restricted visibility. China stated that for fully autonomous MASS, collision avoidance would likely be radar-based, not reliant on human vision, highlighting the obsoleteness and the need for revision within certain legal frameworks that are based on human traits.[69]

At the 102nd MSC session, the results of the second step of the regulatory scoping exercise were presented. This included reviews of existing regulatory frameworks in relation to the new MASS code. France presented the assessment of SOLAS Chapter II-1, concerning construction, subdivision and stability, machinery, and electrical installations, within the regulatory scoping exercise, which highlighted potential adaptations needed to accommodate MASS. Given that MASS operations could potentially eliminate the need for direct human intervention, specific requirements related to the ship's structure, machinery, and electrical systems may require modification to support autonomous operations. The presence of seafarers, traditionally required for

[65] MSC 100th session, MSC 100/INF.10, Results of technology assessment on MASS, submitted by Republic of Korea, pp. 1–2.

[66] Ibid, annex, pp. 6–8.

[67] Ibid, p. 9.

[68] Ibid, p. 14.

[69] MSC 101st session, MSC 101/5/2, The initial review of the mandatory IMO instruments related to maritime safety and security, submitted by China, p. 2.

handling emergencies and maintaining machinery, necessitates reconsideration of these rules for MASS. Discussions included considering alternative compliance options that could maintain the safety levels provided by current human-centred requirements, but adapted for remote or autonomous operations. The findings suggested the development of new regulations or amendments to existing ones to adequately cover autonomous ship operations without compromising safety standards.[70]

Japan presented an analysis related to SOLAS Chapter II-2, regulating fire prevention, fire detection and fire extinction, where concerns primarily focused on adapting fire safety measures to accommodate unmanned operations. The discussion centred on ensuring that fire detection and suppression systems could operate effectively without human intervention. Japan proposed that amendments might include demands on more sophisticated automated systems that can detect, diagnose, and suppress fires independently, aboard MASS. Furthermore, the review underscored the importance of redefining the roles and responsibilities of "master", "crew" and "responsible person". It was suggested that specific amendments or new instruments could be developed to address these unique needs, ensuring that fire safety standards remain robust in the context of MASS operations.[71]

Belgium, China, and the Netherlands reviewed SOLAS Chapter III, concerning lifesaving appliances and arrangements, as a part of the regulatory scoping exercise, presented during the session. Their findings included the highlighting of certain potential gaps within the chapter based on the idea of handling emergency situations, prescribed for in SOLAS Chapter III, without personnel on board. Issues that were identified included on board communications in relation to emergency situations, evacuating persons on board ships in emergency situations, manning and supervising survival crafts, the recovery of persons from the water in emergency as well in search and rescue situations, and the role of the master in aforementioned situations.[72]

Turkey reviewed SOLAS Chapter IV, which deals with radiocommunications, and recognised the necessity to update provisions to reflect the operational realities of MASS. This included ensuring that communication standards and requirements are suitable for remote operations, which may not involve traditional shipboard personnel. The potential gaps identified necessitated amendments to current instruments and the need for the creation of new

[70] MSC 102nd session, MSC 102/5/6, Summary of results of the second step of the RSE for SOLAS chapter II-1, submitted by France, pp. 2–4.

[71] MSC 102nd session, MSC 102/5/19, Summary of results of the second step of the RSE for SOLAS chapter II-2, submitted by Japan, pp. 2-5.

[72] MSC 102nd session, MSC 102/5/4, submitted by Belgium, China, and the Netherlands, annex, pp. 3–4.

ones to address the technical and operational requirements of MASS-specific communication systems, including emergency communications and navigational safety messages.[73]

The review of SOLAS Chapter V, regulating safety of navigation, submitted by China, acknowledged several adjustments needed to accommodate the navigation of MASS. The primary focus was on ensuring that navigation systems and protocols are adapted to allow for remote and autonomous operations, maintaining or enhancing current safety levels. This could, according to the proposal, involve redefining the qualifications and roles of the shipmaster and navigational crew to fit a remote operational framework, alongside the integration of advanced automated navigational systems. Moreover, proposals included the development of new instruments, specifically regarding vessels on the second, third, and fourth degree on the MASS scale of autonomy, and amending instruments related to vessels on the first and second degree on the MASS scale of autonomy. Furthermore, the need for regulations regarding operations of remote operation centers was stressed.[74]

Japan submitted a review over SOLAS Chapter VI, dealing with carriage of cargoes, in relation to issues that could arise pertaining to MASS. Japan highlighted the need for clarifying and defining the role, and meaning of the role, "master", on board a MASS, in relation to SOLAS Chapter VI. Furthermore, Japan highlighted gaps within the legislation that could arise in relation to emergency situations, ship inspections, and the handling and responsibility of dangerous cargo, pertaining to MASS.[75] Moreover, Japan submitted in its review of SOLAS Chapter VII, concerning the carriage of dangerous goods, a proposal that the development of new procedures is needed related to situations of spillage, fire, and other emergencies pertaining to cargo on board unmanned MASS. Finally, the role and meaning of "master", "crew", and other personnel on board in the aforementioned situations was deemed in need of clarification.[76]

Norway submitted its review of SOLAS Chapter IX, regulating the management for the safe operation of ships, in which it stated that there is a need for developing new regulations concerning remote control stations or remote operational stations, since this is assumed to be a central part of the operations

[73] MSC 102nd session MSC 102/5/15, Summary of the results of the second step of the RSE for SOLAS chapter IV, submitted by Turkey, pp. 2–3.

[74] MSC 102nd session MSC 102/5/9, Summary of results of the second step of the RSE for SOLAS chapter V, submitted by China, pp. 2–4.

[75] MSC 102nd session, MSC 102/5/20, Summary of the results of the second step of the RSE for SOLAS chapter VI and associated codes, submitted by Japan, p. 5.

[76] MSC 102nd session, MSC 102/5/21, Summary of the results of the second step of the RSE for SOLAS chapter VII and associated codes, submitted by Japan, p. 6.

of MASS, and that there is no current legislation on the subject. In addition to this, Norway stressed the need for defining the roles and meaning of "master" and "crew" on board MASS. Lastly, Norway highlighted the need for expanding cybersecurity legislation, following the nature of MASS being more sensitive to technology related threats, for example, cyberattacks.[77]

Concerning SOLAS Chapter XI-1, dealing with special measures to enhance maritime safety, Finland analysis suggested that for MASS operations, developing a holistic new instrument for unmanned and/or automated ships, particularly to address issues related to the master and remote operational centers. Additionally, the proposal suggest that the Casualty Investigation Code may require amendments to include shore-based personnel in the definition of a seafarer and to clarify the involvement of States where remote control centers are located, concerning their substantial interest in marine casualties.[78]

In addressing Chapter XI-2, regulating special measures to enhance maritime security, Finland stated the need for defining the role of the shipmaster in security procedures, emergency response, and coordination with port facilities.[79] Moreover, in a statement concerning strategic themes regarding MASS, Finland emphasised the importance of advancing data-sharing capabilities to support the operation of MASS They advocated for a decentralised information exchange system that utilises open and interoperable programming interfaces and open standards. Finland also stressed the necessity of ensuring data openness and availability for safe, secure, and environmentally sustainable automation. Including regulatory or voluntary sensor data from ships as well as comprehensive data sets about ship movements and anticipated routes, which were valuated as essential for remote control and e-Pilotage purposes. Furthermore, Finland highlighted the importance of developing a governance framework to manage data security and traceability.[80]

Lastly, Finland pointed out that every voyage of a MASS may necessitate the oversight of a qualified individual, or in certain contexts such as remote operations centers, multiple qualified persons. Finland suggested that the traditional role of the ship's master may need redefinition to broaden its scope to include additional responsible entities or individuals. In the document,

[77] MSC 102nd session, MCS 102/5/25, Summary of results of the second step of the RSE for SOLAS chapter IX and the ISM Code, submitted by Norway, p. 6.

[78] MSC 102nd session, MSC.102/5/10, Summary of results of the second step of the RSE for SOLAS chapter XI-1 and related codes, submitted by Finland, pp. 2–4.

[79] MSC 102nd session MSC 102/5/11, Summary of results of the second step of the RSE for SOLAS chapter XI-2 and the ISPS code, submitted by Finland, pp. 2–3.

[80] MSC 102nd session, MSC 102/INF/17, Strategic themes in MASS perspective, submitted by Finland, pp. 3–4.

Finland also emphasised the need to distinctively address product liability so that the responsibility of manufacturers or programmers of autonomous systems should be explicitly defined and treated separately. Finland also underlined the critical need to establish clear frameworks for responsibility and accountability concerning the functioning and operation of automated systems.[81]

In summary, it is submitted that these first sessions covering the development of the MASS code highlights and brings forth opinions on how MASS should be handled from a regulatory perspective, with a focus on what issues need to be regulated and further discussed. There is within these sessions no unanimous views expressed concerning how several specific issues should be managed. However, there is consensus regarding the fact that revision of the legal framework is needed, and that the introduction of MASS introduces aspects not currently regulated by current legal instruments.

