AFLOAT AND AIRBORNE: A DUAL EXAMINATION OF IMO AND ICAO PERSPECTIVES ON UNMANNED VEHICLES*[1]

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Abstract

At a time of rapid technological advancement, unmanned ships and aircraft offer great potential in the maritime and aviation sectors. This article considers the regulatory environment for unmanned ships and aircraft, examining how international regulatory approaches can shape the frameworks in these areas. This article compares IMO's classification approach for unmanned ships based on autonomy levels with ICAO's operation-centred and risk-based approach for unmanned aircraft. IMO's regulations for unmanned ships are based on levels of autonomy. Although this approach offers some advantages, it may impose limitations in keeping pace with technological progress. On the other hand, ICAO's approach offers flexible and adaptable regulations by grouping operations according to risk levels. This method offers the ability to adapt to the rapidly changing aviation industry.

ICAO's operation-centred approach could be an inspiration for IMO. This approach ensures that regulations are flexible, adaptable and risk orientated. It can also facilitate rapid adaptation to new technologies and the updating of operational standards.

In conclusion, international regulatory approaches are of great importance in the process of establishing legal regulations for unmanned vehicles. ICAO's operation-centred and risk-based approach can guide IMO's regulations for unmanned ships. Analysing similar approaches in both sectors can help to develop future regulations in a more effective and harmonised manner.

Keywords: Unmanned ships, Unmanned aircraft, Regulatory approaches, IMO, ICAO.

*[1] This article is peer-reviewed.

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1. Introduction

1.1. Scope of the Article

Wherever the human imagination touches, there lies a marvellous potential. Having witnessed the technological magic of unmanned vehicles, the law is obliged to guide this magical journey. Although aviation innovations have taken the law to higher altitudes, unfortunately, the same cannot be said for maritime law. In this article, how aviation law deals with unmanned aircraft technology and maritime law deals (or fails to deal) with unmanned ship innovations will be analysed comparatively and how aviation law can be a good example for maritime law in this regard will be discussed.[1)]

In the legal doctrine, some authors have used the words 'autonomous' and 'unmanned' interchangeably and have indicated this. As explained later in the current article, the International Maritime Organization (IMO) refers to 'autonomous ships', while the International Civil Aviation Organization (ICAO) prefers the term 'unmanned aircraft'. Since the use of the word 'unmanned' has a wider scope[2)], this concept will be included in this article. Because there are both 'autonomous' and 'remotely piloted vehicles' under the umbrella of 'unmanned vehicle'.[3)] Therefore, we believe that it would be more accurate to prefer the word 'unmanned' which has become widespread by taking into account the current ICAO regulations.

As explained below, unmanned aircraft are widely used in civilian and military fields, the wider community is conscious of their presence and their legal framework is more developed.[4)] Many countries have enacted laws and regulations to regulate the use of unmanned aircraft in areas such as airspace management, civil aviation rules, privacy, and data protection.[5)] International law also plays an important role in relation to the military use

1) Breunig, J. and others, (2018). Modeling Risk-Based Approach for Small Unmanned Aircraft Systems, 3.
2) Autonomy should be kept as a descriptive phrase, but one should differentiate between "full autonomy" and "constrained autonomy," with the second being more suitable for ships currently Rødseth, Ø., Wennersberg, L., and Nordahl, H. (2022). Levels of autonomy for ships. *Journal of Physics: Conference Series*, 2311.
3) Veal, R., and Tsimplis, M. (2017). The Integration of Unmanned Ships into The Lex Maritima. *Lloyd's Maritime and Commercial Law Quarterly*, 303.
4) Liu, H. (2023). Maritime and Aviation Law: A Relational Retrospect and Prospect on Unmanned Ships and Aircraft. In *Regulation of Risk* (Leiden, The Netherlands: Brill | Nijhoff), 472.
5) Chatzara, V. (2023). Unmanned Air Transports: The Use of Drones and Legal Issues Arising Thereof. In K. Noussia and M. Chanmunon (Eds.), *The Regulation of Automated and Autonomous Transport* (Springer), 43; Kopardekar, P., and others. (2016). Unmanned Aircraft System Traffic Management (UTM) Concept of Operations. *AIAA Aviation Forum and Exposition*, Washington DC, 13.06.2016, 3, available from https://ntrs.nasa.gov/citations/20190000370, accessed 28.08.2023.

of unmanned aircraft.[6)]

On the other hand, autonomous ships are a newer technology and legal regulations are not as solid as for unmanned aircraft.[7)] The legal framework for autonomous ships is based on the law of the sea, international maritime rules and laws regulating the maritime space of coastal states.[8)] However, in the case of autonomous ships, the legal regulations in this field are still in the developmental stage and there is no fully standardised framework at the international level.[9)]

Since the legal regulations of autonomous ships are generally less developed compared to unmanned aircraft, it is very important to make a comparative analysis. This analysis is useful for several reasons:

First, there are some deficiencies in the legal regulations on unmanned ships. These deficiencies, which may include issues such as security, liability, and certification, require improving the legal framework of unmanned ships.[10)] A comparative analysis with unmanned aircraft identifies legal gaps in autonomous ships and encourages regulation and the creation of a more comprehensive legal framework in these areas.

Second, unmanned aircraft can be an example and a source of inspiration for unmanned ships. Comparative analysis transfers advances and best practices in the aviation industry to the legal regulations of unmanned ships. In this way, the legal framework in unmanned ships can be made more effective and up to date by taking advantage of advances in the aviation sector.

Third, it is important that unmanned ships and aircraft adapt to the needs of future use. Legal regulations need to be updated according to rapidly de-

6) For a long time, the United Nations has debated autonomous weapon systems, which have the potential to violate several ethical and legal laws by using with unmanned aircraft systems. As the product of these discussions, in 1980, the Convention on Certain Conventional Weapons (CCW), also known as the Convention on Inhumane Weapons was adopted, along with three appended protocols. See, Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which may be deemed to be Excessively Injurious or to have Indiscriminate Effects. (1980). 1342 UNTS 137.

7) Liu (2023), 472.

8) Dremliuga, R., and Mohd Rusli, M. H. B. (2020). The Development of the Legal Framework for Autonomous Shipping: Lessons Learned from a Regulation for a Driverless Car. *Journal of Politics and Law*, 13(3), 300.

9) One reason for that, at the time when most of the law of the sea and maritime law treaties were adopted, autonomous vessels were considered a distant idea. See, Dremliuga and bin Mohd Rusli (2020), 296; Boviatsis, M., and Vlachos, G. (2022). Sustainable Operation of Unmanned Ships Under Current International Maritime Law. *Sustainability*, 2.

10) Zhu, L., and Xing, W. (2022). Policy-Oriented Analysis on the Navigational Rights of Unmanned Merchant Ships. *Maritime Policy and Management*, 49(3), 457.

veloping technology and changing needs.[11] Comparative analysis helps to determine how current legislation can adapt to these developments. Thus, unmanned ships can be used in accordance with future requirements and legal regulations can be updated in a timely manner.

For these reasons, as will be discussed in this article, it is important to make an analysis comparing the legal regulations of unmanned ships with unmanned aircraft. This analysis provides benefits in many areas such as detection of legal deficiencies, learning and improvement, adaptation to future needs. Thus, it contributes to the creation of a more fair, consistent, and modern legal framework.

1.2. Rising of Unmanned Vehicles in Skies and Seas

The use of unmanned technology has a relatively long history in the aviation industry.[12] While they were initially used mostly for military purposes[13], the use of fully autonomous aircraft in passenger transportation is also expected to begin in the not-too-distant future.[14] Research has demonstrated that aviation accidents mainly stem from human factors[15] and according to some experts in aviation industry, the use of unmanned aircraft will help minimize accidents.[16]

11) Henderson, I. L. (2022). Aviation Safety Regulations for Unmanned Aircraft Operations: Perspectives from Users. *Transport Policy*, 192.

12) While today's perception of unmanned aircraft may conjure up images of objects built with sophisticated technology, the hot air balloon flown by the Montgolfier brothers in 1783 did not require the control of a pilot. Höhrová, P., Soviar, J., and Sroka, W. (2023). Market Analysis of Drones for Civil Use. *LOGI – Scientific Journal on Transport and Logistics*, 14(1), 55.

13) According to records, Europe experienced its first air warfare in the summer of 1849 when Austrian forces besieging Venice bombarded the city with pilotless hot air balloons. Kozera, C. A. (2018). Military Use of Unmanned Aerial Vehicles. *Safety and Defense*, 4(1), 18 Holman, B. (2009). The First Air Bomb: Venice, 15 July 1849 *Airminded*, available from https://airminded.org/2009/08/22/the-first-air-bomb-venice-15-july-1849/ , accessed 05.07.2023.

14) The world's first self-flying, all-electric, four-passenger eVTOL air taxi was unveiled by Wisk Aero, an Advanced Air Mobility (AAM) and autonomous electric flights company, in the fall of 2022. https://wisk.aero/aircraft/, accessed 05.07.2023.

