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THE 2026 IMO MASS CODE AND THE FUTURE OF MARITIME LABOUR: HUMAN OVERSIGHT, REMOTE OPERATIONS AND A “TECHNOLOGICAL” JUST TRANSITION ¹

Silvio Pedro Alves ^{2*}

Verônica Scriptore Freire e Almeida ^{3**}

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² * **Silvio Pedro Alves:**

- LL. B Maritime Law, MBA in Digital Law, MBA in Maritime, Port and Customs Law.
-Attending to LL.M Masters on Port and Maritime Law at Santa Cecilia University (UNISANTA).

³ ** **Verônica Scriptore Freire e Almeida:**

-PhD in Economic Law - Faculty of Law, University of Coimbra, Portugal (2009-2016).
-Master in Economic Law, Faculty of Law, University of Coimbra, Portugal (2005-2008).
-Conducted research in Washington DC, USA, during a period of PhD Academic Research (2015-2016) and Post-Doctoral Academic Research (2016-2017) at Georgetown University - Law Center.

THE 2026 IMO MASS Code and the future of maritime labour:**human oversight, remote operations and a “technological” just transition****DOI: <https://doi.org/10.5281/zenodo.23087669>****Abstract**

The adoption of the International Code of Safety for Maritime Autonomous Surface Ships (MASS Code) by the International Maritime Organization in 2026 represents a decisive step in the transition from experimental maritime autonomy to internationally regulated autonomous navigation. While much of the regulatory debate has focused on safety, technology and the allocation of operational responsibility, autonomous shipping also raises a fundamental question concerning the future of maritime labour. This article examines the relationship between the MASS Code, the human element and the transformation of maritime occupations. It argues that maritime autonomy should not be understood merely as the replacement of seafarers by machines, but as a spatial, functional and cognitive redistribution of maritime labour among shipboard personnel, autonomous systems and shore-based operators. Through legal, documentary and regulatory analysis, the article examines the roles of the master, remote operators and Remote Operations Centres, as well as emerging requirements for training and professional adaptation.

Drawing upon the concept of Just Transition and the Brazilian constitutional protection against automation as a national case study, the article proposes a human-centred framework for MASS implementation. It further argues that the IMO Experience-Building Phase should operate not only as a technical and safety-oriented regulatory laboratory, but also as a mechanism for gathering evidence concerning occupational

-Professor of the Postgraduate Program - Masters in Health Law, and Masters in Port and Maritime Law - Santa Cecilia University (UNISANTA).

- Practicing Lawyer in Brazil and internationally, specializing in International Law, Digital Law, Health Law, Trust Law, Economic Law and International Relations.

-ORCID: <https://orcid.org/0000-0001-5811-7779>

-E-mail: veronicascriptore@adv.oabsp.org.br .

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transformation, human-machine interaction, skills development and working conditions. The article concludes that the legitimacy and sustainability of autonomous shipping will depend not only on whether autonomous vessels can operate safely, but also on how international and domestic regulatory systems govern the transformation of the human element upon which maritime activity continues to depend.

Keywords: Maritime Autonomous Surface Ships; MASS Code; Maritime Labour; Human Element; Remote Operations Centres; Automation; Just Transition.

Introduction - From Experimental Autonomy to Regulated Autonomy

The development of Maritime Autonomous Surface Ships (MASS) is transforming one of the oldest characteristics of maritime navigation: the relationship between the vessel and the human beings responsible for operating it. Advanced sensors, artificial intelligence, automated navigation, remote-control technologies and high-capacity ship-to-shore connectivity increasingly permit functions traditionally performed on board to be supported, transferred or performed by technological systems or personnel located ashore.

For several years, the regulatory discussion surrounding autonomous shipping was dominated by experimental projects, national trials and the question of whether the existing

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international maritime legal framework could accommodate different degrees of autonomy. The International Maritime Organization (IMO) progressively addressed these issues through a regulatory scoping exercise and subsequent work within the Maritime Safety Committee (MSC).⁴

A significant transition occurred in May 2026, when the MSC, at its 111th session, adopted the non-mandatory International Code of Safety for Maritime Autonomous Surface Ships through Resolution MSC.595(111). The MASS Code took effect on 1 July 2026 and established the first comprehensive international regulatory framework specifically addressing the safe operation of autonomous and remotely operated merchant ships.⁵

The adoption of the Code does not represent the conclusion of the regulatory process. It constitutes an intermediate stage in a

4 Henrik Ringbom, ‘Regulating Autonomous Ships—Concepts, Challenges and Precedents,’ *Ocean Development & International Law* 50, nos. 2–3 (2019): 141–169, <https://doi.org/10.1080/00908320.2019.1582593>; International Maritime Organization (IMO), ‘Outcome of the Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS),’ MSC.1/Circ.1638 (3 June 2021).

5 IMO, Resolution MSC.595(111), International Code of Safety for Maritime Autonomous Surface Ships (MASS Code), adopted 22 May 2026, MSC 111/22, annex 16; IMO, ‘IMO Adopts First Global Code for Autonomous Ships,’ 22 May 2026; IMO, ‘FAQ – Autonomous Shipping,’ accessed 23 September 2026.