#### 4.1.1.2 The 103rd to 108th session

During the 103rd session, the Republic of Korea submitted detailed comments on the potential gaps and themes identified from the regulatory scoping exercise concerning MASS.[82] Korea stated that clarifications are needed for the roles and definitions of masters, seafarers, remote operators, and responsible persons, especially for MASS operating under higher autonomy levels on the MASS scale. According to Korea, a clear stance is needed regarding whether remote operators qualify as seafarers to align with their training, responsibilities, and legal obligations. Korea suggested that discussions should establish requirements for crew members certified to manage, for example, life-raft operations, evacuation, and firefighting on MASS. Therefore, re-evaluation of SOLAS chapters IV and V, along with COLREGs, regulating these situations, was stressed. This re-evaluation should create comprehensive and detailed roles applicable across all relevant IMO instruments. Moreover, Korea asserted a need to discuss the requirements for shipboard communication, particularly for radio personnel handling distress, safety, and urgency communications.[83]

Furthermore, Korea stated that the concept of the remote operation centre is integral to the operation of MASS, serving as the hub from which remote operators control and manage ships from shore. Korea accentuated the

[81] MSC 102nd session, MSC 102/INF/17, Strategic themes in MASS perspective, submitted by Finland, p. 5.

[82] MSC 103rd session, MSC 103/5/1, Comments on the potential gaps and themes identified by the results of the RSE Submitted by the Republic of Korea, pp. 1–2.

[83] Ibid, Annex, p. 1.

necessity of the remote operation centre for ensuring the wireless communication and navigation safety of the ship, necessitating a review and establishment of definitions, design requirements, necessary facilities, and performance standards, particularly under SOLAS chapters IV, concerning radio communications, and chapter V, regarding safety of navigation. Additionally, Korea stated that the need to decide whether MASS should include high-risk vessels such as nuclear ships, passenger ships, and chemical tankers, each presenting unique risks and operational complexities.[84]

Additionally, Korea stated that from autonomy level 2 onwards, tasks traditionally performed by human navigators, such as route setting and collision avoidance decisions based on radar, global positioning system, compass, echosounder, and automatic identification system, are expected to be performed by autonomous navigation systems and therefore need revision. For example, coming legislation could require the installation of additional sensory equipment such as cameras and LiDAR (Light Detection and Ranging) with a certain degree of functionality to match the visual and auditory capabilities of human navigators. As autonomous and manned ships will inevitably coexist, in relation to COLREGs, distinguishing features such as specific lights and shapes should also be required to indicate whether vessels are autonomously operated. For autonomy levels 3 and 4, where no seafarers are on board, systems must be developed to identify and respond to the lights, shapes, and sound signals of other ships using advanced sensory technology, such as cameras, acoustic sensors and LiDAR, with a cognitive ability equal to the one of humans. In scenarios of high autonomy where no crew is on board, the traditional methods of transmitting and receiving radio communications and distress signals should be re-evaluated so that MASS have systems in place to appropriately transmit distress signals to shore-based operators and surrounding vessels in emergencies. Furthermore, life-saving arrangements under SOLAS Chapter III, which are predominantly designed for manned operations, will see a significant number of provisions become inapplicable and therefore, need amendments.[85]

Korea also submitted that international support obligations for ships in distress should be extended to MASS, especially those operating at autonomy levels 3 and 4, where no seafarers are onboard. This necessitates the clarification of how these autonomous ships can aid and support to people and other ships, as their inability to participate in traditional search and rescue operations poses significant challenges.[86]

[84] MSC 103rd session, MSC 103/5/1, Comments on the potential gaps and themes identified by the results of the RSE Submitted by the Republic of Korea, Annex, p. 1.

[85] Ibid, p. 2.

[86] Ibid, pp. 2–3.

Moreover, Korea stated that current cargo operation procedures, which rely on human supervision for tasks such as loading and securing, must be reassessed. This includes determining the extent to which onshore personnel might need to intervene in these operations. Additionally, the safety and handling of cargo, particularly dangerous goods on autonomous ships, require a thorough review to ensure that safety standards are maintained or enhanced in unmanned operations.[87]

Regarding pilot operations, Korea expressed that the current requirements does not align with scenarios where ships are remotely controlled. This calls for the development of new regulations or alternatives that accommodate remote pilotage. Discussions are also needed on how pilots can be utilised in ports when autonomous ships, particularly those at levels 3 and 4, dock without onboard seafarers.[88]

Concerning ports, according to Koreas review, port state control of unmanned ships requires guidelines and regulations, including those pertaining to the detention of ships. Moreover, the applicability of regulations concerning the boarding of seafarers, such as SOLAS regulation V/14, concerning manning of ships, and STCW (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers) regulation I/14, responsibilities of companies, to shore-based personnel like remote operators needs examination. This includes considering whether shore-based personnel should be classified as seafarers and whether the competency requirements applicable to onboard personnel can be adapted for those controlling ships from shore. Finally, the procedures for responding to emergency situations on unmanned ships, including cybersecurity measures and strategies to counteract cybercrimes against ships, require comprehensive review and adaptation. For future actions, the committee recognised the need for new proposals to address gaps in IMO instruments identified through the regulatory scoping exercise.[89]

During the 104th session, a proposal for a new output on how the new MASS code should be developed was presented by several parties. The proposal stated that addressing every IMO instrument separately could lead to inconsistencies, following the everchanging nature of MASS technology.[90]

[87] MSC 103rd session, MSC 103/5/1, Comments on the potential gaps and themes identified by the results of the RSE Submitted by the Republic of Korea, pp. 3–4.

[88] Ibid, p. 4.

[89] Ibid.

[90] MSC 104th session, MSC 104/15/26, Proposal for a new output on the development of international provisions for Maritime Autonomous Surface Ships (MASS), Submitted by Belgium, Canada, Denmark, Finland, France, Germany, Marshall Islands, Norway, Singapore, United States, BIMCO and the International Association of Classification Societies, p. 2.

Moreover, in a proposal submitted by Japan, The Russian Federation, The United Arab Emirates and the International Association of Classification Societies, the main issues in addressing regulatory challenges in relation to MASS where identified as, developing the instrument, and developing new definitions and terminology related to MASS. Regarding definitions, the proposal suggested that the meaning of master, crew or responsible person, remote operational centers, and remote operators, where of highest priority in terms of uncertainty related to the new MASS code.[91]

At the 105th session China's submitted a detailed commentary on the proposed roadmap for developing the MASS code. The submission emphasised that the development of a non-mandatory MASS instrument should serve as the initial step, allowing for an experience-building phase within the industry and among administrations. This approach would support the gradual integration of MASS into the IMO regulatory framework, aligning with previous regulatory scoping exercise results that identified potential gaps due to the new risks introduced by MASS operations.[92]

Chinas submission also suggested adjusting the draft roadmap to prioritise the development of the MASS instrument without immediate amendments to existing conventions. It recommended that the roadmap include clear stages, starting with addressing common issues and establishing the framework of the MASS instrument, followed by the development of specific provisions, and if feasible, a review of existing conventions.[93]

Norway presented a comprehensive discussion on key issues and a proposed structure for the development of a goal-based instrument for MASS during the session. To establish a clear roadmap, including scope, steps, and timelines, Norway followed Chinas suggestions and emphasised that the proposed instrument should not be seen as a new construction but as an extension to existing regulations like SOLAS to accommodate MASS operations.[94] Norway's proposal suggested initially adopting the goal-based instrument as a non-mandatory code to provide guidance and facilitate the transition to a mandatory code. The goal is to ensure that MASS operations maintain a safety level equivalent to conventional operations under SOLAS for similar types of ships. Norway proposed objectives for the committee's

[91] MSC 104th session, MSC 104/15/25, Submitted by Japan, Russian Federation, United Arab Emirates and IACS, p. 2.

[92] MSC 105th session, MCS 105/7/7, Comments on key principles and common understanding of a MASS instrument and the draft road map, submitted by China, p. 2 ff.

[93] Ibid, p. 4.

[94] MSC 105th session, MSC 105/7/3, Discussion on some key issues in the development of the MASS instrument and proposal for a structure of a draft MASS code, submitted by Norway, p. 2.

consideration, such as developing the instrument ensuring that MASS could coexist with conventionally operated ships without necessitating special precautions. The focus would be on setting broad goals and functional requirements for MASS operations, with technical criteria and operational requirements to follow based on technological and industry developments.[95]

A draft structure for the code was included in Norway's proposal, suggesting a focus on functional requirements for ship operations like watertight integrity, stability, anchoring, fire safety, navigation, and steering. Each function of a ship would be addressed individually within the code, meaning that if one system of the ship is autonomous, only the MASS provisions for that system would apply. The structure proposed in the annex of the document was described as a functional approach, dividing the code into general principles and specific requirements for various ship operations. This would, according to the proposal, allow for modular application of the code, where compliance with the MASS provisions for one function does not necessarily imply compliance for all.[96]

Additionally, the MSC agreed with the Legal Committee on the formation of a Joint MSC/LEG/FAL Working Group as a cross-cutting mechanism to address common issues from the MASS regulatory scoping exercises by the three Committees.[97]

During the 106th session, China submitted a document stating its perspective on some of the key issues in need of clarification within the new MASS code. In the submitted document, China proposed a re-evaluation of the traditional concept of "master" within the context of MASS as delineated in IMO instruments. Moreover, the discussion extended to the functional necessity of the master's physical presence aboard the vessel, declaring it essentially unnecessary.[98]

Moreover, China suggested that a revision of these traditional roles is necessary. The proposal specifically addressed the need for regulatory adjustments to accommodate scenarios where the master's duties might be performed remotely. Furthermore, China pointed out that while some duties traditionally reserved for the master might now be handled by other ship officers or even remotely from a remote operational centre, the principle of having a designated master, or an equivalent role capable of fulfilling these responsibilities,

[95] MSC 105th session, MSC 105/7/3, Discussion on some key issues in the development of the MASS instrument and proposal for a structure of a draft MASS code, submitted by Norway, pp. 2–4.