15) Shappell, S., and others. (2007). Human Error and Commercial Aviation Accidents: An Analysis Using the Human Factors Analysis and Classification System. *Human Factors*, 49(2), 227–242. Additionally, human factors can be quite varied. For instance, pilots check themselves with the 'IMSAFE' checklist before a flight. The letters in this acronym stand for illness, medication, stress, alcohol, fatigue and emotions; respectively. See, Federal Aviation Administration. (2020). *Aviation Instructor's Handbook* (FAA-H-8083-9B); Mendonca, F. A. C., Keller, J., Levin, E., and Teo, A. (2021). Understanding Fatigue within a Collegiate Aviation Program. *The International Journal of Aerospace Psychology*, 31(3), 183.

16) Unmanned aircraft may help prevent unintended accidents as well as deliberate disasters. The Germanwings Flight 9525 disaster, in which the co-pilot deliberately crashed the plane for suicide in 2015 and caused the death of 150 people, can be cited as an example. See for detailed information, Pasha, T., and Stokes, P. R. A. (2018). Reflecting on the Germanwings Disaster: A Systematic Review of Depression and Suicide in Commercial Airline Pilots. *Frontiers in Psychiatry*, Vol 9, 1.

Unmanned aircraft, which have many areas of use such as military operations, fire suppression, logistics, agricultural use, humanitarian aid in emergencies, meteorology, film production, space exploration, help humanity with their unique technologies.[17)]

Unmanned vehicle technology must have an affinity for the colour blue, as it has begun to dominate the seas as well as the skies. Autonomous ships are ships that can navigate without human intervention and are used for various purposes.[18)] They provide a wide range of benefits from cargo transport to marine research, underwater exploration, maritime safety and fleet management.[19)] Autonomous ships offer advantages such as increased productivity and reduced labour costs.[20)] They also provide a continuous flow of data, making them ideal for gathering and analysing information in maritime-related areas.[21)] They increase occupational safety and energy efficiency while reducing human error.[22)] These developments aim to provide more effective, safe and sustainable solutions in the maritime industry.[23)]

In the maritime industry, the use of unmanned vehicles is much more nascent than in the aviation industry.[24)] The world's first unmanned commercial shipping operation took place on May 7, 2019, when a box of oysters collected in Essex, UK, was delivered to customs officials in Ostend,

17) Gautam, T., and Johari, R. (2023). Drone: A Systematic Review of UAV Technologies. In S. Tanwar and others (Eds.), *Proceedings of Fourth International Conference on Computing, Communications, and Cyber-Security* (CCCS 2022) (Lecture Notes in Networks and Systems, vol 664, Springer, Singapore, 147.

18) Utne, I., Rokseth, B., Sørensen, A., and Vinnem, J. (2020). Towards supervisory risk control of autonomous ships. *Reliability Engineering and System Safety*, 196, 106757.

19) Kretschmann, L., Burmeister, H.-C., and Jahn, C. (2017). Analyzing the Economic Benefit of Unmanned Autonomous Ships: An Exploratory Cost-Comparison Between an Autonomous and a Conventional Bulk Carrier. *Research in Transportation Business and Management*, 25, 76.

20) Maritime experts note that the shipping industry is risky, and its workers have limited supply. According to these authors, autonomous ships are also protective of workers and labour. See, Negenborn, R. R., and others. (2023). Autonomous ships are on the horizon: here's what we need to know. *Nature*, 615, 30; Kretschmann, Burmeister and Jahn (2017), 76.

21) Dremliuga and bin Mohd Rusli (2020), 296.

22) According to maritime experts, human error factor is one of the key reasons of transportation accidents at sea. See, Michael Boviatsis and George Vlachos (2022), Sustainable Operation of Unmanned Ships Under Current International Maritime Law, Sustainability, 1, 7369, 2. An example of human error in the maritime sector is the Suez Canal blockage. The giant container ship "Ever Given" crashed into the shore in the Suez Canal on 24 March due to poor visibility caused by sandstorms and bad weather conditions. https://www.bloomberg.com/news/features/2021-06-24/how-the-billion-dollar-ever-given-cargo-ship-got-stuck-in-the-suez-canal, accessed 06.07.2023; Vio, I., and Brdar, M. (2022). Maritime Autonomous Surface Ships – International and National Legal Framework. *Pomorski Zbornik*, 62, 144.

23) Felski, A., and Zwolak, K. (2020). The Ocean-Going Autonomous Ship—Challenges and Threats. *Journal of Marine Science and Engineering*, 8(1), 41, 1.

24) Liu (2023), 471.

Belgium, by a 12 metres unmanned ship with an aluminium hull.[25] Thanks to technological developments such as surveillance, analysis, sensor technology and navigation software, autonomous control of much larger ships is becoming possible.[26] The Soleil, a Japanese ferry, became the first major ship to operate without human assistance in January 2022. The ship berthed, unberthed, turned, reversed, and guided itself for 240 kilometres across the Iyonada Sea from Shinmoji in northern Kyushu.[27]

Increasing interest and research in autonomous vehicles also leads to economic development of the sectors.[28] According to statistics, the worldwide unmanned aircraft marketplace had a value at $6.29 billion[29] in 2021 and is expected to rise at a compound annual growth rate (CAGR) of 19.3% between 2022 and 2031, reaching $37.06 billion by 2031.[30] The global marketplace for autonomous ships is estimated to be worth $85.84 billion in 2020, and is expected $165.61 billion by 2030, with a CAGR of 6.8% between 2020 and 2030.[31]

In both areas of economic growth and investment, legal regulations are needed to ensure the safe and ethical use of these technologies, to address privacy and security concerns, ensure compliance with international law and prevent potential conflicts.[32]

2. Maritime Law Aspect

2.1. Overlapping with the ‘Ship’ Definitions

To start with, since United Nations Convention on the Law of the Sea

25) https://www.gsdm.global/maritime-autonomous-surface-ships-mass-and-framework-development-challenges/, accessed 05.07.2023.
26) Liu (2023), 471.
27) Negenborn and others (2023), 30.
28) Felski and Zwolak (2020), 1.
29) All $ symbols used in this study refer to United States dollars.
30) S., A., and Mutreja, S. (2022). Autonomous Aircraft Market by Aircraft Size, Maximum Take-off Weight, Application, End-Use: Global Opportunity Analysis and Industry Forecast, 2021-2031, available from https://www.alliedmarketresearch.com/autonomous-aircraft-market-A07121, accessed 06.07.2023.
31) Jadhav, A., and Mutreja, S. (2020). Autonomous Ships Market by Level of Autonomy, Ship Type, Component and Fuel Type: Global Opportunity Analysis and Industry Forecast, 2020-2030, available from https://www.alliedmarketresearch.com/autonomous-ships-market, accessed 06.07.2023.
32) Consider the case of an unmanned aircraft that may mistakenly break down private land and cause damage. Similarly, if the scope of this scenario is broadened to include an unmanned aircraft entering the airspace of a foreign State without authorisation, a violation of international law will result. Similarly, the unauthorised entry of an autonomous ship into the maritime territory under the jurisdiction of another State would also constitute a violation of international law.

(UNCLOS)[33], the most important instrument of international maritime law, uses the terms ship and vessel interchangeably, it can be said that these concepts have essentially the same meaning.[34] In this study, the use of the term ship is preferred.

To understand whether unmanned ships are within the scope of existing international maritime law regulations, first, it is necessary to examine the definition and determine whether it overlaps with the 'ships' within the scope of the agreements.[35] However, it is challenging to assess whether unmanned ships will fall into this category because there is no uniform legal definition of 'ship' in UNCLOS, other treaties, or customary international law.[36]

The main difference of unmanned ships from ships that constitute the main object of international maritime law regulations is the presence of seafarers.[37] Therefore, it should be examined whether the presence of a seafarer on the board is an integral factor for a floating object to be classified as a 'ship'.

For a better understanding of the issue, it would be useful to analyse whether unmanned ships are excluded from the 'ship' definitions in documents regulating international maritime law. In International Convention for the Prevention of Pollution from Ships (MARPOL)[38], the fundamental international instrument governing the prevention of ship-caused pollution of the marine environment, 'ship' is defined as,

> *"...a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms."*

Another important document in international maritime law is the Convention on Civil Liability for Oil Pollution Damage (CLC).[39] The CLC was enacted to ensure that those who suffer oil pollution harm because of maritime casualties involving oil-carrying ships receive proper compensation.

33) United Nations Convention on the Law of the Sea. (1982). 1833 UNTS 3.
34) McKenzie, S. (2020). When Is a Ship a Ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea. *Melbourne Journal of International Law*, 21(2), 2.
35) Vio and Brdar (2022), 144.
36) McKenzie (2020), 2.
37) Zhu and Xing (2022), 448.
38) 1978 Protocol Relating to the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). (1978). 1340 UNTS 61.
39) Protocol of 1992 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969. (1992). 1956 UNTS 1.