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longer trajectory toward a mandatory international regime. The IMO roadmap contemplates an Experience-Building Phase (EBP), followed by the development of the mandatory MASS Code from 2028, its planned adoption by 1 July 2030 and entry into force on 1 January 2032.⁶

This transitional period is particularly important. Decisions taken during the coming years will influence not only the technical architecture of autonomous shipping but also the future relationship between human beings and increasingly autonomous maritime systems.

Much of the debate surrounding MASS has understandably concentrated on navigation safety, collision avoidance, cybersecurity, communications, certification and the allocation of responsibility. Yet the same technological transformation produces another regulatory question: what happens to maritime work when functions traditionally performed by people on board are transferred to automated systems or personnel ashore?

⁶ IMO, ‘FAQ – Autonomous Shipping,’ accessed 23 September 2026 (roadmap: Experience-Building Phase framework at MSC 112; mandatory-Code development from 2028; adoption by 1 July 2030; entry into force 1 January 2032).

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This question should not be reduced to predicting whether autonomous ships will eliminate seafarers. Such a binary approach risks obscuring the more complex transformation already emerging. Autonomy may reduce the need for certain shipboard functions while simultaneously creating or expanding functions involving remote supervision, system management, data analysis, cybersecurity, maintenance, emergency intervention and shore-based operations.

The central argument developed in this article is therefore that maritime autonomy should be understood not simply as a process of labour substitution but as a process of spatial, functional and cognitive redistribution of maritime labour.

Spatial redistribution occurs when functions move from the ship to shore-based operational structures. Functional redistribution occurs when tasks previously undertaken directly by human operators are divided between persons and autonomous systems. Cognitive redistribution occurs when human involvement shifts from direct execution toward supervision, interpretation, intervention and management of increasingly complex technological systems.

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This perspective produces a different regulatory question. Instead of asking only how many seafarers may eventually be removed from vessels, regulation should also ask which functions will be transformed, where human responsibility will be located, which competencies will become necessary and how existing maritime professionals may participate in the emerging technological environment.

The article examines these questions through legal-dogmatic, documentary and regulatory analysis of the MASS Code, IMO materials and international labour principles. The concept of Just Transition is employed analytically to investigate whether principles originally developed to address structural economic and environmental transformations can contribute to the governance of technological change in maritime employment. The Brazilian constitutional protection against automation is subsequently examined as a national case study demonstrating how domestic constitutional law may interact with the emerging international MASS regime. Three propositions are advanced.

First, the Labour Redistribution Thesis maintains that MASS should be analysed as a redistribution of maritime labour between shipboard personnel, autonomous technological systems and

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shore-based operators rather than solely as technological substitution.

Second, the Technical-Social EBP Proposition argues that the IMO Experience-Building Phase should collect evidence not only concerning technical performance and safety but also regarding human-machine interaction, occupational transformation, training requirements and shore-based working conditions.

Third, the Just Technological Transition Framework proposes that anticipation, participation, skills development and protection should accompany the implementation of maritime autonomy.

Together, these propositions seek to place the human element within the regulatory discussion before the mandatory international regime is consolidated.

2. The 2026 IMO MASS Code: A New Regulatory Stage

The regulation of autonomous shipping presents an unusual challenge for international maritime law. Existing conventions were developed on the assumption that vessels would ordinarily be operated by human beings located on board. Concepts such as the master, crew, lookout, watchkeeping and command traditionally presuppose physical presence aboard the ship.

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Autonomous and remotely operated vessels disturb this assumption.

The IMO's regulatory work therefore required more than the development of technical standards. It required consideration of how existing legal concepts could operate when technological systems perform functions previously associated with human decision-making or when responsible persons exercise operational functions from shore.

The MASS Code represents the first comprehensive international response to this problem.

Rather than regulating autonomy exclusively through a particular technological architecture, the Code adopts a goal-based approach. This is significant because autonomous technologies are developing more rapidly than traditional international regulatory processes. A prescriptive regime based upon specific technologies could rapidly become obsolete.⁷

⁷ IMO MASS Code, Resolution MSC.595(111), Part II, chs. 7–8, especially paras. 8.1–8.7. The Code structures autonomous and remote operation through the Concept of Operations, Operational Envelope, Operational Design Domain, modes of operation, allocation of functions and human oversight.

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The goal-based approach instead seeks to establish safety objectives and functional requirements capable of accommodating different technological configurations and modes of operation.

This also reflects an important conceptual feature of MASS regulation: autonomy should not necessarily be understood as a fixed category. A vessel may operate through different modes during a single voyage. Certain functions may be automated, others remotely controlled and others performed conventionally by people aboard.

Consequently, the relevant regulatory question becomes not simply whether a ship is “autonomous”, but which functions are autonomous, which are remotely performed and which remain under direct human control.

This functional perspective has important implications for labour.

If autonomy is function-specific rather than vessel-specific, the transformation of employment is similarly unlikely to occur through the immediate disappearance of entire occupations. Tasks and responsibilities may instead be progressively reorganised.

The non-mandatory nature of the 2026 Code is therefore particularly significant. It permits administrations, operators and

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other stakeholders to acquire operational experience before the mandatory regime is finalised.

The Experience-Building Phase can consequently become an important bridge between regulatory experimentation and binding international law.