[96] Ibid p. 3 and MSC 105/7/3 Annex pp. 1–5.

[97] Ibid.

[98] MSC 106th session, MSC 106/INF. 18, submitted by China, pp. 1–2.

remains fundamental. The proposal emphasised the importance of redefining this role to fit the unique requirements of MASS operations, ensuring that all duties, whether performed on board or remotely, uphold the safety, security, and environmental standards set forth by IMO. In conclusion, China advocated for a clear and updated definition of the master's role in the context of MASS within IMO instruments.[99]

During the 107th session, Japan proposed a draft text regulating human involvement and the human element in the new MASS code. Stating that the human element is recognised as the utmost important factor in preventing marine accidents, Japan expressed the need for developing provisions regulating humans involved with MASS.[100] The draft code emphasised the role of seafarers on board MASS in understanding and managing the ship's autonomous systems. It mandated that seafarers be educated in the operation of these systems. Additionally, in accordance with the draft, seafarers are expected to take immediate manual control of the MASS if the autonomous systems malfunction or deviate from their operational design domain. The competence requirements for these seafarers should, according to the proposal, include extensive knowledge of the autonomous systems related to situational awareness, collision avoidance, and cyber security, along with the ability to conduct risk assessments and manage significant risks associated with the over-reliance on automated systems.[101] Additionally, set forth by the draft text, remote control operators are tasked with the oversight of MASS from remote operational centers and are required to possess competencies and experience equivalent to officers who meet the STCW code requirements. The MASS code specifies that remote control operators should have a thorough understanding of the MASS systems, to ensure they can effectively manage and intervene in the operations from a remote location. Responsibilities of remote control operators, according to Japan, should include managing backup communication systems in case of disconnections, and performing regular maintenance and record-keeping of the systems. Remote control operators must also be adept in applying risk assessments and managing the inherent risks associated with autonomous operations.[102]

Concerning the same topic of the human element, Korea and the International Transport Workers' Federation proposed considerations on competencies for MASS remote operators. The proposal highlighted that demands put on remote operators should differ, depending on the type of MASS, whether crew with authority and responsibility is onboard, and level of autonomy of the

[99] MSC 106th session, MSC 106/INF. 18, submitted by China, pp. 2–3.

[100] MSC 107th session, MSC 107/5/6, Proposed text for a human element section in the draft MASS code Submitted by Japan, pp. 1–2.

[101] Ibid, Annex, p. 1.

[102] Ibid, Annex, pp. 1–2.

MASS. Furthermore, the proposal stated that remote operators must possess complete situational awareness of the MASS. Additionally, remote operators need to recognise discrepancies between sensor data and actual environmental conditions, which can arise from sensor errors. The ability to adapt to changes in weather and water conditions along the ship's route is noted as necessary for optimal route planning. In controlling the ship, remote operators are tasked with maintaining robust communication with the crew onboard and with onshore emergency response teams such as vessel transport service and coast guard, requiring skills comparable to those mandated by IMO Standard Marine Communication Phrases.[103]

Furthermore, the proposal included that remote operators should be held responsible for making swift and informed decisions in response to incidents, abnormalities, or system malfunctions. According to the proposal, this should include initiating appropriate actions during cybersecurity threats and ensuring continuous operation through effective system and communication management.[104] Moreover, regarding network security and cybersecurity, Korea stated that MASS, encompasses a complex array of digital sensors and systems, rendering them extra susceptible to cyber threats in relation to traditional ships and that this vulnerability should be especially considered in the development of the new MASS code. Essential measures should, according to Korea, include authentication and encryption of communications between the ship and external entities, deep packet inspection to detect and block attacks, data flow control, and artificial intelligence-based anomaly detection within internal networks.[105]

Moreover, Koreas proposal stated that developing such network security equipment requires a clear articulation of security requirements controlling data, functions, and operational access to maintain the confidentiality and integrity of information assets. System functional requirements should detail the operations performed by the target system or required user interactions, with performance requirements specifying metrics like processing speed, throughput, and system availability. Interface requirements must define how the system interacts with other software, hardware, and communications protocols. Lastly, the composition of network security equipment should encompass all necessary hardware, software, and network components, supported by comprehensive testing to ensure that the system operates correctly and

[103] MSC 107th session, MSC 107/5/8, Consideration on the minimum competencies required for MASS navigation for remote operators, submitted by Republic of Korea and the International Transport Workers' Federation, pp. 2–3.

[104] Ibid, p. 3.

[105] MSC 107th session, MSC 107/INF.11, Considerations, and requirements for network security equipment for the operation of MASS, submitted by the Republic of Korea, pp. 3–5.

meets the intended performance benchmarks. These stringent security protocols are, according to the proposal, vital to safeguarding MASS operations from cyber threats. [106]

During the session Belgium submitted a study on remote operational centers in view to their certifications for consideration to the new MASS code. The study highlighted the uniqueness of remote control centers and the need for new legislation regarding them. Stressing that no international regulation exists on the matter, Belgium proposed that all states involved should agree upon certain guidelines regarding demands on technical designs, communication lines, organisation, and operations of remote operational centers.[107] In the study, it is proposed that international conventions, such as SCTW and SOLAS, should apply to MASS, as well as being amended to fit the purpose. Furthermore, it is proposed that remote control operators shall be classified as seafarers, as they are integrated in the international ship traffic. Moreover, the use of the term "master" shall be used only when there is crew onboard the ship itself. When there is no crew onboard, the study proposes the use of a supervisor that acts in the sense of a fleet captain, from a remote operational centre.[108]

France submitted a report on its own national framework covering MASS currently in force. Following the implementation of certain MASS, the national law came into force in October 2021. With the purpose of influencing the new MASS code, France put forth a selection of choices it had made in regard to legal insecurities introduced by MASS. Regarding masters, France maintained the definition as "the person in command of the autonomous ship", thereby making no difference in regard to where the master is located, and the distribution of responsibility or liability, in relation to traditional ships. Furthermore, remote operators were defined as seafarers, allowing certain requirements within, for example, STCW and European Union regulations, to apply, enforcing proper training on those designated to the ship.[109]

At the 108th session, France and Spain jointly submitted a proposal concerning the application of COLREGs to MASS, specifically focusing on the steering and sailing rules. They highlight that Part B of COLREGs, which is

[106] MSC 107th session, MSC 107/INF.11, Considerations, and requirements for network security equipment for the operation of MASS, submitted by the Republic of Korea, pp. 4–5.

[107] MSC 107th session, MSC 107/INF.14, Study on the definition and organization of a Remote-Control Centre (RCC) with a view to its certification, submitted by Belgium, pp. 2–3.

[108] Ibid, Annex, p. 7.

[109] MSC 107th session, MSC 107/INF.12, Report on the Regulatory Framework for MASS implemented in France, submitted by France, pp. 2–3.

divided into three sections, is premised on the assumption of a human navigator using sight, hearing, and radar to assess and manage collision risks. However, for MASS, where navigation is conducted remotely, or autonomously, the scenario changes significantly as remote navigators rely on sensor signals from the ship to the remote operations centers interpreting a virtual representation of reality rather than perceiving it directly. The proposal underscores the need for adaptations in the application of COLREGs to MASS, acknowledging the difference between human perception and electronic detection, which is crucial due to the potential discrepancies between the actual scenario and its remote representation. The co-sponsors argue that this fundamental difference may necessitate pre-emptive measures such as more significant course alterations or speed adjustments to ensure collision avoidance. They suggest incorporating provisions into the MASS code that remote navigators be acutely aware of these differences and the associated need for enhanced caution in navigation decisions.[110]

To address these challenges, France and Spain proposed several specific considerations for the MASS code. They recommended that remote navigators always be cognisant of the fact that they are analysing represented scenarios, which may not fully correspond to the actual surroundings of the MASS. This understanding was presented as vital, as it can affect the navigational decisions taken by remote operators, potentially requiring additional actions to prevent collisions. Moreover, they advocate for the design of autonomous navigation systems to account for these nuances, ensuring that any deviations between the perceived and actual environmental conditions are clearly communicated to the remote navigator, enabling informed decision-making to maintain safety levels equivalent to conventional vessels. According to their proposal, this approach aims to ensure that MASS operations adhere to the safety standards established by COLREGs while accommodating the unique aspects of remote navigation.[111]

The IMRF (The International Maritime Rescue Federation) has underscored significant impacts and potential enhancements that MASS could introduce to search and rescue operations globally. With a growing proportion of ships potentially operating without crew or with minimal crew, the traditional model of search and rescue, which often relies on crewed ships to assist persons in danger at sea, faces new challenges. In regions where dedicated search and rescue services are sparse and dependent primarily on passing ships, the advent of MASS presents both challenges and opportunities to augment search and rescue capabilities. The IMRF proposes that MASS should be

[110] MSC 108th session, MSC 108/4/7, Steering and sailing rules and MASS code, submitted by France and Spain, p. 2.