In Article 2, ‘ship’ is defined as,

> *“...any sea-going vessel and seaborne craft of any type whatsoever constructed or adapted for the carriage of oil in bulk as cargo...”*

The definition of ‘ship’ in Convention on the International Regulations for Preventing Collisions at Sea (COLREGs)[40], which is one of the most important works of IMO and determines the ‘rules of the road’ or navigation rules that must be followed by ships and other vessels at sea to prevent collision between two or more ships, is as follows:

> *“The word ‘vessel’ includes every description of watercraft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water.”*

Another definition of ‘ship’ is included in the United Nations Convention on Conditions for Registration of Ships[41], finalised in 1986, which attempts to define the elements necessary for the registration of ships in a national register.[42] Pursuantly, ‘ship’ means,

> *“...any self-propelled seagoing vessel used in international seaborne trade for the transport of goods, passengers or both...’*[43]

Since not all floating objects can be entitled to international rights and obligations, international instruments contain definitions setting out the conditions for their classification as ‘ships’. Although the definitions may vary slightly due to the purpose of the documents, a close definition is reached when the definition of ‘ship’ in the main instruments regulating

40) Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). (1972). 1050 UNTS 16.

41) United Nations Convention on Conditions for Registration of Ships. (1986). However, the Convention has not yet entered into force because it has not reached the number of States Parties required for its entry into force. Nevertheless, since it is an important endeavour for the national registration of ships, the definition of ship is included in this article.

42) Kasoulides, G. C. (1989). The 1986 United Nations Convention on the Conditions for Registration of Vessels and the Question of Open Registry. *Ocean Development and International Law*, 20(6), 543-576.

43) United Nations: Convention on Conditions for Registration of Ships (1987). *International Legal Materials*, 26(5), 1229–1250. http://www.jstor.org/stable/20693153, accessed 10.07.2023.

international maritime law is examined.[44] None of the ship descriptions in the documents contain an explicit requirement for human presence on board, nor do they explicitly exclude the existence of autonomous ships.[45]

However, the fact that these documents do not exclude autonomous ships while defining ‘ship’ is not due to their intention to include autonomous ships within their scope, but simply since autonomous ships did not exist at the time the documents were drafted. Although it may seem economical and expeditious at first sight to take advantage of the wide ship scope of the Conventions and bring autonomous ships under the umbrella of these regulations, there are no provisions that can provide appropriate answers to the nature and characteristics of autonomous ships.[46] Because, as will be explained in the following sections of our article, these instruments contain regulations for manned ships. In other words, there is a serious deficiency in the existing regulations for autonomous ships.[47] To tackle this issue, IMO carried out a study to assess scope of autonomous ships which will be discussed in detail.[48] How the regulations for unmanned aircraft in aviation law can be a good example for maritime law will be discussed in our article.

2.2. IMO Regulatory Scoping Exercise on MASS

The International Maritime Organization (IMO) has conducted a significant study to investigate the compliance of autonomous ships with existing regulations.[49] In June 2017[50], the Maritime Safety Committee (MSC) of the

44) Ship definitions in other instruments regulating international maritime law do not exclude autonomous ships. For instance, according to the definition given in the Hague-Visby Rules, ship means “any vessel used for the carriage of goods by water”. Similarly, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, or the London Convention for short, defines both ships and aircraft together as follows: “Vessels and aircraft means waterborne or airborne craft of any type whatsoever. This expression includes air-cushioned craft and floating craft, whether self-propelled or not.” Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. (1972). 1046 UNTS 120.
45) Boviatsis and Vlachos (2022), 3.
46) Zhu and Xing (2022), 459.
47) Karlis, T. (2018). Maritime Law Issues Related to the Operation of Unmanned Autonomous Cargo Ships. *WMU Journal of Maritime Affairs*, 17, 126.
48) Vio and Brdar (2022), 144.
49) Jo, M. C., and others (2020). Study on the Potential Gaps and Themes Identified by IMO Regulatory Scoping Exercise (RSE) for the Use of Maritime Autonomous Surface Ships (MASS). In *IOP Conference Series: Materials Science and Engineering* 929(1), 1; Zhu and Xing (2022), 458.
50) The beginning of the discussion of ship automation within IMO actually dates back to almost 6 decades ago. At the 8th MSC meeting in 1965, the term ‘ship automation’ was discussed and the term was used broadly to include complete/partial automation systems and remote control. See, Jo and others (2020), 2; Kim, T. E., and others. (2022). Safety challenges related to autonomous ships in mixed navigational environments. *WMU Journal of Maritime Affairs*, 21(2), 142.

Organization started a "regulatory scoping exercise" to establish the scope of applicability of its regulation tools and their potential reach regarding Maritime Autonomous Surface Ships (MASS).[51)] After 4 years of start, at the 103rd session of the Committee[52)], the Outcome of the regulatory Scoping Exercise for the use of MASS has accepted containing a review of the extent to which the current regulatory structure under the authority of the MSC might be shaped to tackle MASS activities.[53)]

The Committee defined the MASS as "a ship which, to a varying degree, can operate independent of human interaction" for the aims of the exercise.[54)] During the execution of the exercise, the autonomy of the ships was divided into four separate levels, which made the process easier and more convenient. Pursuantly, the levels of autonomy, without any hierarchy between them[55)], are defined as follows:

- 1st Degree, ship with automated processes and decision support: In this category, to run and manage shipboard systems and operations, seafarers are present. Although there may be seafarers on board who are prepared to take charge, some operations may be automated and occasionally run unattended.
- 2nd Degree, remotely controlled ship with seafarers on board: The ships are managed and run from a different place under this category. There are seafarers on board who can assume command and manage the systems and operations of the ship.
- 3rd Degree, remotely controlled ship without seafarers on board: Ships in this category are controlled and operated from different places, and on board, there are no seafarers.
- 4th Degree, fully autonomous ship: The operating systems of ships in the last category of autonomy levels, can make decisions and determine actions by themselves.

The scoping exercise procedure consisted of two phases. The first phase, which was completed in September 2019, was generally to identify existing and potentially usable instruments. For this purpose, IMO documents con-

51) Karlis (2018), 120.
52) The session is held between 5 and 14 May 2021.
53) Outcome of the Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS). International Maritime Organization, Maritime Safety Committee MSC.1/Circ.1638, 3 June 2021. Available from https://www.imo.org/en/MediaCentre/PressBriefings/pages/MASSRSE2021.aspx, accessed 20.08.2023.
54) MSC.1/Circ.1638 (2021), 3.
55) This is clearly stated in the exercise report. It is even indicated that MASS can operate at one or more levels of autonomy during a single journey. See, MSC.1/Circ.1638 (2021), 4.

taining provisions on maritime safety, security, compensation, liability, etc. were labelled in 4 different types. These types are as follows:
- Apply to MASS and prevent MASS operations; or
- Apply to MASS and do not prevent MASS operations and require no actions; or
- Apply to MASS and do not prevent MASS operations but may need to be amended or clarified, and/ or may contain gaps; or
- Have no application to MASS operations.[56)]

Following the completion of the first phase, the second phase was to analyse and determine the most appropriate and effective way to organise MASS operations. In carrying out this analysis, inter alia, human, technological and operational factors were taken into account and the following conclusions were reached:
- equivalences as provided for by the instruments or developing interpretations; and/or
- amending existing instruments; and/or
- developing new instruments; or
- none of the above as a result of the analysis.

Since the scope of our study is unmanned ship, it is mainly limited to autonomous vehicles at the third and fourth degrees according to IMO classification.[57)] However, from a general point of view, IMO's autonomy-based rating system is open to criticism in various aspects. Firstly, from a technical point of view, various question marks concern regulators and operators. An unmanned ship may be operated by a system of several components that perform different tasks with different levels of human intervention.[58)] This complexity can make classification based on levels of autonomy difficult to apply. Especially from a legal perspective, it is important to ensure the variability and compatibility of autonomy levels between these components.

The rapid advancement of technological developments brings further challenges to classification based on levels of autonomy. This has important implications, especially from a legal perspective. The level of autonomy of a device or technology is usually related to the capabilities of that device. However, as technology is constantly evolving, the level of autonomy of a device can change in a short period of time.[59)] For example, while an un-

56) MSC.1/Circ. 1638 (2021) Annex, 4-5.
57) Kim and others (2022), 148.
58) McKenzie (2020), 6.
59) Kim and others (2022), 154.

manned ship may initially have a limited level of autonomy, it may reach a higher level of autonomy with software updates or new hardware additions.

This poses a major challenge for regulators. Regulators should closely follow technological developments and update regulations frequently. Otherwise, existing regulations will quickly become outdated and unable to keep pace with technology. This can pose a significant risk in terms of security and legal liability.

For businesses, this situation may increase uncertainty. Businesses purchase technologies that comply with existing regulations and plan to use these technologies for a certain period of time. However, when technology advances rapidly, businesses may have multiple levels of autonomy when using these technologies. This increases the difficulty for businesses to maintain compliance with existing regulations and operational continuity.

Additionally, a rating system based on the level of autonomy may be inadequate when different operations are involved for the same ship.[60] During a marine pollution monitoring and clean-up operation, the unmanned ship may have a high level of autonomy because it may need to make quick and independent decisions to detect and clean up pollutants. However, this same ship may need a lower level of autonomy during a harbour security mission, as more human intervention and coordination may be required.

This complexity may make law enforcement difficult. There may be separate regulations and equipment requirements for each level of autonomy. For example, unmanned ships with a high level of autonomy may require more monitoring and certification, while unmanned ships with a low level of autonomy may require more human intervention and operational control.