The question addressed later in this article is whether the evidence collected during this phase should remain predominantly technical or whether the experience-building process should also examine the transformation of the human element.

3. The Human Element under the MASS Code

The expression “autonomous ship” may suggest the progressive disappearance of human involvement. The regulatory architecture of the MASS Code points in a different direction. A ship qualifies as MASS where autonomous or remote technologies replace or support functions normally carried out by crew on board, and the regulatory analysis is expressly functional: relevant ship functions may be performed autonomously, remotely or conventionally by people aboard. This functional approach

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supports a distinction between the automation of a ship and the disappearance of the human element.⁸

The adopted framework accordingly preserves human oversight. The master remains responsible for the safe operation of the MASS at all times and may be located on board or at a ROC; however, where crew or other persons are on board, the Code provides that the master should be physically present on board. Remote Operations Centres (ROCs) provide an institutional location from which qualified personnel may monitor or control vessel functions. The ROC itself is therefore not merely communications infrastructure. It becomes part of the operational architecture through which safety-critical maritime functions can be exercised.⁹

This development produces a fundamental legal consequence. Human responsibility may remain continuous even where human physical presence aboard the vessel becomes discontinuous. MASS regulation must consequently determine not only whether a

⁸ IMO MASS Code, paras. 8.6.1–8.7.4. Paragraph 8.6.2 requires identification of autonomous or remotely operated functions, their allocation to human or software agents, supervision and location; paras. 8.7.1–8.7.4 require human oversight, capacity to intervene or override, and a human master.

⁹ IMO MASS Code, ch. 14, paras. 14.2.1.10–14.2.1.15. The master is responsible for safe operation at all times; the master may be on board or at a ROC, but where crew or other persons are on board the Code provides that the master should be physically present on board.

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particular function can be automated, but who remains responsible for that function, where that person may be located and what competence is required to exercise the function safely.

3.1 The Master: Responsibility without Necessary Physical Presence

The traditional legal relationship between command and physical presence aboard the vessel is modified by MASS operations. Under the adopted framework, the master remains responsible for safe operation at all times and may exercise that responsibility from a ROC where the applicable operational conditions permit.

This separates two concepts that conventional maritime operations ordinarily combine: legal-operational responsibility and physical location.

The distinction is significant. If command can lawfully be exercised from a ROC, maritime law must preserve continuity of authority during changes of operating mode, transfers of control and communications interruptions. It must also ensure that the person assuming command possesses sufficient knowledge of the

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vessel, its operational condition and the technological environment through which command is exercised.

The development of Chapter 14 of the MASS Code illustrates this concern. The final preparatory work addressed safe manning, allocation of responsibilities between onboard personnel and remote operators, watchkeeping, fatigue and the competence of personnel performing MASS functions. the regulatory objective is therefore not removal of human responsibility but its reconstruction within a distributed operational environment.¹⁰

3.2 Shipboard Personnel and Hybrid Manning

MASS does not necessarily imply an uncrewed ship. Different modes of operation may require different combinations of onboard personnel, remote operators and autonomous systems. The Code consequently requires the modes of operation for which the vessel is designed to be identified.

This makes manning a dynamic rather than purely numerical question.

¹⁰ IMO MASS Code, ch. 14, especially paras. 14.1.1–14.4.2 (manning, watchkeeping, fatigue, STCW linkage, training, familiarization and competence).

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Where personnel remain aboard, conventional maritime competencies continue to be relevant. However, interaction with autonomous systems introduces additional requirements concerning technological supervision, interpretation of system status and intervention following abnormal or degraded operation.

The result may therefore be hybrid manning conventional maritime expertise operating alongside remote and autonomous functions.

This reinforces the central argument of this article. The legally relevant issue is not merely whether crew numbers decrease, but how functions, responsibilities and competencies are allocated across the entire MASS operational system.

3.3 Remote Operators and the Relocation of Maritime Functions

Remote Operations Centres constitute the clearest institutional expression of the spatial redistribution of maritime labour.

IMO's preparatory work defined a remote operator as a qualified person engaged to operate some or all MASS functions from a ROC. It also contemplated circumstances in which a single

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ROC could be responsible for a MASS, responsibility could pass between ROCs, and a master located in a ROC could, subject to appropriate conditions, be responsible for more than one MASS.¹¹

These possibilities transform the geography of maritime work.

Navigation, machinery supervision and other functions traditionally associated with the bridge or machinery spaces may, where the regulatory and technical conditions permit, be exercised from shore. Yet their maritime character does not disappear merely because the operator is geographically separated from the ship.

This produces what may be described as a functional-location paradox: the function remains maritime, while the worker performing it may no longer be legally or physically situated within the traditional maritime workplace.

That paradox becomes particularly important when training and labour protection are considered.

¹¹ IMO MASS Code, para. 4.32 (remote operator); see also paras. 13.4.2–13.4.4 and 14.2.2–14.3 concerning ROC operations, watchkeeping and control. For the earlier joint-working-group treatment of remote operators, see IMO, MSC 107/5/1, Report of the MSC-LEG-FAL Joint Working Group on MASS (2 May 2023), annex 1.