[111] Ibid, p. 3.

equipped with specific functionalities to maintain and possibly enhance the current search and rescue response capability. These functionalities include the ability of MASS to receive, process, and disseminate distress signals efficiently in accordance with distress and safety system procedures. This encompasses handling distress alerts from distress and safety radio systems, voice radio calls, and visual and audible signals, ensuring that all critical information such as the distress position, number of persons in danger, and vessel identifiers are promptly shared with other ships, the remote operations centre, and relevant rescue coordination centers. Additionally, MASS should be capable of detecting objects related to distress incidents, such as wreckage or persons in the water, during both day and night and communicate these findings effectively to aid SAR (Search and Rescue) operations.[112]

Moreover, it was stated that the draft MASS code already incorporates general principles for SOLAS obligations of MASS in responding to search and rescue situations, but the IMRF views that further detailed development is necessary. The IMRF proposed that MASS should possess capabilities that allow them to perform at least equivalently to crewed vessels in search and rescue operations, includes navigating to the location of distress using various inputs like satellite data and radar, communicating with persons in distress, coordinating with search and rescue units, and providing essential needs such as shelter and medical care to survivors until they can be transferred to appropriate facilities.[113]

During the 108th session, an updated draft version of the new MASS code was presented. In the draft, some preliminary legal choices were made. Regarding the purpose of the code, the definition was made that the code seeks to address matters needed for MASS to function in an environmentally sound, secure, and safe manner, complementary to other IMO instruments.[114] Moreover, certain terminology and definitions where established, in a preliminary manner. "MASS Onboard Crew" was defined as "*[...] a master, other officers and operational staff [physically][who may be present] on board a MASS.]"*[115], and MASS Remote Crew was defined as *"[...] a remote master, remote operators and responsible persons controlling operating MASS*

[112] MSC 108th session, MSC 108/4/15, Requirements, and capabilities for MASS to fulfil search and rescue obligations Submitted by the International Maritime Rescue Federation (IMRF), pp. 2–4.

[113] Ibid, p. 4.

[114] MSC 108th session, MSC 108/4, Report of the Correspondence Group Submitted by Marshall Islands, Annex 1, p. 6.

[115] Ibid, p. 9.

*remotely and/or providing assistance to the crew in the MASS operation.]*"[116]. Master of a MASS was defined as the person in command of a MASS.[117]

Moreover, regarding the master of a MASS, four key principles were preliminary established in the draft code. Firstly, it was stipulated that there, regardless of autonomy level or operational mode, should be a human master responsible for a MASS. Secondly, the human master may not be on board, nor is obligated to be on board, depending on the technology used on the MASS, and the presence of other humans on board. Thirdly, the master of a MASS should be able to intervene, regarding all operations of the MASS, whenever necessary. Lastly, it was stipulated that several masters may be responsible for the same MASS on a single voyage, and that there at any given time only should be one master responsible for the MASS. Moreover, regarding this stipulation, it was stressed that further consideration, considering the conditions relevant to the regulation, was required.[118]

Concerning safety measures on board MASS, the draft code requires there to be several stages of functionality, for when the MASS deviates from its normal functioning. The requirement suggests that the MASS functionality shall contain four stages of operations. The first stage is where the MASS functions normally, the second stage consists of a degraded state of functionality, where the MASS still can function, but with certain minor malfunctions. Within this second, degraded, stage, the MASS should be able to recover itself to the stage of normal functionality, through certain self-made measures. Following these two stages, there shall be a third "Fallback state", consisting of an internal plan within the MASS functionality where the MASS is not functioning normally but is able, through certain self-impaired measures, to recover itself to the degraded state of functioning and later to a normal state of functioning. The fourth stage consists of a stage of contingency, where the MASS is unable to recover from its fallback state, and is therefore a threat to other ships, the marine environment, the life at sea, and infrastructure.[119]

Furthermore, the draft stipulates that questions of verification regarding whether a MASS is compliant in its functionality and approval of the technology and functioning of the MASS, and in extension the approval for the MASS to sail, is a responsibility under the administration of the MASS,

[116] MSC 108th session, MSC 108/4, Report of the Correspondence Group Submitted by Marshall Islands, Annex 1, p. 9.

[117] Ibid.

[118] Ibid, p. 9f.

[119] Ibid, p. 23f.

meaning the state of which flag the MASS flies. This process will be guided by certain guidelines provided by the IMO.[120]

In summary, it is submitted that these last sessions of the MSC contain specific and concrete proposals as to how and why certain issues pertaining to MASS shall be materialised, from a regulatory perspective. The proposal of a draft code clearly puts forth the current view of the committee on certain issues, although preliminary. It should however be noted that multiple legal questions remain unanswered, and several questions remain vaguely answered, following what is presented by the committee.

### 4.1.2 The MSC-LEG-FAL joint working group sessions

At its 109th session, the Legal Committee, along with the Maritime Safety Committee at its 105th session, and the Facilitation Committee at its 46th session, endorsed the formation of the MSC-LEG-FAL joint working group on Maritime Autonomous Surface Ships. The group was established as a collaborative mechanism to tackle the shared high-priority issues identified through the regulatory scoping exercises conducted by each of the three committees. The joint working group was mandated to develop a comprehensive work plan that integrates the roadmaps formulated by the three committees. Its primary responsibilities include addressing the common issues highlighted by the regulatory scoping exercise and providing periodic recommendations and feedback to the committees.[121]

During the joint working groups first session, common gaps and themes across all MSC, FAL, and LEG instruments were presented as mainly: the role, competence and responsibility of the master and crew, the role, competence and responsibility of the remote operator, definitions and terminology of MASS and the use of certificates and other documents.[122] Furthermore, the group highlighted and further stressed that current IMO instruments are based on the presence of crew and a master. Therefore, the group concluded that an amendment of current regulations and instruments is necessary, following the crewless nature of autonomous vessels. The group also stated in its report that the responsibilities and duties of the crew and master onboard, include a wide

[120] MSC 108th session, MSC 108/4, Report of the Correspondence Group Submitted by Marshall Islands, Annex 1, pp. 14–15.

[121] Joint MSC-LEG-FAL MASS Working Group 1st session, MASS-JWG 1/2, Consideration of the common issues identified in the RSEs of the three committees and how best to address them, Submitted by the Chairs of the Maritime Safety, Legal and Facilitation Committees, pp. 1–2.

[122] Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common issues identified in the RSEs of the three committees and how best to address them, Submitted by the Chairs of the Maritime Safety, Legal and Facilitation Committees, pp. 1–2.

array of actions necessary for the safety and functioning of modern day shipping, currently set out in COLREG, SOLAS, among other instruments.[123]

Within the scope of the MASS joint working groups agenda, China presented a proposal on key elements to be considered regarding the common issues of the new MASS code. Focusing on the need for clarification surrounding master and crew, remote-control stations or centers, and remote operators, China defined some of the most pressing issues, according to their delegation.[124] Regarding master and crew, China articulated the necessity to re-evaluate the conventional roles and responsibilities attributed to the master and crew within the context of MASS. China proposed that irrespective of the autonomy level, a human should consistently be designated as the MASS master. Furthermore, China suggested that responsibilities conventionally assigned to the master and crew may require adjustments to reflect the reduced level of human intervention associated with higher autonomy levels, such as in the case of stowaways, as the current obligations would seem unfulfillable for a master not physically present onboard. Additionally, China recommended a thorough examination of liability, especially in incidents where automated systems assume control, to establish clear accountability standards.[125]

Furthermore, China addressed the emergence of remote-control stations and centers as integral components within the operational framework of MASS. It emphasised the necessity to delineate the jurisdiction and location of these centers, which might be positioned in countries not directly linked to the operations of the MAS.[126] China also recognised the nascent role of remote operators in MASS operations and proposed deliberations to potentially classify them as seafarers, formally integrating them as part of the ship's crew. This classification would influence their representation in maritime documents and their involvement in operational decisions. China also highlighted the necessity to define the liability and legal responsibilities of remote operators distinctly.[127]

Moreover, during the first session of the joint working group, The United Arab Emirates and Russia presented a proposal for a draft for the MASS code. The draft consisted of three parts, an introductory general part, consisting of

[123] Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common issues identified in the RSEs of the three committees and how best to address them, Submitted by the Chairs of the Maritime Safety, Legal and Facilitation Committees, pp. 2–3.

[124] Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common issues identified in the RSEs of the three committees and how best to address them, Proposal on the key elements to be considered regarding the common issues, submitted by China, pp. 2–3.

[125] Ibid, p. 3.

[126] Ibid, p. 4.