From a legal perspective, this makes it complex to assess the legal compliance of operations and enforce regulations. It also raises important questions about the safety and liability of operations. It is therefore important that the legal framework is flexible and harmonised to effectively address different levels of autonomy and maritime operations.

Furthermore, legal complexity may arise when there are different phases of a single operation that are covered by more than one level of autonomy. For example, an unmanned ship may have high levels of autonomy during a coast guard mission because it must have the ability to scan, detect and respond. However, the same unmanned ship may need a lower level of autonomy in in-port transport operations, as this may require more human intervention and compliance with local regulations.

In legal terms, the categorisation of such complex operations and the

60) Kim and others (2022), 155.

enforcement of regulations is a major challenge. Managing different levels of autonomy and developing appropriate regulations for each level can be a major effort for regulators and businesses. Moreover, this process is time-consuming and can be complicated by the diversity of operations. This complexity can also create challenges for assessing the legal compliance and liability of operations. Determining which levels of autonomy can be used in which circumstances and for how long can create legal complexity.

Besides, categorisation based on autonomy levels may have some shortcomings in terms of risk analysis and management.[61] One of these deficiencies is that a given level of autonomy may not fully reflect the potential risk of an operation. The nature of operations may involve different levels of risk, but autonomy levels may not adequately address this complexity. Legally, the risk analysis and management of such operations may require a more comprehensive approach rather than relying solely on categorisation based on autonomy levels. It should be remembered that each operation has a unique risk profile and that these risks are based on more than the level of technological autonomy. Legal regulations should be applied more flexibly, taking into account the risks, objectives and environmental impact of operations.[62]

In conclusion, categorisation based on levels of autonomy may have shortcomings in terms of risk management and legal regulations would adopt a broader perspective to better reflect the complexity and risks of operations. This could provide a better framework for ensuring both the safety and legal compliance of operations.

In the next section of this paper, ICAO's model regulations for unmanned aircraft, which are based on an operation-centred and risk-based approach, will be examined in detail and the aspects of this approach that can be adopted by the maritime industry will be discussed.

3. Aviation Law Dimension

3.1. The Term "Unmanned Aircraft"

A decent and detailed classification of manned aircraft is found in Annex 7 of the Chicago Convention.[63] In the Annex, ICAO also refers unmanned aircrafts as "an aircraft which is intended to be operated with no pilot on

61) Kim and others (2022), 150.
62) Breunig and others (2018), 20.
63) Annex 7 to the Convention on International Civil Aviation, Aircraft Nationality and Registration Marks, Sixth Edition, July 2012, ICAO, 2.

board shall be further classified as unmanned".[64] According to this definition, an unmanned aircraft can be categorised in any of the ICAO classifications, e.g., aeroplane, helicopter, or glider.[65] On the other hand, some authors in the legal doctrine have correctly noted that unmanned aviation can be divided into various categories.[66] These categories consider factors like whether the pilot is remotely present, the degree of autonomy, and if the term encompasses just the aircraft or the entire system as well. Additionally, there's a varying degree of complexity among these categories.[67]

As the use of new technology increases day by day, it is an option for regulators to integrate unmanned aircrafts into existing regulations. However, while taking this step, the extent to which the existing rules are compatible with the aims and objectives of unmanned aircraft operations should be taken into consideration.[68] In cases where it is determined that new regulations are needed, it should be kept in mind that the new rules to be introduced should not undermine the structure of the existing ones.[69]

The following quotation from a decision of the Supreme Court of Oregon in 1960 illustrates the necessity and importance of the law catching up with technology:

> *"If the mind of man can invent and operate a flying machine, it ought to be able to devise a rule of law which is adequate to deal with the problems flowing from such inventiveness. This is the challenge of the common law."*[70]

The process becomes more complex and time-consuming if the concerns raised by various parties are numerous, both in the case of integration into existing regulations and when new regulations are to be introduced. According to some, it is simple to understand why the establishment of legislation and regulatory framework regarding this topic is complicated and

64) Apart from Annex 7, in the Article 8 of Chicago Convention refers to 'pilotless aircraft'. Pursuant to the Article, *"No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft."*.

65) Scott, B. I., and Nunes de Pinho Veloso, G. (2022). Chapter 2: Terminology, Definitions and Classifications. In *The Law of Unmanned Aircraft Systems Second Edition* (Ed. Benjamyn I Scott, Wolters Kluwer, Alphen aan den Rijn), 9.

66) Scott and de Pinho Veloso (2022), 9.

67) Scott and de Pinho Veloso (2022), 9.

68) Henderson (2022), 192.

69) Morrison and others (2021), 276.

70) Atkinson v. Bernard, Inc., 223 Or. 624, 355 P.2d 229 (Or. 1960), available from https://law.justia.com/cases/oregon/supreme-court/1960/223-or-624-3.html, accessed 29.07.2023.

still under advancement given the quick advancement of unmanned aircraft technology, the widening range of uses, and the plethora of safety, security, and privacy issues that occur.[71)]

3.2. Model UAS Regulations

Although ICAO is the most important international aviation organization, it is not an international aviation regulator.[72)] This means that ICAO standards cannot override the national regulations of states. Accordingly, national regulations are the rules that air transport operators are legally required to comply with in the airspace and airports under the sovereignty of the States concerned.[73)]

While national regulations have the supremacy in terms of unmanned aircraft, ICAO's work on the regulation of this field is admirable. A regulatory framework for unmanned aircraft systems (UAS) that fly outside of IFR International airspace was requested by member states of ICAO.[74)] In order to find similarities and efficient procedures that would be in line with the ICAO aviation structure and that a wide variety of States may put into effect, the ICAO studied the current UAS legislation of several States.[75)] As a result of this work, ICAO Model UAS Regulations Parts 101[76)], 102[77)] and

71) Morrison and others (2021), 276; Chatzara (2023), 45.
72) Elfita Agustini, Yaya Kareng, and Ong Argo Victoria (2020). The Role of ICAO (International Civil Aviation Organization) in Implementing International Flight Safety Standards. In *Excellent Human Resource for the Sustainable Safety of Inland Water and Ferries Transport in New Normal Era-International Webinar (IWPOSPA 2020)*, KnE Social Sciences, 100-114.
73) Chatzara (2023), 55.
74) Liu (2023), 488.
75) Morrison, C., and others (2022). Transnational Organizations in Drone Law and Policy. In *Anthony Tarr and others (eds)*, Routledge, 290.
76) ICAO Model UAS Regulations Part 101 (2020), available from https://www.icao.int/safety/UA/Documents/Model%20UAS%20Regulations%20-%20Parts%20101%20and%20102.pdf, accessed 22.08.2023.
77) ICAO Model UAS Regulations Part 102 (2020), available from https://www.icao.int/safety/UA/Documents/Model%20UAS%20Regulations%20-%20Parts%20101%20and%20102.pdf, accessed 22.08.2023.

149[78] were formed.[79]

In the description of the Model Regulations, it is stated that these documents do not replace the Chicago Convention or its Annexes, nor are they to be interpreted in any way to interfere with the legal structures of States.[80] In line with this, it was also noted that the legal requirements presented in the documents may not be the same for each State, taking into account the differences in the legal structures of States, and that States are free to adapt the model regulations to their specific needs.[81] From a general perspective, they are designed to provide States with model language that will make it easier to implement UAS rules.[82]

In a general summary, Part 101, which is designed for low-risk operations and states that all unmanned aircraft must be registered, covers situations where unmanned aircraft weighing 25 kg or less operate within limited parameters.[83] Part 102, on the other hand, focuses on such operations employing unmanned aircraft that weigh over 25 kg or less than 25 kg yet fail to comply with requirements of Part 101.[84] Lastly, proposed regulations are outlined in Part 149 for the certification and execution of Approved Aviation Organizations, which are expected to carry out activities like providing operator competency licenses, allowing the use of unmanned aircraft, and authorizing unmanned aircraft activities.

In this section of this study, these model regulations prepared by ICAO will be examined. In our opinion, these model regulations provide useful guidance to member states when developing or updating their unmanned

78) ICAO Model UAS Regulations (2020), Part 149, available from https://www.icao.int/safety/UA/Documents/Model%20UAS%20Regulations%20-%20Part%20149.pdf, accessed 22.08.2023.

79) Joint Authorities for Rulemaking on Unmanned Systems (JARUS), an assembly of specialists formed in 2007 with the aim of suggesting certification, specifications, and operational regulations to those with an interest like the ICAO, local aviation authorities, and regional authorities for their attention and use, is the source of the regulatory framework for unmanned aircraft. JARUS also has published a work in 2019 proposes a risk-based concept for performance-based regulations of unmanned aircraft operations. Pursuant to this document, a risk-based approach is described in terms of three operational categories, which are Category A (Open), that stands for very low risk operations, Category B (Specific), which stands for limited risk operations, and Category C (Certified), which stands for traditional high-risk operations. The document is available from http://jarus-rpas.org/wp-content/uploads/2023/06/jar_10_doc_UAS_Operational_Cat.pdf, accessed 29.08.2023. For more information see, Liu (2023), 488; Morrison and others (2022), 290.

80) Part 101 and Part 102, Description, 1: Part 149, Description, 1.