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4. From Crew Reduction to Labour Redistribution

Public discussion of autonomous shipping frequently frames labour consequences through the prospect of crew reduction. This concern is understandable. If technological systems perform functions previously undertaken by seafarers, demand for onboard occupations may decline.

However, crew reduction alone provides an incomplete analytical framework.

Maritime autonomy should instead be examined through what this article describes as the Labour Redistribution Thesis.¹²

The thesis identifies three interconnected forms of redistribution.

4.1 Spatial redistribution

The first is spatial.

12 Krzysztof Wróbel, Mateusz Gil and Jakub Montewka, ‘Identifying Research Directions of a Remotely-Controlled Merchant Ship by Revisiting Her System-Theoretic Safety Control Structure,’ *Safety Science* 129 (2020): 104797, <https://doi.org/10.1016/j.ssci.2020.104797>; Thomas Porathe, ‘Autonomous Ships: A Research Strategy for Human Factors Research in Autonomous Shipping,’ in *Advances in Human Aspects of Transportation* (Springer, 2021), 479–486, https://doi.org/10.1007/978-3-030-80012-3_55.

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Traditional maritime work is fundamentally organised around the vessel. The ship is simultaneously a workplace, operational environment and, for many seafarers, a temporary residence.

Remote operation separates maritime functions from this physical environment.

A navigation or monitoring function can migrate from bridge to Remote Operations Centre. Diagnostic functions may move from engine room to shore-based technical centres. Specialist intervention may become available remotely across several vessels.

Maritime labour therefore begins to occupy a distributed operational environment encompassing both sea and shore.

4.2 Functional redistribution

The second form is functional.

Automation does not necessarily transfer complete occupations from human beings to machines. It may instead transfer individual tasks.

Navigation provides a clear example. Route planning, collision-risk assessment, sensor interpretation, steering, communications and emergency decision-making can potentially be distributed differently between human operators and automated systems.

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The resulting occupational transformation is therefore granular.

The legal and labour implications should be examined at the level of functions and responsibilities rather than through a binary distinction between “crewed” and “uncrewed” vessels.

4.3 Cognitive redistribution

The third form is cognitive.

Traditional ship operation requires continuous perception, interpretation and decision-making by human operators. Automated systems increasingly perform parts of these cognitive processes.

Human responsibility may consequently shift toward supervision of automation, interpretation of system-generated information, management of exceptions and intervention in circumstances that the automated system cannot safely resolve.

This transformation can create a paradox.

Automation may reduce routine workload while simultaneously increasing the complexity of the remaining human tasks. Operators may be expected to intervene precisely when

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situations are unusual, rapidly developing or technologically ambiguous.

The required competencies may therefore become more specialised rather than less important.

Taken together, these three dimensions demonstrate why maritime autonomy cannot adequately be described solely as replacement of labour.

The more accurate description is redistribution of the human element across a socio-technical maritime system.

5. Remote Operations Centres and the Emergence of New Maritime Competencies

The relocation of maritime functions necessarily raises the question of professional competence.

The development of the MASS Code has treated manning, training and watchkeeping as interconnected human-element questions. Before adoption, IMO had already reached a clear position concerning persons physically aboard: where seafarers serve on a MASS, the STCW Convention applies. The more difficult issue concerned remote operators working from ROCs, because the

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conventional STCW architecture is built around seafarers serving aboard seagoing ships.

The adopted Chapter 14 goes further than using STCW merely as an analytical baseline. It provides that STCW training and watchkeeping standards may be considered by the Administration for assigned ROC roles and that a ROC may be treated as a directly associated location to the navigational bridge or machinery space so that STCW watchkeeping provisions may also apply to remote operators. It further requires remote operators, at a minimum, to be qualified to a level not less than that required by the STCW Convention and Code, together with additional training appropriate to remote operations. This reflects a practical regulatory principle: physical relocation of a maritime function should not justify lowering the competence required to perform that function safely.¹³

Accordingly, a remote operator exercising navigation or machinery-related responsibilities is expected under the non-mandatory Code to meet at least the relevant STCW competence

13 IMO MASS Code, paras. 14.1.2–14.1.3, 14.2.2 and 14.4.2. Remote operators should, at a minimum, be qualified to a level not less than that required under the 1978 STCW Convention and STCW Code and receive additional remote-operations training.

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level, supplemented by training specific to remote operations, autonomous systems and the ROC environment.

This approach also finds support in empirical regulatory research. The European Maritime Safety Agency's study of competences for MASS operators concluded that increasing automation does not eliminate the human operator and that changes in operators' functions require corresponding changes in competence and training. ¹⁴

5.1 From Conventional Competence to Hybrid Competence

Future MASS professionals are therefore likely to require what this article describes as hybrid maritime competence.

Traditional knowledge may include navigation, ship handling, collision avoidance, machinery operation, emergency procedures and maritime communications. Technological competence may additionally include autonomous-system supervision, sensor interpretation, connectivity management, human-machine

¹⁴ European Maritime Safety Agency (EMSA), CMOROC Final Report – Identification of Competences for MASS Operators in Remote Operations Centres (6 December 2023); G.R. Emad, H. Enshaei and S. Ghosh, 'Identifying Seafarer Training Needs for Operating Future Autonomous Ships: A Systematic Literature Review,' *Australian Journal of Maritime & Ocean Affairs* 14, no. 2 (2022): 114–135, <https://doi.org/10.1080/18366503.2021.1941725>.