[127] Ibid, p. 4.

the objectives, scope of application, definitions, alternative designs, functional requirements, system safety, and cybersecurity. Part two of the draft-code handled functional requirements such as navigation, cargo handling, controlling the operation of ship, care for persons onboard, marine engineering and machinery installations, electric and electronic engineering as well as electric installations, maintenance and repair, communication, subdivision and stability, fire safety, life-saving appliances and equipment, and lastly remote control centers. Part three regarded verification and certification methods for autonomous vessels, drills and emergency exercises, as well as training features.[128]

During its second session, The MSC-LEG-FAL joint working group presented a report regarding its development and contribution of the new MASS code. During the groups discussion on the role and responsibilities of the master of a MASS, it was argued by some that there is no need for a new definition of the master in the context of MASS, as these ships fundamentally remain ships, and the role of the master aligns with that on conventional ships. However, others highlighted the necessity for a more detailed consideration of the master's functions, particularly in the context of MASS operations, before finalising any roles and responsibilities. The discussion also touched on the potential prematurity of defining the master's role given the current uncertainties about how fully autonomous ships will operate and the extent to which they will allow for human intervention.[129]

Moreover, the group stated that the consensus emerging from the discussion underscored the necessity of having a human master responsible for MASS operations, irrespective of the mode of operation or the degree of autonomy. It was recognised that such a master may not need to be physically on board, depending on the technology utilised by the MASS and whether there are other persons on board. Regardless of these factors, it was agreed that the master should always have the capacity to intervene when necessary.[130] Furthermore, the joint working group discussed legal uncertainties that could arise following the possibility of a master of a MASS being responsible for multiple MASS at once, as well as the possibility of the role of the master of

[128] Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common issues identified in the RSE's of the three committees and how best to address them, Proposal for draft Code for Maritime Autonomous Surface Ships, submitted by the Russian Federation and the United Arab Emirates, annex, p. 1.

[129] MSC 107th session, MSC 107/5/1, Report of the MSC-LEG-FAL Joint Working Group on MASS on its second session, p. 4.

[130] Ibid, pp. 4–5.

a MASS being passed on at multiple times during a single voyage of a MASS.[131] It is submitted that no conclusions where reached.

The group also addressed the intricate legal implications concerning the jurisdiction and responsibility of the flag State, particularly when a remote operation centre is established outside the territorial jurisdiction of that flag State. This complexity arises from the potential overlap between the territorial jurisdiction of the state hosting the remote operational centre and the flag state jurisdiction mandated by international maritime law. It was acknowledged that maintaining effective flag state jurisdiction and control is critical, aligning with Article 94 of UNCLOS, and that the relationship might necessitate a "genuine link" between the flag state and the remote operation centre, especially when the remote operation centers is located outside the flag state. Furthermore, there was a suggestion to adopt an oversight mechanism akin to that used in the ISM (The International Safety Management Code), where a flag state could audit and certify a company operating ships under its flag, even if based outside its territorial jurisdiction. This mechanism was proposed to ensure that the flag state retains adequate oversight capabilities over entities operating its vessels, thereby preserving the integrity of its jurisdictional claims. However, various views on limiting discussions to cases where remote operation centers are located within the flag state's territory were expressed. While some delegations favoured this limitation to simplify legal complications, others argued that such a constraint would not be practical and that discussions should encompass broader scenarios. Ultimately, the group concurred that issues concerning the jurisdiction of remote operation centre located outside a flag state's territory should be forwarded to the LEG for comprehensive analysis. The group also stated that the interpretation of relevant UNCLOS provisions, particularly concerning the genuine link and jurisdictional overlap, remains a matter for states parties to UNCLOS.[132]

During the joint working groups third session, Russia submitted a document in which it strongly emphasises the critical importance of maintaining and enhancing the human element in the operation of MASS. This perspective is highlighted through their extensive commitment to developing specialised training programs aimed at equipping personnel with the skills necessary to effectively manage these advanced vessels. These training programs comply with STCW and are designed to prepare maritime professionals for roles such as chief mate, watchkeeping officer, and MASS master at remote operations centers. Furthermore, the Russian Federation views the enhancement of

[131] MSC 107th session, MSC 107/5/1, Report of the MSC-LEG-FAL Joint Working Group on MASS on its second session, p. 5.

[132] Ibid, pp. 9–10.

human competencies as essential for ensuring that MASS can operate safely and effectively alongside traditional vessels.[133]

China also submitted a proposal regarding how the issues of certificates, information sharing, and cybersecurity should be handled within the new MASS code. China proposed that the regulatory framework for MASS requires further clarification, particularly concerning the application of provisions for onboard certificates and documents. Chinas proposal highlighted the need to categorise onboard certificates and documents into three distinct groups: those demonstrating compliance with IMO requirements, logs that record onboard activities, and publications and manuals that guide safe operations. China underscores that MASS must retain onboard certificates to evidence compliance with IMO standards, including adapting requirements under the Maritime Labour Convention for ships without crews. The relevance of keeping logs that record human-centric activities such as maintenance and training is questioned for crewless MASS, suggesting a possible re-evaluation. Additionally, operational manuals and training guides typically designed for human operators need to be reconfigured to suit the autonomous operations of MASS. Moreover, China points out that a remote operations centre managing MASS operations should also maintain necessary certificates and documents to demonstrate compliance with the relevant requirements. These should include detailed records of ship operations and ensure that all operational manuals and instructions are accessible to remote operators, aligning with the latest draft of the MASS code.[134]

The proposal further advocates the retention of essential certificates and documents on both MASS and in remote operation centers to show compliance with IMO regulations and support safe operations, with an emphasis on facilitating the use of electronic formats for these documents. This approach aligns with existing IMO guidelines that already promote electronic certificates for conventional ships. In addressing interactions with port States, China suggests enhancements to the formalities required upon the arrival, stay, and departure of MASS. This includes updating the general declaration and crew list to reflect MASS operations, thereby informing port authorities about the autonomous and remotely-controlled nature of these vessels, which is critical for port state control inspections. China's proposal aims to ensure that MASS operations are integrated into existing regulatory frameworks, addressing unique challenges through the adoption of electronic document management and transparent communication of compliance and operational data to port authorities. According to China, the initiative is intended to foster an

[133] Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3, submitted by the Russian Federation, pp. 2–3.

[134] Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3/1, submitted by China, p. 2.

environment where MASS can operate efficiently within global shipping regulations while adapting to their autonomous capabilities.[135]

Japan proposed further discussion on the framework outlined in the draft MASS code concerning the inspection of remote operations centers by flag states, particularly when these remote operation centers are located outside the flag state's territorial jurisdiction. The proposal emphasised that such inspections, conducted with the consent of the host state and in alignment with the new MASS code provisions, should not be viewed as infringing upon the sovereignty of the state where the remote operation centers is established. This approach mirrors the established practices under SOLAS and ISM, where flag state inspections of ship management companies do not impinge on the sovereignty of the host state as long as they are party to SOLAS.[136]

Moreover, Japan argued that a similar principle should apply to the certification and verification of remote operation centers under the MASS code, suggesting that the implementation of such inspections would be consistent with international norms, provided that the MASS code is adopted by the MSC as a mandatory code binding upon States Parties to SOLAS. With the MSC's current timeline aiming to introduce the MASS code initially as a non-mandatory instrument by the end of 2024, and subsequently as a mandatory instrument by the end of 2026, Japan raises questions about the enforcement capabilities and jurisdictional authority of flag states under the MASS code during its non-mandatory phase, especially among States Parties that have accepted the Code.[137]

In summary, it is submitted that the joint working group develops on certain matters discussed and put forth during the MSC sessions. The joint working group mainly analysis a selection of issues discussed during the MSC sessions and focuses on them. Whilst this serves to somewhat resolve the chosen issues, what is not discussed by the joint working group, remains partially unanswered, suggesting that there is a selectiveness on what is discussed, and what is excluded.

## 4.2 Legal implications of the MASS code

In a study made by the European Maritime Safety Agency, discussing possible legal issues related to MASS, it is presented that SOLAS is fundamentally

[135] Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3/1, submitted by China, pp. 3–4.

[136] Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3/2, submitted by Japan, pp. 2–4.

[137] Ibid, p. 4.

premised on the assumption of human presence aboard ships, which shaped the creation of its regulations with seafarers' roles in mind. Furthermore, current SOLAS regulations are deemed generally compatible with MASS operations, as these vessels are assumed to have qualified seafarers onboard capable of performing necessary human interventions such as manual operations and responding to emergencies. However, the regulations do not address new risks identified in recent studies, suggesting a need for updates to better accommodate autonomous ship operations. Moreover, specific issues arise concerning SOLAS compliance, particularly with requirements for continuous watchkeeping at control stations and bridge attendance. These regulations presuppose minimum manning levels that may not align with the operational realities of autonomous ships, indicating potential areas for regulatory adjustment. For instance, SOLAS Chapter II-2 mandates centralised fire detection alarms in a continuously manned control station for passenger ships carrying over 36 passengers. This requirement presents compliance challenges for MASS where the bridge might be unmanned periodically.[138]

Further discussed in the study, SOLAS Chapter III, concerning lifesaving appliances, and Chapter V, on safe manning, do not directly conflict with the operation of MASS as long as there is a competent crew on board. Chapter III's regulations on emergency training and evacuation drills are currently met with the existing crew configurations on passenger ships. However, Chapter V's requirements for safe manning are based on principles set for conventional vessels, which may not adequately reflect the staffing needs of autonomous ships, suggesting that revisions may be necessary to ensure that personnel numbers, roles, and responsibilities are appropriately calibrated for autonomous operations. Thus, while current provisions do not hinder MASS compliance, the evolving context of maritime operations necessitates a re-evaluation of SOLAS regulations to ensure they remain applicable and effective in overseeing autonomous maritime activities.[139]

COLREGs Rule 5, which emphasises the necessity of human qualities such as “sight and hearing,” implies that human physical presence is essential in the monitoring role and is always applicable without exceptions or allowances for equivalent standards across all ships. Technological advances and changes in ship design have led to a more flexible interpretation of Rule 5. For instance, the adaptation to enclosed bridges, which affected the ability to meet hearing requirements, resulted in a formal amendment to SOLAS, allowing for an alternative approach that accommodates these changes. The IMO has historically not adhered to a strictly literal interpretation of Rule 5, suggesting

[138] SAFEMASS, Study of the risks and regulatory issues of specific cases of MASS – Part 1, pp. 76–77, EMSA, Rep. No. 2019-1296, <https://www.emsa.europa.eu/mass/safe-mass.html>, (accessed 21 April 2024).