81) For instance, Model Flying New Zealand (MFNZ) is awarded special privileges under Part 101, allowing their members to undertake activities at their own sites that would otherwise be prohibited by the laws. For detailed information, see, Henderson (2022), 195.

82) Morrison and others (2022), 290.

83) Henderson (2022), 194.

84) Morrison and others (2022), 291.

aircraft regulations. This is because these model regulations can be used to ensure consistency and harmonisation between different countries by providing an internationally harmonised framework. At the same time, they reflect the latest developments in the unmanned aircraft industry and are up-to-date and responsive to contemporary issues. This helps member states to make up-to-date and appropriate regulations and supports the safe and effective conduct of unmanned aircraft operations.[85)] On the other hand, there are aspects of the documents that need to be improved or that can be considered deficient, which will be discussed in the following chapters.

3.2.1. Part 101

The background of the Advisory Circular 101-1[86)], which provides advice on best practices to be followed when operating small unmanned aircraft weighing 25 kilograms or less, operating in accordance with Part 101 rules, mentions that the civil use of unmanned aircraft has increased significantly in recent years and that these aircraft can now perform tasks that were previously difficult or risky for humans.[87)] Part 101, which this advisory circular describes, contains model regulations for the civilian use of unmanned aircraft.[88)] The most prominent feature of Part 101 is its focus on lower risk operations and its aim to ease the regulatory and administrative duties on operators.[89)]

Part 101 regulates relatively low-risk activities, for instance daylight operations and it has a weight limit for unmanned aircraft.[90)] This model regulation will apply to unmanned aircraft weighing between 15 kg and 25 kg.[91)] Higher risk unmanned aircraft such as night operations or unmanned aircraft weighing more than 25 kg are regulated under Part 102, which will be discussed in the next section of this article.[92)]

In this part of this article, various features of Part 101 that are prominent and should be considered by States that may want to implement the model will be examined. These features are registration, operating conditions, and operator obligations.

85) Morrison and others (2022), 290.
86) Advisory Circular (AC) 101-1, available from https://www.icao.int/safety/UA/UAID/Documents/AC%20101-1.pdf, accessed 22.08.2023.
87) Henderson (2022), 194.
88) AC 101-1, Description.
89) Morrison and others (2022), 291.
90) Chatzara (2023), 55.
91) Part 101, 101.3 Applicability and Open Category (a) (2), 8.
92) Part 101, 101. 29 Weather and Day Limitations, 14.

3.2.1.1. Registration

Registration of unmanned aircraft and certificate of registration are regulated in Part 101, under the Subpart B named 'operating rules'. It is stated that anyone who is legally permitted to possess an unmanned aircraft and who intends to operate one in [country] must register that unmanned aircraft and have an active certificate of registration for the particular aircraft.[93] The following statements were included on the Advisory Circular after emphasizing the significance of registration:

> *"It allows identification of the aircraft and owner and provides the [CAA] with data regarding the industry. Registration is also a way to record experience with a particular model of UA should the operator elect to expand operations into [Part 102]."*

It is appropriate to emphasise registration under Part 101. Because registration of unmanned aircraft with a national registration system will provide significant advantages for their operations.[94] These advantages are important not only for the unmanned aircraft operators but also for the general safety and order of the airspace.[95]

The first advantage is ease of identification. By registering unmanned aircraft, they and their owners in the airspace can be more easily identified.[96] This allows for faster identification of those responsible for any breach of rules, involvement in an accident or inappropriate behaviour in the airspace, and easier identification of those responsible for the sanctions to be imposed for violations.[97] This will contribute to the safety and orderliness of the airspace.

The second advantage will arise in airspace monitoring and management. Registered unmanned aircraft help to monitor and manage airspace more effectively. All aircraft in the airspace are better integrated with reg-

93) Part 101, 101.5 Unmanned Aircraft Registration and Certificate of Registration, 8.
94) Although States largely require registration for unmanned aircraft operations (e.g., United States, United Kingdom, European Union, Singapore), there are States where registration is not required, such as New Zealand, or where registration is only required for commercial use, such as Australia. See, Henderson (2022), 195.
95) Chatzara (2023), 46.
96) Morrison and others (2022), 292.
97) Chatzara (2023), 46.

istered unmanned aircraft, making air traffic more organised and safer.[98] This reduces the risk of accidents and greatly prevents conflicts in the airspace.

The third advantage is safety and public awareness. Registered unmanned aircraft encourage users to act in accordance with laws and regulations. This encourages more responsible behaviour by the operators of the vehicles and creates a safer environment in the airspace. It can also serve to create a positive perception of unmanned aircraft in society, as unmanned aircraft can be recognised as more reliable and safer if they are registered.[99]

The fourth advantage is industry data and analysis. The registration system provides valuable data to the Civil Aviation Authorities of nations. This data can be used to understand industry growth and trends and to improve policy and regulation. It also helps in the development of unmanned aircraft technology and strategic decisions for the industry.

Finally, the registration of unmanned aircraft through a national registration system encourages their safe and responsible use. This contributes to the orderly and safe operation of the airspace, while providing greater assurance to the operators of the vehicles.[100] It also increases public confidence in unmanned aircraft technology, enabling a more sustainable and successful development of this industry.

3.2.1.2. Standard UA Operating Conditions

Unmanned aircraft is an important technology that has rapidly become popular for various purposes. However, it is of great importance to comply with certain operating conditions to use this technology smoothly and safely. These rules are regulated to ensure the safety of both users and the public.[101] The Model Regulations establish basic unmanned aircraft operating conditions which may vary depending on the circumstances, enabling unmanned aircraft to be performed in accordance with Part 101 operational and regulatory requirements.[102]

In accordance with Part 101, the following basic criteria must be met in order for an unmanned aircraft to be operated under standard operating

98) Some authors in the legal doctrine have expressed their concern that, given that even the private use of unmanned aircraft causes significant disruptions in air traffic circulation, the use of these vehicles for the transport of larger cargo and passengers may also raise safety concerns regarding air traffic. The incident at London Heathrow airport in 2019, where an unmanned aircraft was sighted close to the airport, causing all take-offs to be stopped for approximately one hour, was cited as an example. See, Chatzara (2023), 45.

99) Chatzara (2023), 46; Kopardekar and others (2016), 4.

100) Morrison and others (2022), 292.

101) Kopardekar and others (2016), 4.

102) Part 101, 101.7 Meaning of Standard Unmanned Aircraft Operating Conditions, 9.

conditions:
- Visual Monitoring: The unmanned aircraft must be kept in visual line by the operator or an observer in direct communication with the operator.[103) In other words, the person controlling the vehicle or an observer who fulfils the conditions must be at a distance where they can see it visually.[104) This reduces potential hazards by enabling the operator to monitor the status of the unmanned aircraft and the surrounding conditions.[105) It should be noted, however, that no specific distance limit has been set for the fulfilment of this requirement. The distance will be determined by considering the surrounding conditions and weather conditions.
- Daytime Operation: Unmanned aircraft should be operated during daylight hours. At night or in low light conditions, it may be more difficult to control the vehicle and detect hazards, therefore daytime operation is preferred.[106) This limitation is imposed since Part 101 covers low risk operations.
- Maximum Height Limit: Unmanned aircraft must fly at or below 120 m (400 ft) above the ground.[107) This restriction ensures a safe flight by reducing the risk of collision with other aircraft in the airspace and reduces the risk of flight.[108) Approval under Part 102 is required for unmanned aircraft to be operated at a higher altitude.[109)
- Safe Distance: Unmanned aircraft should not fly closer than 30 m horizontally to a person not directly involved in its operation.[110) This is important to ensure that the vehicle does not get out of control and jeopardise the safety of others and will reduce the risk of the operation.[111)

In addition, the operation of unmanned aircraft is prohibited in certain areas. These vehicles should not be operated in the following areas:
- Prohibited Areas: Unmanned aircraft should not be flown in designated

103) Part 101, 101.7 (a) (1), 9.
104) Regarding visual monitoring, it should be clarified that the line of sight in question is to be understood as a normal sight with the naked eye. More precisely, the use of binoculars or electronic sighting devices is not appropriate in the context of visual line of sight.
105) Morrison and others (2022), 293.
106) Part 101, 101.31 Night Operations, 14.
107) Part 101, 101.7 (a) (2), 9.
108) On the other hand, flying at low altitudes also raises a variety of security concerns. To address these concerns, some authors have argued that it is critical to ensure national and regional security in unmanned aircraft operations in low-altitude airspace, and that important assets such as the White House, airport operations, and various valuable assets, such as monuments, should be protected. See, Kopardekar and others (2016), 4.
109) Morrison and others (2022), 293.
110) Part 101, 101.7 (a) (3), 9.
111) Chatzara (2023), 56.

restricted areas.[112)] These areas include areas closed to unmanned aircraft traffic for security, privacy or other special reasons.[113)]

- Restricted Areas: The use of unmanned aircraft in restricted areas is limited.[114)] These areas usually include security zones around airports or sensitive infrastructure.