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interfaces, cybersecurity awareness and remote situational assessment.

The two categories should not be treated as alternatives.

The safety-critical role of remote operators may depend precisely upon their ability to combine maritime judgement with technological understanding, particularly when an autonomous system encounters circumstances outside its normal operational envelope.

Automation can therefore alter the cognitive structure of maritime work. Routine execution may decrease while supervisory, interpretative and exception-management responsibilities increase.

5.2 Training, Watchkeeping and Fatigue in the ROC Environment

The ROC also creates a new working environment for maritime operations.

The absence of ship motion, isolation and conventional onboard routines does not eliminate human-factor risks. Different risks may emerge: prolonged monitoring, reduced stimulation, multiple-vessel supervision, alarm management, screen-based

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situational awareness, communications dependency and abrupt transitions from passive supervision to safety-critical intervention.

For this reason, watchkeeping and fatigue cannot be treated as problems exclusively to people physically at sea.

The human-element provisions developed for the MASS Code recognise the relevance of sufficient personnel, watchkeeping arrangements, familiarisation and fatigue considerations to remote operation. This creates an important field for the Experience-Building Phase: evidence should be gathered not only on whether ROCs can technically control vessels, but also on how human performance changes under sustained remote-operation conditions.¹⁵

5.3 The STCW–MLC Boundary: Can a Remote Operator Be a Seafarer?

Remote operations reveal a deeper legal problem that the technological discussion alone cannot resolve.

¹⁵ IMO MASS Code, paras. 14.2.1.3, 14.2.1.8–14.2.1.9, 14.2.2 and 14.3; E. Veitch et al., ‘Human Factor Influences on Supervisory Control of Remotely Operated and Autonomous Maritime Vessels,’ *Ocean Engineering* (2024); K. Wróbel et al., ‘On the Influence of Human Factors on Safety of Remotely Controlled Merchant Vessels,’ *Applied Sciences* 11, no. 3 (2021): 1145, <https://doi.org/10.3390/app11031145>.

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The STCW Convention and the Maritime Labour Convention 2006 approach maritime workers from related but distinct regulatory perspectives. STCW is principally concerned with competence, certification and watchkeeping. The MLC establishes labour and social standards for seafarers.

For people physically serving aboard a MASS, the relationship is comparatively straightforward. Existing maritime instruments continue to apply according to their respective scope.

The position of a permanently shore-based remote operator is different.

Article II(1)(f) of the MLC defines a seafarer as a person employed, engaged or working in any capacity on board a ship to which the Convention applies. The geographical component of this definition creates difficulty for an operator who performs a safety-critical maritime function entirely from a land-based ROC.¹⁶

The operator may therefore occupy an unusual regulatory position: functionally maritime for purposes of ship operation, yet potentially outside the personal scope of the principal international maritime labour convention.

¹⁶ International Labour Organization (ILO), Maritime Labour Convention, 2006, as amended, art. II(1)(f).

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STCW presents a related but distinct issue. IMO's earlier MASS work recognised that the Convention applies to seafarers serving aboard ships but did not straightforwardly encompass remote operators located ashore. The MASS regulatory process has consequently considered using STCW competence and watchkeeping standards as the basis for certification of remote operators rather than assuming automatically that conventional STCW status follows them ashore.¹⁷

This distinction should be preserved.

Competence equivalence does not necessarily produce labour-status equivalence.

A remote operator could therefore be required to possess maritime qualifications comparable to an onboard officer while remaining, for employment-law purposes, a shore-based worker governed primarily by national labour legislation rather than the MLC.¹⁸

17 IMO MASS Code, paras. 14.1.2–14.1.3 and 14.4.2; IMO, MSC 107/5/1, annex 1 (recording the earlier regulatory question whether remote operators should be designated as seafarers and the interaction with STCW and local employment rules).

18 Junghwan Choi and Sangil Lee, ‘Legal Status of the Remote Operator in Maritime Autonomous Surface Ships (MASS) Under Maritime Law,’ *Ocean Development & International Law* 53 (2022), <https://doi.org/10.1080/00908320.2022.2036276>; Barbara Stępień, ‘Can a Ship

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That possibility creates what may become a significant protection gap.

Questions concerning working hours, minimum rest, medical fitness, occupational health, repatriation, employment agreements, social protection and collective representation may receive different answers depending upon whether the worker is legally classified as a seafarer, a shore employee or a new hybrid category.

The MLC itself contains a mechanism for resolving doubts concerning particular categories of persons who perform work aboard ships: under Article II(3), the competent national authority determines their status after consultation with shipowners' and seafarers' organizations. That mechanism, however, was designed around uncertainty concerning persons connected with work on board. A worker permanently located ashore presents a conceptually different problem.¹⁹

MASS therefore exposes a potential divergence between two forms of legal status:

Be Its Own Captain? Safe Manning of Autonomous and Unmanned Vessels,' Marine Policy 148 (2023).

¹⁹ ILO, Maritime Labour Convention, 2006, art. II(3).

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operational status, determined by the maritime function and responsibility exercised; and

labour status, determined by the legal definition of the worker and the geographical context in which work is performed.