[139] Ibid, p. 77.

the possibility that electronic instruments could substitute for the human function of observation, provided the technologies employed are as effective and safe as diligent human lookouts.[140]

Additionally, COLREGs emphasises that ships must be operated by a human and that navigational decisions are based on a seamanlike assessment of each situation. This requirement is detailed in COLREGs Rule 2, which states that nothing in the rules exonerates any vessel from the consequences of neglecting to comply with the rules or from neglecting any precautions required by the ordinary practice of seamen. The rule also notes that special circumstances may necessitate a departure from these rules to avoid immediate danger. Incorporating "good seamanship" into automated navigation presents challenges, particularly as COLREGs Rule 2 states that simply following the rules is insufficient. Ships must be capable of handling situations where the rules do not provide a safe solution, requiring a navigator's common sense in principles of navigation, scenario prediction, risk evaluation, and strategic planning. This poses a compliance challenge at higher levels of autonomy where the operator is not continuously present on the bridge and is only partially involved in navigational decisions.[141]

Assuming that highly automated ships are classified as "ships" or "vessels" under UNCLOS, they fall under its comprehensive rules concerning the rights and responsibilities of flag, coastal, and port states. A specific issue arises with UNCLOS Article 94, which mandates that each flag state effectively exercise jurisdiction and control over its ships, ensuring that each is commanded by qualified masters and officers, with an adequately qualified crew. Furthermore, UNCLOS Article 94 compels flag states to adhere to internationally accepted regulations, procedures, and practices, and to ensure compliance. This provision allows UNCLOS to adapt over time without being tethered to a fixed technical standard or detail. Thus, it is argued that the IMO is well within its rights to regulate autonomous shipping comprehensively. Although there may be some tension with the specific wording of UNCLOS Article 94, the framework of UNCLOS is not intended to obstruct the advancement of new maritime technologies. Moreover, legal acceptance of entirely crewless ships under Article 94 would require explicit endorsement and detailed global regulation by the IMO.[142]

[140] SAFEMASS, Study of the risks and regulatory issues of specific cases of MASS – Part 1, p. 74, EMSA, Rep. No. 2019-1296, <https://www.emsa.europa.eu/mass/safe-mass.html>, (accessed 21 April 2024).

[141] Ibid, p. 75.

[142] H. Ringbom, "Regulating Autonomous Ships—Concepts, Challenges and Precedents", (2019), *Ocean Development & International Law*, Vol. 50 at pp. 161–162.

Additionally, regarding UNCLOS Article 94, in the context of UNCLOS, the terms specified in Article 94 such as "manning," "master," "officers," "crew," and "seamanship" are not defined with explicit meanings, which allows for a functional interpretation of these terms. This observation is crucial given that Article 94 encompasses not only crewing requirements, but also broader measures related to the construction, design, and equipment of ships, all aimed at enhancing navigational safety. Importantly, Article 94's primary objective is to ensure that seas and oceans are navigated by seaworthy vessels to safeguard navigation and protect the marine environment. The International Court of Justice suggests that the use of generic terminology in this Article reflects a state's intent to adopt a functional approach to the interpretation of these terms, accommodating technological advancements and preventing the ossification of maritime regulations. This perspective is supported by the underlying goal of Article 94, which is to maintain safe and competent ship operations, irrespective of whether the vessels are manned by humans, controlled remotely, or operate autonomously. As long as the technical equipment onboard meets the competence levels required for navigational safety, comparable to those expected of traditional ships, the stipulations set out in UNCLOS should be satisfied.[143]

Thus, the essence of Article 94(4) of UNCLOS could be interpreted to mean that human control is necessary only for specific types of vessels where technology cannot fully replicate human oversight. While further clarifications through IMO conventions might be beneficial to eliminate potential ambiguities, a substantial amendment to UNCLOS may not be necessary to accommodate these interpretations.[144]

Regulation VII of the STCW Regulations 2010 mandates that watch officers maintaining bridge and engineering watches must be physically present on the bridge or in the engine room, respectively. Additionally, there is a stipulation for a continuous watch on board while in port when dangerous cargo is present. These requirements would necessitate modifications in the context of wholly autonomous vessels, as the traditional roles and presence of human watch officers would be fundamentally altered by the introduction of fully autonomous ship operations.[145]

## 4.3 Concluding remarks

[143] I. Parlov, "Can the International Regulatory Framework on Ships' Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?", (2023), *Ocean Development & International Law*, Vol. 54. at p. 169.

[144] Ibid, p. 170.

[145] B. Soyer and A. Tettenborn, *Artificial Intelligence and Autonomous Shipping :Developing the International Legal Framework*, Oxford: Hart Publishing, 2021 at p. 18.

Concerning regulating, certifying, and approving the technology that will operate MASS, regulators face a choice between two primary strategies. The first approach is rule-based technical regulation, which sets specific design standards for equipment, demanding that MASS manufacturers adhere to detailed requirements for product configurations, materials, and designs. Traditionally, maritime safety regulations like those in SOLAS have employed this method, specifying exact guidelines for ship construction and stability, supported by classification society rules. However, the unique challenges of autonomous navigation systems may render traditional rule-based regulation less effective. Autonomous navigation systems integrate complex hardware and software to perform intricate data processing tasks, where system performance depends not only on individual components but also on their interplay. Consequently, for example, the diversity in potential sensor configurations and software behaviours makes rigid rules potentially counterproductive.[146]

Given these dynamics, a performance-based regulatory framework, which specifies desired outcomes rather than prescribing specific technological solutions, appears more suitable for autonomous navigation systems. Such regulations would focus on the performance and safety outcomes of autonomous navigation systems rather than the exact technical means by which these outcomes are achieved. This shift acknowledges the rapid pace of technological change in autonomous navigation systems and the diverse array of possible configurations that can meet safety standards. For example, the complexity of regulating cyber-physical systems like autonomous navigation systems, especially with embedded machine learning components, suggests that flexibility in regulatory approaches is necessary.[147]

In this chapter there was an attempt to further present issues previously highlighted during the developing sessions of the code, as well as issues not yet mentioned. In conclusion, MASS technology introduces many issues that could be regulated in a satisfying way, if implemented correctly. Following the discussions held during the sessions, and in commentary adhering to the sessions, it can be submitted that opinion leans towards that strict but undefined regulations could be the most effective and satisfying way to regulate MASS. In the following chapter, the writers' thoughts on some legal issues pertaining to MASS and the MASS code will be presented, as well as answers to the research questions stated earlier in the thesis.

[146] M. Viljanen, "How to Ensure Safe Navigation: Navigation Safety Regulation in MASS", in T. M. Johansson et al., *Autonomous Vessels in Maritime Affairs: Law and Governance Implications*, Cham: Springer Nature Switzerland AG, 2023 at pp. 145–146.

[147] Ibid, pp. 146–147.

# 5 Conclusions and summary

As discussed in the introductory chapter of the thesis, the shift from having to not having personnel onboard a ship, is bound to create some legal questions. With all regulatory instruments pertaining to shipping, in some way, having been developed based on the premise that ships are steered, commanded, and tended to by humans physically onboard the ship, the conclusion can be drawn that amendments to the regulatory framework are necessary.

The extent of the amendments, however, seem to not necessarily be as extensive as the so called paradigm shift implies. In reference to the first research question of this thesis, the current field of public maritime law allows for autonomous ships in most parts of its respective frameworks. However, certain issues are deemed as in need of amending if the shift to MASS should be deemed feasible, from a compliance perspective.