- Overpopulated Areas: Unmanned aircraft should not fly over densely populated areas.[115)] This is important for the safety of people and the protection of privacy.[116)]

- Controlled Aerodromes: Unmanned aircraft should not fly in movement areas located within [4 km] of controlled aerodromes.[117)] This can be considered as a precautionary measure to avoid interference with flight traffic and to ensure aviation safety.[118)]

In addition, the use of unmanned aircraft in areas where fire, police or other public safety or emergency operations are being conducted should not be undertaken without the approval of the relevant authorities.[119)] Such operations should be planned and organised in advance.

Finally, the person operating the unmanned aircraft should control only that vehicle and multiple vehicles should not be operated by the same person at the same time. This is important to ensure the coordination and safety of the unmanned aircraft.

All these standard operating conditions are important to ensure the safe and effective use of unmanned aircraft and to protect the safety of society.[120)] By complying with these rules, owners and operators of unmanned aircraft can guarantee safe flights.

3.2.1.3. Obligations of Operators

As explained in the previous sections of our study, today, the use of unmanned aerial vehicles is increasing and gaining an important place in the aviation sector. With this developing technology, unmanned aircraft opera-

112) Part 101, 101.7 (b) (1), 9.
113) Morrison and others (2022), 293.
114) Part 101, 101.7 (b) (2), 9.
115) Part 101, 101.7 (b) (3), 9.
116) For detailed information see, Oh, S. and Yoon, Y., (2022). Data-driven risk analysis of unmanned aircraft system operations considering spatiotemporal characteristics of population distribution. *Transportation Research Interdisciplinary Perspectives*, 16, 100732.
117) Part 101, 101.7 (b) (4), 9; Chatzara (2023), 57.
118) Since the Model Regulations are not mandatory for States and serve as an example, it should be noted that various States regulate these rules in different ways. For example, for aerodromes, the ICAO limit of 4 km is regulated as 5 km by Singapore and 5.5 km by Australia. See, Henderson (2022), 195.
119) Part 101, 101.7 (c), 9.
120) Kopardekar and others (2016), 4.

tors have a great responsibility for aviation safety and human life safety.[121] Especially in flights carried out near aerodromes, certain legal obligations must be fulfilled. Since it is directly related to aviation safety, under this title, important obligations of unmanned aircraft operators regulated in Part 101 will be explained:

- **Remote Pilot Licence Requirement:** Although a pilot licence is not required for unmanned aircraft operations generally in terms of Part 101, knowledge of aeronautical charts and airspace usage is very important for flights to be performed over or within approximately 4 km of aerodromes.[122] If performed in light of this information, flights can be carried out safely and smoothly and the risk of collision with other aircraft can be minimised.

- **Minimisation of Hazard and Risk:** Operators are obliged to minimise hazards to persons, property, and other aircraft as far as possible.[123] When planning flights, all hazards must be considered, and precautions must be taken to ensure a safe flight. These hazards include flying away from areas where people congregate, flying over structures and buildings, and unsuitable weather or visibility conditions.[124] Minimising hazards and risks is vital for a safe and smooth aviation operation and ensures the safety of people.[125]

- **Prohibited Operations:** No one should operate unmanned aircraft in a careless or reckless manner that jeopardises aviation safety or the safety of life or property of others. It is also prohibited to operate an unmanned aircraft at the same time as operating a vehicle or aircraft.[126] This rule is intended to protect aviation safety by ensuring that operators conduct their flights in a responsible and safe manner.

- **Alcohol or Drugs:** Flight crew members or remote pilots may not operate within 8 hours of alcohol ingestion[127] and may not operate an unmanned aircraft while using substances that have a mental effect that may endanger or potentially endanger aircraft safety.[128] Because the use of alcohol or drugs may adversely affect the mental and physical abilities of the persons performing the tasks, which may jeopardise the safe operation of the aircraft and increase the risk of possible accidents.

121) Morrison and others (2022), 294.
122) Part 101, 101.41 Requirement for a Remote Pilot Licence, 15.
123) Part 101, 101.17 Hazard and Risk Minimization, 11.
124) AC 101-1, 101.17 Hazard and Risk Minimization, 9.
125) Morrison and others (2022), 294.
126) Part 101, 101.43 Prohibited UAS Operations, 15.
127) AC 101-1, 13.
128) Part 101, 101.45 Alcohol or Drugs, 16.

The duty of the operators is to carry out flights safely, without causing inconvenience to the public and without creating unnecessary hazards. Flights that do not comply with legal regulations are always considered dangerous and may be subject to criminal sanctions.[129] Operators must take all efforts and measures to minimise hazards in their operations, like health and safety regulations in the working environment. Furthermore, by fulfilling the obligations imposed by the regulations, they will play a safer and more responsible role in the aviation industry. If these obligations are not meticulously and at the highest level, operators may find it difficult to defend themselves in the event of post-flight incidents. Therefore, ensuring compliance with legal regulations and safety standards should be the primary responsibility of unmanned aircraft operators.

The Model Regulations prohibit the careless or irresponsible use of unmanned aircraft and the operation of an unmanned aircraft while driving another vehicle.[130] It is also strictly prohibited to operate unmanned aircraft while under the influence of alcohol or drugs. Such violations will be subject to criminal sanctions, as with other mechanisms, and behaviour that could jeopardise aircraft safety will not be permitted.

3.2.2. Part 102

Part 102 covers operations involving unmanned aircraft that do not comply with the aviation standard conditions of Part 101 and pose a higher risk. Such operations entail higher risks, either because the unmanned aircraft weighs more than 25 kg or because of the nature of the environment in which the operation is to be performed (e.g., night flights, flights beyond visual line, etc.).

The most important objective of Part 102 is to provide a detailed assessment and risk mitigation process that is authorised by the national aviation authorities.[131] These comprehensive assessment and risk mitigation measures aim to ensure that high-risk operations can be carried out safely.[132]

129) One example is the risk of hacking of unmanned aircraft and their support systems, which could lead to privacy breaches or threats to public safety. Another example is the risk that unmanned aircraft capable of carrying large payloads could be used to transport hazardous materials close to security-sensitive locations and/or infrastructure targeted for terrorist acts. See, Chatzara (2023), 45.

130) Morrison and others (2022), 294.

131) Morrison and others (2022), 296.

132) *"[Part 102] provides a framework for UA that is flexible providing the [CAA] with the discretion to tailor operational requirements to each proposed operation. Given the rapid advancements underway with UA technology, this approach ensures the regulatory regime can accommodate these aircraft while addressing the risks related to their activity."* AC 102-1 Background, 7.

Within this framework, the focus of Part 102 is on safety, which naturally represents the most critical point that attracts the attention of national authorities and operators.

As inspiring as innovative technology and aviation practices may be, safety is always paramount. ICAO's Part 102 provides States with a model framework for the regulation, monitoring and supervision of high-risk unmanned aircraft operations. These regulations aim to both ensure airspace safety and minimise risk, even while pushing the boundaries of aviation innovation.[133)] In this section, we will focus on the highlights of Part 102, which has several important model legal frameworks for unmanned aircraft.

3.2.2.1. Unmanned Aircraft Remote Pilot Certification

As the scope of Part 102 includes higher risk unmanned aircraft operations, a remote pilot licence is required to ensure the safety of the activity. Accordingly, an operator wishing to conduct unmanned aircraft activities outside the scope of Part 101 must hold a Remote Pilot Licence (RPL).[134)] For applicants wishing to obtain an RPL, ICAO requires two different categories of qualification.

The applicant, who must be at least 16 years of age, must demonstrate both general aviation knowledge and unmanned aircraft operations knowledge if they wish to hold an RPL.[135)] There is more than one way to demonstrate these competencies.[136)] In accordance with the Model Regulation Recommendation, the applicant may demonstrate general aviation knowledge by passing an aeronautical knowledge test[137)], an aeronautical licence theory test[138)], the theory component of a remote pilot training course[139)] or an acceptable foreign equivalent.[140)] It is sufficient for the applicant to hold one of these qualifications.

In addition to general aviation knowledge, the applicant must demonstrate competence in unmanned operations.[141)] This may be demonstrated by completing a remote pilot training course[142)] or a manufacturer's train-

133) Morrison and others (2022), 296.
134) Part 102 Unmanned Aircraft Remote Pilot Certification, 14.
135) Morrison and others (2022), 296.
136) Morrison and others (2022), 296.
137) Part 102, 102.1 Eligibility for Remote Pilot Licence (a) (1), 16.
138) Part 102.1 (a) (2), 16.
139) Part 102.1 (a) (3), 16.
140) Part 102.1 (a) (4), 16.
141) Morrison and others (2022), 297.
142) Part 102.1 (b) (1), 16.

ing course[143], depending on the category of unmanned aircraft; by passing the regulatory flight test[144], or by demonstrating the competencies required for the safe operation of the relevant unmanned aircraft type and control station under standard operating conditions.[145] As with general technical aviation knowledge, it is sufficient for the applicant to hold one of these qualifications.

It should be stated that ICAO's requirement that an applicant for a remote pilot licence for unmanned aircraft must have both general aviation and unmanned aircraft operations knowledge is entirely appropriate. Firstly, general aviation knowledge enables the operator to understand air traffic regulations, aviation terminology and general safety protocols. This helps the operator to manage their interaction with air traffic, share safely with other aircraft and better assess potential risks.[146] Knowledge of unmanned aircraft operations demonstrates mastery of topics such as how to fly the vehicle, different flight modes and air traffic controllers, which in turn supports safer operations.