This article does not argue that the MLC should automatically be extended to every remote operator. Nor would such an extension necessarily be appropriate for all ROC functions.

It argues instead that the question should be addressed deliberately before large-scale remote operation becomes established.

The Experience-Building Phase provides an opportunity to identify which remote functions are sufficiently connected with navigation, command and ship operation to require maritime-specific competence and labour protection, while dialogue between IMO, ILO, national administrations, shipowners and workers' organisations can determine whether existing legal categories remain adequate.

The emergence of ROCs may therefore require international maritime law to confront a question that conventional shipping rarely needs to be asked:

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Can maritime work remain legally maritime when the maritime worker no longer goes to sea?

6. From Just Transition to a Just Technological Transition

The concept of Just Transition developed principally in response to the employment and social consequences of environmental and economic restructuring. The International Labour Organization's Guidelines for a just transition towards environmentally sustainable economies and societies for all provide a policy framework centred upon decent work, social protection, skills development and social dialogue among governments, workers' organizations and employers' organizations.²⁰

The environmental origins of the concept should be acknowledged. Maritime automation is not equivalent to decarbonization, and this article does not suggest that the ILO's original Just Transition framework was designed specifically to regulate autonomous shipping.

Nevertheless, the underlying governance problem extends beyond environmental transition.

²⁰ ILO, Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All (Geneva: International Labour Office, 2015).

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Structural technological change can generate productivity, safety and economic benefits while simultaneously transforming occupations, competencies, working conditions and employment opportunities. These consequences create a distributional problem similar in structure, although not necessarily in cause or scale, to other forms of economic transition: benefits may be widely distributed while adjustment costs are concentrated among groups of workers.

More recent ILO work provides additional support for extending the analytical framework beyond its original environmental setting. The Organization has increasingly addressed green and digital transitions together, emphasizing the role of skills development, lifelong learning and social dialogue in enabling workers and enterprises to adapt to technological change. Its recent work concerning artificial intelligence similarly addresses employment, productivity, working conditions, social protection, workers' rights and social dialogue as interconnected dimensions of technological transformation.²¹

21 ILO, Navigating the Future: Skills and Jobs in the Green and Digital Transitions (Geneva: ILO, 2024); ILO, Harnessing Artificial Intelligence for Decent Work, Report of the Director-General, International Labour Conference, 114th Session (Geneva: ILO, 2026).

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The extension proposed in this article is therefore not a claim that the established concept of Just Transition and technological transition are legally identical. Rather, it identifies a set of governance principles capable of informing the social management of maritime automation.

This article describes that adaptation as a Just Technological Transition.

A Just Technological Transition neither prohibits technological substitution nor presumes that every existing occupation must be preserved indefinitely. Technological development has historically altered the organization of maritime labour, and autonomous systems represent another stage in that continuing process.

The normative concern is instead directed toward how transition occurs.

Four dimensions are particularly relevant to maritime autonomy.

Anticipation requires regulators, employers and training institutions to identify functions likely to be transformed before technological change produces occupational displacement or acute skills shortages.

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Participation requires that workers and their representative organizations participate alongside governments, employers and professional institutions in discussions concerning the organization and implementation of technological change.

Skills development requires access to education, qualifications, reskilling and lifelong learning capable of connecting existing maritime knowledge with emerging autonomous and remote-operation functions.

Protection requires appropriate labour-market and social-protection mechanisms for workers who cannot immediately transition into newly created or transformed functions.

These dimensions are mutually reinforcing.

Anticipation without training identifies a problem without creating a pathway through it. Training without participation may produce programmes disconnected from workers' experience and actual occupational needs. Participation without adequate protection may involve workers in a transition while leaving them to absorb their costs.

Applied to MASS, the resulting proposition is therefore not that international maritime safety law should become a comprehensive system of labour regulation.

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It is that technological regulation should recognize occupational transformation sufficiently early to permit the institutions responsible for training, employment and social protection to respond before new technological structures become entrenched.

This distinction is central to a human-centred implementation of maritime autonomy.

7. The Brazilian Constitutional Perspective: From Protection Against Automation to Governance of Transition

Brazil provides a particularly relevant national case study because the 1988 Federal Constitution expressly recognizes workers' protection in relation to automation.

Article 7, XXVII establishes, among the social rights of urban and rural workers, “protection in the face of automation, as provided by law.”²²

The constitutional language is remarkable for its directness. Technological change is not treated solely as a matter of economic

²² Brazil, Constitution of the Federative Republic of Brazil of 1988, art. 7, XXVII.

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policy or managerial discretion. Its consequences for labour are recognized within the constitutional catalogue of social rights.

The provision should nevertheless not be interpreted in isolation.

Article 170 establishes that the Brazilian economic order is founded simultaneously upon the appreciation of human labour and free enterprise and is directed toward ensuring a dignified existence in accordance with social justice. Its principles include the reduction of regional and social inequalities and the pursuit of full employment.²³

This constitutional architecture is relevant because it rejects a simplistic opposition between technological innovation and labour protection.

Free enterprise and the appreciation of human labour coexist within the same constitutional economic order. Consequently, protection against automation need not be understood as a prohibition against innovation. Equally, technological innovation cannot automatically be treated as constitutionally indifferent to its effects upon workers.