Regarding SOLAS, created on the premise of human presence and furthermore with the purpose to protect human health and life, the absence of human personnel onboard creates certain gaps in the current demands set forth by the legislation. As stated in the regulatory scoping exercise, the question of defining the role of responsible personnel onboard, such as the master and the crew, is of very high importance. The reasoning as to why this is such an important factor of the security onboard MASS is because there simply, in an event where human life or health is at risk, needs to be a person responsible for avoiding or deterring said risk, and liable in an event where damage is inflicted. With the principle onboard manned ships of there always being someone in charge, this issue is handled. In the case of MASS, where these terms are yet to be defined, such an event would lead to legal uncertainty as to what the legal reasoning is. With MASS lacking this hierarchy of responsibility, a new system is needed. Built into the hierarchy of responsibility is the presumption that the one in charge at the time of an emergency can and will take action to minimise the damage caused by the emergency at hand. With MASS, even though a human could be assigned responsibility and liability it is not certain that that person can affect the emergency situation, as control over the ship could be dispersed and incalculable by a single human, given the nature of the technology of the ship.

From a practical viewpoint, specifically regarding emergency situations where dangerous goods are involved, regulated in SOLAS Chapter VII, concerning the carriage of dangerous goods, certain differences should be made regarding what the MASS in question is transporting. As shown earlier in the thesis, there will be fallback procedures when MASS are involved in any kinds of emergency situation relating to the functionality of the ship.

However, given the damage some cargo can impose on its surroundings, it is fair that MASS transporting dangerous goods that could impose harm on its surroundings are regulated specifically to minimise the risk of the goods imposing harm in any way. As discussed in relation to COLREGs part B, human-like senses are valued highly. To repeat, maritime law is somewhat built around the premise of human interaction and action, in relation to cargo, this could include inspecting cargo during voyages, using human senses. With this possibility being removed on some MASS, a possible amendment could include a requirement on MASS voyages where dangerous goods are shipped that there is either a human on board, responsible for ensuring that the cargo is handled in a safe manner and that there in case of an emergency is enough resources to minimise damages to both the cargo and its surroundings, or technology that replaces the human inspectors function. This replacive technology could include sensors, adapted to each unique type of dangerous cargo, to supervise and alert if something were to happen to the cargo that would impose any type of danger. If the technology were to totally replace human presence on board the MASS, the technology should also be able to successfully defer the danger in any given situation, if needed.

Regarding the definitions of master, and other crew, the draft suggests, at this point, rather clear guidelines. Following the tradition of there always being a master, or someone at an equal hierarchical position, the new code should not create any further issues. In practice, the master liability is the same, although demands set out on the system of the MASS will probably be much higher, considering the master will surrender much of his or hers control over the ship to the autonomous system of the ship itself. To compensate for the master's partial loss of control over the ship, whilst still being in possession of the liability, insurance policies and contracts between the parties involved will probably evolve so that the risk and liability is balanced.

By explicitly stating that the master should have the means to intervene, the new code suggests that the master always should possess some sort of control, and that the master should be able to exercise said control, over the ship. How this matter of control will look remains unstipulated in the draft code. Furthermore, the current stipulation lacks clarity as to how far this requirement stretches. Whilst possible on some routes, where the master could attain physical control over the ship by presence on board, the master will not always be within feasible distance to get to the ship physically, or already be onboard. Control by other means than physical presence would mean that control is exercised remotely. In these cases, there could be cases where connectivity with the MASS is lost, as technical faults arise. Moreover, concerning technical faults, the draft code requires there to exist a "Fallback state", and a "Contingency plan". Whilst these requirements suggests that issues that arise should be able to be handled internally by the MASS's own functionality, the

requirement itself cannot be taken as a guarantee that this will always be the case. To clarify how these situations should be handled, and to what extent the master shall try to assume control over the ship, the obligation to be able to intervene, and the capability of the MASS itself to on its own recover from the fallback and contingency stages, should be viewed and applied together. This should be done to clarify clearly, in relation to the type of MASS, and its voyage, what the master's obligations are in any given case where he or she needs to exercise control over the ship but is constrained. Furthermore, this obligation should be applied in relation to the risks implied when control is lost and shall be reattained. For example, the master's possibility to intervene on a MASS functioning as a transporter of a few passengers at a time over a small river, should not be the same as an ultra large cruiser navigating the high seas, considering the difference in risk of imposing damage as a fault of the master being unable to exercise control over the ship. Therefore, the draft should be amended to further specify how far reaching the obligation to be able to intervene is, and furthermore, be adjusted to fit the relevant voyage, ship, and cargo transported by the MASS.

Concerning the flag state of a MASS, there are several issues in need of addressing before the code can be seen as legally fit for practice. During the joint working group sessions, Japan led a discussion concerning the geographically unbound nature of remote operational centers, and its possible effect on the flag of the MASS in control by the centre. As expressed in the conclusion of the discussion, this issue is yet to be addressed within the code and has been passed on to the LEG committee. This uncertainty, in combination with the responsibility of the administration of MASS, which in extension is the state of the flag of which the MASS flies, is of utmost importance to the functionality of the MASS ships in use. Given the complicated nature of MASS, and the extensive responsibility of the flag state of the MASS to verify and approve its functionalities, a somewhat far-reaching burden is placed on the, of the MASS, responsible state. Furthermore, given the complexity, and the cost of entertaining such approval and verification, a possible amendment to the MASS code would be to not place the burden of approval of verification of the ship on the single responsible flag state, but on an organisation under the IMO. This could ensure that all MASS would follow the same stipulated criteria, ensuring that MASS functions, as the purpose of the code stipulates, in a safe, secure, and environmentally sound manner. Furthermore, the centralisation of such a task would lessen the economical and administrational burden of members of the IMO, eliminating their need to all parallel to each other develop the same type of agencies, applying the same standards. Furthermore, centralising such an approval and certification agency would remove the possibility of shipping companies exploiting certain states rules, that may be more favourable for the shipping company, for their own benefit, at the expense of security and safety of others. If the issue

is to remain unclear, as Japan suggests, it could be possible for MASS to fly the flag of its choice, given the geographically unbound nature of remote operational centers, and their link to the MASS.

Moreover, concerning the approval and certification of MASS, the nature of the technology operating the ship, further motivates the issue to be centrally managed. As shown earlier in the thesis, the demands set on the technologies operating a MASS cannot be easily defined. The MASS code should therefore, in its final version, set demands on the operating technology on performance-based premises, as well as providing clear guidelines as to what the performance-based obligations include. Furthermore, these obligations should be enforced and controlled by a single organisation, as to guarantee that all MASS follow the same principles of operation, as well as the motivation stated in the foregoing paragraph.

In conclusion, the thesis has examined the implications of transitioning from crewed to autonomous ships, specifically focusing on the compatibility of current maritime laws with the coming MASS code. The analysis reveals that while the current legal framework largely accommodates autonomous vessels, certain aspects, especially those requiring continuous human oversight and emergency response, necessitate significant clarification. As highlighted and discussed in the legislative history of the MASS code, many legal issues pertain to the question of who should be deemed in control and liable for a MASS. Solely by providing an answer to this question, the MASS code will solve an extensive number of legal uncertainties. This leads to an affirmative answer to the first research question of there existing legal ambiguities, regarding the role of human operators and safety protocols within these frameworks that need addressing. Regarding the second and third research question, the draft MASS code presents a foundational effort to resolve these ambiguities. It proposes a framework where responsibilities for oversight and emergency interventions are redefined, suitable for MASS operations. However, these provisions are still in their nascent stages, and the draft code's current iterations requires further refinement to ensure comprehensive coverage and practical application. Thus, while preliminary, the proposed amendments in the MASS code are poised to offer some of the necessary clarifications, pending further detailed enhancements and international consensus.

Finally, it is the writer’s opinion that the MASS code should be further developed and amended through performance-based regulations, allowing for different solutions to the regulatory issues that MASS technology introduces. Given the difference between various MASS, their use, purposes, and voyages, performance-based regulations appear most fitting. Additionally, regarding the MASS code itself, it can be stated that several legal uncertainties

still exist and remain unanswered. This will most likely be the case up until the code is finalised, as well as nuanced through doctrine and legal precedent.

# Bibliography

**Books**

Attard, David Joseph, Balkin, Rosalie P. and Greig, Donald W, *The IMLI Treatise on Global Ocean Governance: Volume III: The IMO and Global Ocean Governance*, (Oxford University Press, Oxford, 2018).

Barret, Jill and Barnes, Richard, *Law of the sea: Unclos as a living treaty*, (British Institute of International & Comparative Law, London, 2016).

Deplano, Rossana and Tsagourias, Nicholas, *Research methods in international law: a handbook*, (Edward Elgar Publishing, Northampton, 2021).

Evans, Malcolm D., *International Law*, (Oxford University Press, Oxford, 2010).

Hauck, Sué González, Kunz, Raffaela, Milas, Max, *Public International Law: A Multi-Perspective Approach*, (Routledge, Abingdon, 2024).

Johansson, Tafsir Matin, Fernández, Jonatan Echebarria, Dalaklis, Dimitrios, Pastra, Aspasia and Skinner, Jon A., *Autonomous Vessels in Maritime Affairs: Law and Governance Implications*, (Springer Nature Switzerland AG, Cham, 2023).

Kraska, James and Park, Young-Kil, *Emerging technologies and the law of the sea*, (Cambridge University Press, Cambridge, 2022).

Lehrberg, Bert, *Praktisk juridisk metod*, (Iusté, Uppsala, 2022).

Mukherjee, Proshanto K., *Mukherhee on Maritime Legislation*, (WMU Publications, Malmö, 2021).