3.2.2.2. Risk Mitigation

In Part 102, which regulates relatively higher risk operations, it is instructive to note the various measures taken by ICAO in relation to these operations.

Firstly, Part 102 provides guidance to operators to ensure that night operations, which fall outside the scope of Part 101[147], are made safe. The provision requires operators to describe certain requirements to ensure that night flights are carried out safely and effectively.[148] This is because night flights require special attention due to low visibility conditions and increased risk factors.[149] In the application, the operator should describe: the availability of equipment to ensure that the vehicle is visible to other manned or unmanned aircraft; how visual contact with the vehicle will be maintained; planned flight zones; risks to persons or property taking off from the ground; and how flights will be notified to the emergency services.[150]

143) Part 102.1 (b) (2), 16.
144) Part 102.1 (b) (3), 16.
145) Part 102.1 (b) (4), 16.
146) Morrison and others (2022), 297.
147) Part 101, 101.29 Weather and Day Limitations, 14.
148) Chatzara (2023), 64.
149) Morrison and others (2022), 298.
150) AC 102-1, 10. The model regulation also recommends that States provide an explanation of what the term "day" refers to, depending on the specific characteristics of the region.

The proposals will allow applicants to assess potential risks and hazards in advance. The Regulation also serves to improve public safety by addressing how emergency services will be notified of night flights, thereby optimising response procedures.

One of the operations that are considered high risk and for which additional information is required from applicants is operations that will be carried out over crowds of people or in congested areas where people may be present.[151] To protect public safety, applicants wishing to conduct such operations should include in their application the potential hazards and risks; vehicle configuration; reliability of the vehicle and control system; mitigations in the event of potential system failure; system redundancy and, where applicable, operator's steps to obtain consent or notify affected people.[152]

Another type of high-risk operation concerns the altitude limit at which unmanned aircraft operate. It has been stated that a ceiling limit of 120 m (400 ft) is imposed in Part 101 for unmanned aircraft to ensure coordination with other aircraft operating in the airspace, such as conventional aircraft and helicopters, and to manage air traffic in a safe and secure manner.[153] If the operator of the unmanned aircraft wishes to operate beyond this limit, in accordance with Part 102, he/she must first determine the class of airspace he/she intends to fly in, as different rules will apply according to this categorisation.

These are not the only high-risk activities for which Part 102 places additional demands on operators on a case-by-case basis. The model regulation also includes various requirements for operations within 4 km of an aerodrome, for use in agricultural activities, out of visual range, and close to buildings and structures where people are present.[154]

3.2.2.3. Eligibility of Unmanned Aircraft

To carry out high-risk operations safely, there are several requirements that must be met not only by the operators, but also by the unmanned aircraft systems themselves. Moreover, these requirements impose various obligations not only on the operators but also on the manufacturers.[155] In our opinion, this approach is justified, as the imposition of obligations on manufacturers ensures that the vehicles produced meet certain quality standards and makes the products more reliable and safer. Lack of quality

151) Part 101, 101.35 Operation Over and Near People, 14-15.
152) Oh and Yoon (2022), 2.
153) Chatzara (2023), 45.
154) Morrison and others (2022), 298.
155) Morrison and others (2022), 299.

control may cause vehicles to operate in unexpected ways or malfunction. The responsibilities imposed on manufacturers will also make it easier for manufacturers to be held liable for accidents caused by defects in the design of devices or deficiencies in manufacturing. This is also important for the development of the industry. The imposition of liability on manufacturers will lead to the continuous development of unmanned aircraft technology, the obligation to comply with quality and safety standards and the development of more reliable and advanced technology products in the sector.

To operate in a specific category in accordance with the model regulations presented in Part 102, unmanned aircraft must fulfil the following conditions:

- The vehicle must be designed, manufactured, or modified so that it is free from safety defects identified by the authority.[156)]
- Bear a label (in English, legible and permanently affixed to the vehicle) indicating its suitability for operation.[157)]
- Have up-to-date remote pilot operating instructions applicable to the operation of the unmanned aircraft. The person who designed, manufactured, or modified the vehicle shall provide the instructions if the vehicle is sold, transferred, or used by a person other than the person who designed, manufactured, or modified it.[158)]
- An unmanned aircraft may be operated after the person who designed, manufactured, or modified the vehicle has received notification that the authority has accepted the Declaration of Conformity for that vehicle or has received approval from an Approved Aviation Organisation.[159)]
- The unmanned aircraft must have a current aircraft registration.[160)]

3.2.2.4. Authorization or Operator Certificate

ICAO has provided important and detailed guidance to States on the documentation to be submitted when applying for an unmanned aircraft operator certificate in Part 102[161)], where the documents listed in the Model

156) Part 102.19 Specific Category Operations (a) (1), 20.
157) Part 102.19 (a) (2), 20.
158) The information to be included in the instructions is also listed under the same heading. Accordingly, the instructions must include at least “a system description that includes the required UAS components, any system limitations, and the declared category or categories of operation; modifications that will not change the ability of the UAS to meet the requirements for the category or categories of operation the UAS is eligible to conduct; and instructions that explain how to verify and change the mode or configuration of the UA, if they are variable”. See, Part 102, 102.19 (a) (3), 20-21.
159) Part 102.19 (a) (4), 21.
160) Part 102.19 (a) (5), 21.
161) Morrison and others (2022), 300.

Regulation for Applicants include the following[162]:
- **Person with primary responsibility for the operation:** This rule requires the applicant to identify all primary individuals.[163] These are the individual(s) with major control over any aspect of the unmanned aircraft activity, who may or might not be the same person who submitted the initial application.[164]
- **Location of operation:** This standard necessitates the identification of the valid locations where unmanned aircraft activities will take place.[165]
- **Operational Risk Assessment:** This provision necessitates an Operational Risk Assessment (ORA), which is a component of a safety management system.[166] While there are numerous ORA approaches available, the ORA ought to be customized to fit the operation's risk, including suitable mitigations specified.[167]
- **Reporting procedures:** The rule demands that processes be put in place for reporting accidents and incidents.[168]
- **Licensing and qualifications:** This rule govern employee licensing, qualifications, training, and competency standards.[169] The rule envisions the [CAA] being met in two main areas of knowledge and competence: general aviation competence and thorough understanding of the unmanned aircraft.[170]
- **Cargo-handling and dropping of items:** When an operator is interested in transporting cargo, especially hazardous commodities, drop items, or undertake farming activities, protocols must be devised to ensure the activity can be carried out without causing injury to people or property.[171]
- **Amendment and distribution of the application and documentation:** The applicant must have a method in place for modifying the application submittal in order to meet this criterion.[172]
- **Approvals:** This necessitates the operator identifying any permits that were issued in connection with the operation.[173]

It should be noted that this list is not exhaustive and that there are other

162) Part 102.23 Application for a UAS Authorization or UAS Operator Certificate, 21.
163) Part 102.23 (b) (1)-(2), 21.
164) AC 102-1, 15.
165) AC 102-1, 16; Part 102.23 (b) (3), 21.
166) Part 102.23 (b) (4), 22.
167) AC 102-1, 16.
168) AC 102-1, 16; Part 102.23 (b) (5), 22.
169) Part 102.23 (b) (6), 22.
170) AC 102-1, 17.
171) AC 102-1, 21; Part 102.23 (b) (11), 22.
172) AC 102-1, 24; Part 102.23 (b) (13), 23.
173) AC 102-1, 24; Part 102.23 (b) (14), 23.

documents that applicants should attach to their applications.[174)]

3.2.3. Part 149

Part 149 of the ICAO Model Regulations deals with the rules for the certification and operation of Approved Aviation Organisations (AAOs).[175)] As there is not yet an advisory circular accompanying Part 149, the definition of an AAO can be derived from the following provision in Part 101:

> *"...an approved organization (AAO) means an organization having appropriate expertise in the design, construction or operation of an unmanned aircraft, or appropriate knowledge of airspace designations and restrictions, and who has been approved by the [CAA] to perform various functions... "*[176)]

Part 149 contains regulations on aviation organisations authorised and approved to fulfil various duties, and in a sense encourages the existence of such organisations.[177)] It should be stated that it is quite appropriate for ICAO to include such a structure in a model regulation prepared for States. By means of AAOs, the workload on the Civil Aviation Authorities of the countries will be reduced to a great extent.

We believe that the reduction of this workload may also have a positive effect on the industry. The fact that AAOs will be able to carry out procedures such as remote pilot licensing, unmanned aircraft maintenance and inspections more quickly will ease the bureaucratic process and make the industry more independent.[178)] This may contribute to the rapid and safe development of the unmanned aviation sector.[179)]

4. Voyage of Unmanned Duel in the Legal Arenas: Seas or Skies?

As detailed in the previous sections of our study, both IMO and ICAO have undertaken various framework studies on the legal regulation of unmanned ships and unmanned aircraft. The work of both organisations is valuable, but the most notable difference is their approach to the subject.[180)]

174) Details of aircraft to be used, control systems, aircraft maintenance, operational procedures, construction and design of unmanned aircraft; AC 102-1, 19-22.
175) Morrison and others (2022), 302.
176) Part 101, 101.21 Approved Person or Organization (AAO), 11.
177) Morrison and others (2022), 302.
178) Morrison and others (2022), 302.
179) Breunig and others (2018), 3.
180) Liu (2023), 490.