²³ Brazil, Constitution of the Federative Republic of Brazil of 1988, art. 170, caput and items VII–VIII.

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A systematic reading of Articles 7, XXVII and 170 therefore permits a different interpretation: protection against automation can function as a constitutional basis for the governance of technological transition.

Under this interpretation, the relevant legal question is not whether automation should be prevented, but whether institutions exist to anticipate its labour consequences, facilitate professional adaptation, enable social dialogue and protect workers exposed to disruptive transition.

MASS provides a particularly suitable context in which to test this proposition.

The international regulatory regime primarily addresses the safe integration of autonomous and remotely operated ships into maritime activity. Brazilian implementation of that regime will necessarily involve technical questions concerning vessel operation, certification, navigation, connectivity and safety.

Yet if implementation alters the number, location, competencies or legal status of maritime workers, Article 7, XXVII provides a constitutional reason for those consequences to enter the domestic regulatory discussion.

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The Brazilian case therefore demonstrates how an international technological regime may interact with a domestic constitutional social order.

The MASS Code establishes international safety architecture. Domestic constitutional law may simultaneously shape the social conditions under which technological transformation is incorporated into the national maritime sector.

This does not mean that Article 7, XXVII supplies a complete regulatory solution. The constitutional provision itself anticipates legislative implementation, and the detailed institutional mechanisms required for autonomous maritime operations remain to be developed. Its significance is normative. It establishes that the labour consequences of automation are not legally invisible.

For MASS implementation in Brazil, this provides a constitutional foundation for policies concerning professional qualification and reskilling, collective participation, labour-market adaptation and other mechanisms capable of reconciling technological development with the protection of human labour.

The Brazilian experience consequently offers a national example of the broader thesis developed in this article: the regulation of technological systems and the governance of their

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social consequences should not evolve as entirely separate legal processes.

8. The MASS Experience-Building Phase as a Technical and Social Regulatory Laboratory

The period following adoption of the non-mandatory MASS Code creates an unusually valuable regulatory opportunity.

The IMO roadmap provides for the development of a framework for the MASS Experience-Building Phase, followed by development of the mandatory Code from 2028. The mandatory MASS Code is expected to be adopted by 1 July 2030 and to enter into force on 1 January 2032.²⁴

The purpose of the EBP is to gather practical experience from Member States and industry so that implementation of the non-mandatory Code can inform development of the future mandatory regime.

²⁴ IMO, ‘FAQ – Autonomous Shipping,’ accessed 23 September 2026; IMO, MSC 110 meeting summary, ‘Maritime Safety Committee, 110th Session, 18–27 June 2025,’ revised MASS roadmap.

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At the time of writing, however, the detailed EBP framework has not yet been established. Its development is scheduled for consideration at MSC 112 in December 2026.

This timing is important.

It means that the scope of the evidence to be gathered during the EBP remains a live regulatory question rather than a closed institutional decision.

This article proposes that the MASS EBP should be designed as a technical and social regulatory laboratory.

The expression does not imply that IMO should assume the functions of the International Labour Organization or national labour authorities. Rather, it recognizes that autonomous shipping is a socio-technical system and that evidence concerning human performance is relevant both to maritime safety and to the institutions responsible for occupational transition.

Technical evidence will necessarily remain central.

Administrations and operators require evidence concerning navigation performance, system reliability, connectivity, cybersecurity, emergency procedures, interaction with conventional shipping and transitions between modes of operation.

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But the MASS Code itself places substantial importance on the human element, including the master, onboard personnel and remote operators. The safe performance of autonomous vessels consequently depends upon understanding how those persons interact with technological systems.²⁵

EBP could therefore gather structured evidence concerning at least seven human dimensions:

functional transfer — which functions move from onboard personnel to autonomous systems or shore-based operators;

human intervention — when, why and how frequently human operators intervene in autonomous operation;

competence transformation — which new competencies are required, and which traditional maritime competencies remain necessary;

remote working conditions — workload, fatigue, situational awareness and organizational arrangements within ROCs;

²⁵ IMO MASS Code, paras. 8.6–8.7 and ch. 14. The adopted Code expressly addresses function allocation, human oversight, the human master, remote operators, safe manning, watchkeeping, fatigue, training and competence.

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operational distribution — how responsibility is divided between masters, onboard personnel, remote operators and technological systems;

training and professional mobility — whether existing maritime professionals can transition into emerging MASS functions and what additional education is required; and

new occupational risks — including risks associated with prolonged remote monitoring, connectivity dependency, cybersecurity incidents and human-machine interface design.

These categories are not proposed as labour standards.

They are proposed as evidence categories.

That distinction permits the EBP to remain within the logic of experience-building while producing information that can subsequently inform IMO safety regulation, STCW-related work, ILO deliberations, domestic labour policy and professional training systems.

There is precedent within IMO practice for using experience-building processes to collect evidence before regulatory requirements are reviewed. The significance of the MASS EBP lies in applying the same evidence-oriented logic to an unusually complex socio-technical transformation.

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A narrowly technical EBP could determine whether autonomous vessels operate effectively while failing to capture how their operation restructures the human system surrounding them.