Nääv, Maria and Zamboni, Mauro (red.)., *Juridisk metodlära*, (Studentlitteratur, Lund, 2018).

Ringbom, Henrik, Røsæg, Erik and Solvang, Trond, *Autonomous ships and the law*, (Routledge, Abingdon, 2021).

Sandgren, Claes, *Rättsvetenskap för uppsatsförfattare*, (Norstedts Juridik AB, Stockholm, 2021).

Soyer, Bariş and Tettenborn, Andrew, *Artificial intelligence and autonomous shipping: developing the international legal framework*, (Hart Publishing, Oxford, 2021).

Todd, Paul, *Advanced Introduction to Maritime Law*, (Edward Elgar Publishing Limited, Cheltenham, 2021).

Wright, Glenn, *Unmanned and Autonomous Ships: An Overview of MASS*, (Routledge, Abingdon, 2020).

**Articles**

Parlov, Iva, "Can the International Regulatory Framework on Ships' Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?", (2023) Ocean Development & International Law, vol 54.

Ringbom, Henrik, "Legalizing Autonomous Ships", (2020) Ocean Yearbook vol. 34.

Ringbom Henrik, "Regulating Autonomous Ships—Concepts Challenges and Precedents", (2019) Ocean Development & International Law" 2019, vol. 50.

Veal, Robert and Tsimplis, Michael, "The integration of unmanned ships into the lex maritima", (2017) Lloyd's Maritime & Commercial Law Quarterly, vol. 303.

**Online sources**

DNV GL AS Maritime Safety, "SAFEMASS, Study of the risks and regulatory issues of specific cases of MASS – Part 1", (2020) European Maritime Safety Agency, <https://www.emsa.europa.eu/mass/safemass.html>, accessed 21 April 2024.

IMO, "Autonomous shipping",<https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx>, accessed 8 May 2024.

IMO, "Conventions, International Convention for the Safety of Life at Sea (SOLAS), 1974", <https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx>, accessed 10 May 2024.

IMO, "Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs )", <https://www.imo.org/en/About/Conventions/Pages/COLREG.aspx>, accessed 15 April 2024.

IMO, "Scoping exercise begins, to look into how safe, secure and environmentally sound Maritime Autonomous Surface Ship operations may be addressed in IMO instruments", <https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx>, accessed 18 April 2024.

IMO, "Structure of IMO", https://www.imo.org/en/About/Pages/Structure.aspx#3, accessed 7 May 2024.

IMO, "IMO takes first steps to address autonomous ships", https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx, accessed 7 May 2024.

Yara, "MV Yara Birkeland", https://www.yara.com/news-and-media/media-library/press-kits/yara-birkeland-press-kit/, accessed 14 May 2024.

**IMO Committee sessions documents**

MSC, Outcome of the regulatory scoping exercise for the use of mass, MSC.1/Circ.1638 Annex.

MSC 98th session, MSC 98/20/2, 27 February 2017, Maritime Autonomous Surface Ships: Proposal for a regulatory scoping exercise, submitted by Den-mark, Estonia, Fin-land, Japan, the Netherlands, Norway, the Republic of Ko-rea, the United Kingdom and the United States.

MSC 98th session, MSC 98/20/2, Proposal for a regulatory scoping exercise, sub-mitted by Denmark, Estonia, Finland, Japan, the Netherlands, Norway, the Republic of Korea, the United Kingdom and the United States.

MSC 99th session, MSC 99/5/2, Proposals for the development of a work plan, submitted by ICS.

MSC 99th session, MSC 99/5/5, Plan of approach for the scoping exercise, submitted by Australia, Canada, Denmark, Estonia, Finland, Japan, the Neth-erlands, Norway, Singapore, Sweden, the United Kingdom, the United States, IMarEST and IMCA.

MSC 100th session, MSC 100/5, Report of the Correspondence Group on MASS, submitted by Finland.

MSC 100th session, MSC 100/INF.6 Annex, Preliminary analysis of the In-ternational Regulations for Preventing Collisions at Sea, 1972, submitted by China.

MSC 100th session, MSC 100/INF.10, Results of technology assessment on MASS, submitted by Republic of Korea.

MSC 101st session, MSC 101/5/2, The initial review of the mandatory IMO instruments related to maritime safety and security, submitted by China.

MSC 102nd session, MSC 102/5/4, submitted by Belgium, China, and the Nether-lands.

MSC 102nd session, MSC 102/5/6, Summary of results of the second step of the RSE for SOLAS chapter II-1, submitted by France.

MSC 102nd session MSC 102/5/9, Summary of results of the second step of the RSE for SOLAS chapter V, submitted by China.

MSC 102nd session, MSC.102/5/10, Summary of results of the second step of the RSE for SOLAS chapter XI-1 and related codes, submitted by Finland.

MSC 102nd session MSC 102/5/11, Summary of results of the second step of the RSE for SOLAS chapter XI-2 and the ISPS code, Submitted by Finland.

MSC 102nd session MSC 102/5/15, Summary of the results of the second step of the RSE for SOLAS chapter IV, submitted by Turkey.

MSC 102nd session, MSC 102/5/19, Summary of results of the second step of the RSE for SOLAS chapter II-2, submitted by Japan.

MSC 102nd session, MSC 102/5/20, Summary of the results of the second step of the RSE for SOLAS chapter VI and associated codes, submitted by Japan.

MSC 102nd session, MSC 102/5/21, Summary of the results of the second step of the RSE for SOLAS chapter VII and associated codes, submitted by Japan.

MSC 102nd session, MCS 102/5/25, Summary of results of the second step of the RSE for SOLAS chapter IX and the ISM Code, submitted by Norway.

MSC 102nd session, MSC 102/INF/17, Strategic themes in MASS perspective, submitted by Finland.

MSC 103rd session, MSC 103/5/1, Comments on the potential gaps and themes identified by the results of the RSE Submitted by the Republic of Korea.

MSC 104th session, MSC 104/15/17, Proposal for a new output on developing a road map to address Maritime Autonomous Surface Ship (MASS) operations in IMO instruments, submitted by China.

MSC 104th session, MSC 104/15/25, Submitted by Japan, Russian Federation, United Arab Emirates and IACS.

MSC 104th session, MSC 104/15/26, Proposal for a new output on the development of international provisions for Maritime Autonomous Surface Ships (MASS), Submitted by Belgium, Canada, Denmark, Finland, France, Germany, Marshall Islands, Norway, Singapore, United States, BIMCO and the International Association of Classification Societies.

MSC 105th session, MSC 105/7/3, Discussion on some key issues in the development of the MASS instrument and proposal for a structure of a draft MASS code, submitted by Norway.

MSC 105th session, MCS 105/7/7, Comments on key principles and common understanding of a MASS instrument and the draft road map, submitted by China.

MSC 106th session, MSC 106/INF. 18, submitted by China.

MSC 107th session, MSC 107/5/1, Report of the MSC-LEG-FAL Joint Working Group on MASS on its second session.

MSC 107th session, MSC 107/5/6, Proposed text for a human element section in the draft MASS code Submitted by Japan.

MSC 107th session, MSC 107/5/8, Consideration on the minimum competencies re-quired for MASS navigation for remote operators, submitted by Republic of Korea and the International Transport Workers' Federation.

MSC 107th session, MSC 107/INF.11, Considerations, and requirements for net-work security equipment for the operation of MASS, submitted by the Republic of Korea.

MSC 107th session, MSC 107/INF.14, Study on the definition and organization of a Remote-Control Centre (RCC) with a view to its certification, submitted by Belgium.

MSC 107th session, MSC 107/INF.14, Study on the definition and organization of a Remote Control Centre (RCC) with a view to its certification, Annex, the drafting of a study on the definition and organisation of a remote control centre (RCC) with a view to its certification, submitted by Belgium.

MSC 107th session, MSC 107/INF.12, Report on the Regulatory Framework for MASS implemented in France, submitted by France.

MSC 108th session, MSC 108/4/7, Steering and sailing rules and MASS code, submitted by France and Spain.

MSC 108th session, MSC 108/4/15, Requirements, and capabilities for MASS to fulfil search and rescue obligations Submitted by the International Maritime Rescue Federation (IMRF).

MSC 108th session, MSC 108/4, Report of the Correspondence Group Submitted by Marshall Islands.

Joint MSC-LEG-FAL MASS Working Group 1st session, MASS-JWG 1/2, Consideration of the common issues identified in the RSEs of the three committees and how best to address them, Submitted by the Chairs of the Maritime Safety, Legal and Facilitation Committees.

Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common is-sues identified in the RSEs of the three committees and how best to address them, Submit-ted by the Chairs of the Maritime Safety, Legal and Facilitation Committees.

Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common is-sues identified in the RSEs of the three committees and how best to address them, Proposal on the key elements to be considered regarding the common issues, submitted by China.

Joint MSC-LEG-FAL Working Group, 1st session, Consideration of the common is-sues identified in the RSE's of the three committees and how best to address them, Proposal for draft Code for Maritime Autonomous Surface Ships, submitted by the Russian Federation and the United Arab Emirates.

Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3, submitted by the Russian Federation.

Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3/1, submitted by China.

Joint MSC-LEG-FAL Working Group, 3rd session, MASS-JWG 3/3/2, submitted by Japan.