In its studies on unmanned ships, the IMO has distinguished between different levels of autonomy. ICAO, on the other hand, has taken an operations-centred approach[181], distinguishing between the risk levels of operations, and developing model regulations for States.[182]

Although both approaches to unmanned vehicles have various advantages and disadvantages, we believe that the operation-centred and risk-based approach will contribute more to the development of the sectors.[183] For this reason, the studies carried out by ICAO can serve as a good example for IMO.[184] The IMO approach, i.e. categorising vehicles according to their level of autonomy and setting the legal basis accordingly, could at first sight provide clear guidance on how governments and regulators should approach these technologies. On the other hand, levels of autonomy may change constantly as technology progresses, requiring constant updating of legislation.[185]

Technology we now consider commonplace was once beyond our imagination merely a decade ago. Such advancements may propel the features and capabilities of unmanned vessels to unprecedented heights.[186] In this case, it is very likely that a distinction made today according to the level of autonomy of the vehicles will be useless soon. Moreover, as explained in the previous sections of our study, the IMO has carried out its studies by taking the existence of fully autonomous ships to a rather 'utopian' point.[187] However, advancements in artificial intelligence and sensor technologies are showing us every day that it won't take centuries for fully autonomous ships to dominate the seas.

To better understand the importance of this issue, a scenario can be considered. Suppose a country decides to base its legislation on autonomous vehicles on levels of autonomy. Initially, the regulations limit autonomous transport vehicles to low levels of autonomy, allowing them to operate only on certain roads and under certain conditions.

However, in the not-too-distant future, autonomy technology is advancing rapidly, and higher levels of autonomy systems are being developed. These higher levels of autonomy will be able to operate safely on a wider road network and in more complex traffic conditions. As a result, legislation that was limited to lower levels of autonomy will no longer be appro-

181) Chatzara (2023), 57.
182) Liu (2023), 490.
183) Kopardekar and others (2016), 7.
184) Liu (2023), 490.
185) Zhu and Xing (2022), 458.
186) Kopardekar and others (2016), 6.
187) Liu (2023), 490.

priate for this new technology and may even become a barrier to progress.

In this situation, regulators need to constantly update legislation and adapt to new technologies. Rapid technological progress requires constant changes in legislation, which can affect the coherence and stability of regulation.[188] It can also create uncertainty for companies and make long-term planning difficult.

This scenario demonstrates that technological progress may necessitate updates to the legal framework, as autonomy levels change constantly. This could highlight some of the challenges of an autonomy-based regulatory framework.In addition, failure to anticipate the future strong presence of fully autonomous vehicles would exacerbate the uncertainties in this scenario.

IMO's distinction by level of autonomy also has deficiencies in maritime safety and risk assessment. The standards and protocols required to ensure safety and manage risks when unmanned ships are travelling at sea may be unclear for a given level of autonomy. There should be clear guidelines on under what circumstances and conditions ship operations should be halted or intervened.

Failure to prioritise risks can also lead to insurance and financial problems. The risk profile and safety of autonomous ship operations should be assessed by insurance companies and insurance premiums should be adjusted accordingly. While autonomous ship technology is developing rapidly, not adopting a risk-based approach may make it difficult to predict insurance models.

On the other hand, the operation-centred and risk-based approach adopted by ICAO in the model regulations prepared by it as an example for States, which provides a legal framework according to the risk levels of the operations, has many advantages.[189]

To start with, unlike the autonomy-based approach, the operation-centred approach provides flexible regulations that can be adapted more quickly to different levels of risk and technological developments.[190] This makes it easier to keep pace with rapidly changing technology and industry. This is because the operation-centred approach analyses risks in more detail and helps to determine the potential risk level of each operation.[191] In this way, higher-risk operations can be subject to stricter regulation, while lower-risk operations can be subject to less strict regulation. This approach ensures a

188) Liu (2023), 490.
189) Liu (2023), 490.
190) Kopardekar and others (2016), 7.
191) Liu (2023), 491.

more efficient use of resources by accurately assessing risks.[192] Less regulation of low-risk activities can help regulators and governments use their resources more effectively and efficiently. This can also optimise audit and compliance processes.

Another advantage of this approach is that it can incorporate continuous improvement. An operations-centric approach allows regulators to continuously collect and analyse data on operations and risks. This can be used to assess the effectiveness and appropriateness of existing regulations, and to update regulations where necessary.[193] This continuous improvement cycle can improve the safety and compliance of the industry.

Increasing the competitiveness of the industry is another benefit of a flexible and liberalised regulatory framework.[194] Fewer restrictions on low-risk activities allow companies to experiment and develop new solutions. More flexible regulation will therefore encourage the development of new and innovative activities.[195] Smarter and risk-based regulations can improve the competitiveness of a country or region in the drone and ship sectors. As companies and developers have more freedom and opportunities, they may be more likely to develop more innovative solutions.

In addition to the technological investment incentives and industry benefits, an operations-centred approach also has greater public benefits. This is particularly the case for low-risk operations. Less regulation of low-risk operations can facilitate faster and more effective emergency response and crisis management. This can be illustrated with an example scenario:

Suppose a natural disaster occurs in a country where the regulatory framework for unmanned aircraft operations is based on risk levels. Due to severe weather conditions and difficult terrain, land and air transport is almost impossible. Low risk unmanned aircraft operations can contribute to a fast and effective emergency response. First, because these types of operations are less regulated and can be controlled quickly, they can be activated quickly and deliver emergency supplies to areas where they are needed. In this way, unmanned aircraft routes can be quickly adjusted and updated as the emergency requires. Reduced regulation of low-risk operations can allow new routes to be created quickly. As a result, flexible regulations can make it more effective to adapt to rapidly changing situations and meet urgent needs.

Another advantage of an operation-centred approach is that it contributes

192) Kopardekar and others (2016), 7.
193) Liu (2023), 491.
194) Breunig and others (2018), 20.
195) Kopardekar and others (2016), 7.

to strengthening the development environment.[196] Because there are far fewer bureaucratic requirements for low-risk operations[197], it is easier to create a test environment in which new technologies and concepts can be tested and developed.[198] In this way, new ideas can be tested and even other uses for unmanned vehicles can emerge.

In addition to the flexibility and freedom offered by low-risk operations, there are several benefits of an operations risk-based approach for high-risk operations.[199] Firstly, more stringent regulation of high-risk operations leads to higher safety standards.[200] This, in turn, supports safer operations and minimises potential accidents or errors. In addition, stricter regulation of high-risk operations may encourage more research and development in these areas. Tailoring regulations to high-risk operations can support technological progress. In addition, the person or company conducting an operation categorised as high risk will be more aware of the potential risks. This helps businesses to be better prepared for the operation and to manage risks effectively.[201]

5. Conclusion

In today's rapidly advancing world of advanced technology, unmanned aircraft and unmanned ships offer extraordinary potential in the aviation and maritime sectors. In the light of these technological advances, the development of regulations should not only be limited to safety and operational standards, but also cover industrial development and other critical aspects. Against this dynamic backdrop, this article provided a detailed look at how two distinct approaches, namely classification by levels of autonomy and risk-based operation-centred regulation, can shape these important regulations.

The aim of this paper was to examine the advantages and disadvantages of these two different approaches to establishing the legal frameworks for unmanned ships and unmanned aircraft, and to present ICAO's classification system for unmanned aircraft operations as an example of IMO's regulations for unmanned ships.

The legal framework developed by ICAO for unmanned aircraft adopts

196) Kopardekar and others (2016), 7.
197) Breunig and others (2018), 3.
198) Liu (2023), 491.
199) Kopardekar and others (2016), 7.
200) Breunig and others (2018), 20.
201) Liu (2023), 492.

an operation-centred approach. This approach allows operations to be categorised according to their risk level and thus ensures that regulations are flexible and adaptable.[202] This approach of ICAO offers the ability to adapt to technological developments in the rapidly changing aviation sector.

At this point, when IMO's regulations for unmanned ships are analysed, it is seen that the classification is based on autonomy levels. Although this approach offers some advantages, it may impose some limitations in terms of keeping pace with technological progress and responding to rapidly changing operational needs.

ICAO's operation-centred approach for unmanned aircraft can serve as an example for IMO. This approach allows regulations to be more flexible, adaptable and risk based. It can also facilitate the rapid adoption of new technologies and the updating of operational standards. At this point, co-operation and information sharing between the aviation and maritime sectors are important for both safety and regulatory effectiveness.

In conclusion, while establishing legal frameworks for unmanned vehicles, different approaches of international regulatory organisations are effective in shaping these frameworks. ICAO's operation-centred and risk-graded approach for unmanned aircraft may inspire IMO's regulations for unmanned ships. Examining similar approaches in both sectors could contribute to the development of future regulations in a more effective and harmonised manner.

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202) Breunig and others (2018), 20.

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