A broader evidence base would permit the mandatory MASS regime to develop with greater understanding of the relationship between autonomy and human performance.

EBP can therefore provide the empirical bridge between the Labour Redistribution Thesis advanced in this article and future regulatory development.

9. A Human-Centred Framework for MASS Implementation

The preceding analysis permits the three principal propositions of this article to be consolidated into a human-centred framework for MASS implementation.

The framework begins with a different regulatory starting point.

Rather than asking only:

What can autonomous technology replace?

MASS implementation should also ask:

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What human function is being transformed, where will that function subsequently be located, who will remain responsible for it and what protection or competence will that person require?

Four sequential regulatory inquiries follow.

9.1 Identify the Functional Transformation

The first step is functional mapping.

For each relevant MASS operation, regulators and operators should identify which functions remain conventionally performed aboard, which are remotely performed and which are executed autonomously.²⁶

This reflects the functional logic already present within IMO's approach to MASS and provides the necessary foundation for analyzing labour transformation.

Without functional mapping, discussion of “automation” remains excessively abstract.

9.2 Locate Human Responsibility

The second step concerns responsibility.

²⁶ IMO MASS Code, para. 8.6.2; see also annex 1, task-allocation and functional-allocation elements of the MASS Record.

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Where functions move between ship, autonomous system and ROC, responsibility must remain identifiable.

This includes the authority of the master, the responsibilities of remote operators, the functions of onboard personnel and the procedures governing transfers between operating modes.

The principle is particularly important because geographical relocation should not produce regulatory invisibility.

A function does not cease to have safety or labour implications merely because it is performed ashore.

9.3 Determine Competence and Labour Status

The third inquiry combines two questions that should remain analytically distinct.

The first is competence: what knowledge, certification and training are necessary to perform the function safely?

The second is labour status: under which legal framework is the person performing that function employed and protected?

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The distinction follows directly from the STCW–MLC boundary identified earlier.²⁷

A remote operator may require maritime competence comparable to that of an onboard officer without automatically possessing the same legal status as a seafarer under international labour law.

Future MASS governance must therefore avoid assuming that technical equivalence necessarily produces legal equivalence.

9.4 Govern the Transition

The final inquiry concerns the transition itself.

Where technological implementation changes occupations or competence requirements, regulators and social partners should consider whether workers have realistic pathways from existing maritime functions into emerging ones.

This is where the Just Technological Transition framework becomes operational.

²⁷ Compare IMO MASS Code, paras. 14.1.2–14.4.2 (competence and watchkeeping of remote operators), with ILO, Maritime Labour Convention, 2006, art. II(1)(f) (seafarer defined by work on board a ship).

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Anticipation identifies transformation.

Participation incorporates affected actors.

Skills development creates professional pathways.

Protection addresses residual adjustment costs.

The relationship among the elements of the proposed framework can therefore be expressed as follows:

TECHNOLOGICAL AUTONOMY



FUNCTIONAL MAPPING



REDISTRIBUTION OF THE HUMAN ELEMENT

SHIPBOARD PERSONNEL ↔ AUTONOMOUS SYSTEMS ↔

REMOTE OPERATORS



RESPONSIBILITY + COMPETENCE + LABOUR STATUS



TECHNICAL AND HUMAN EVIDENCE



JUST TECHNOLOGICAL TRANSITION



HUMAN-CENTRED MASS GOVERNANCE

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The model connects the three propositions developed throughout this article.

The Labour Redistribution Thesis explains what technological autonomy does to maritime work.

The Technical-Social EBP Proposition identifies how evidence concerning that transformation can be gathered.

The Just Technological Transition Framework provides the normative principles through which the transformation can be governed.

The framework does not seek to prescribe a single global employment model for autonomous shipping. National labour systems, maritime industries and technological configurations differ substantially.

Its purpose is more limited and more fundamental: to ensure that the human consequences of maritime autonomy become visible at the same stage at which its technological and safety consequences are regulated.

In this sense, human-centred governance should not be understood as an external social constraint imposed upon technological innovation.

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It is part of the institutional architecture required to make technological transition sustainable.

10. Conclusion — Regulating Autonomous Ships Means Regulating the Future of Maritime Work

The adoption of the IMO MASS Code in 2026 marks the transition of autonomous shipping from regulatory experimentation toward an increasingly structured international regime. Its significance, however, extends beyond the safe operation and certification of autonomous vessels. MASS also transforms the organization, location and legal status of maritime work.

This article argued that this transformation is better understood not simply as labour substitution, but as a spatial, functional and cognitive redistribution of maritime labour. Functions traditionally performed aboard ships may move ashore, tasks may be divided between human operators and autonomous systems, and human responsibility may increasingly shift from direct operation toward supervision, interpretation and intervention.

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This redistribution creates consequences that maritime regulation cannot treat as incidental. Remote Operations Centres relocate safety-critical maritime functions ashore; emerging competence requirements combine traditional maritime knowledge with technological expertise; and shore-based remote operation may separate STCW-related competence from seafarer status under the MLC 2006. Competence equivalence does not necessarily produce labour-status equivalence.

The regulatory response should therefore address not only what autonomous technology replaces, but also which human functions it transforms, where responsibility is relocated and under which legal framework the person performing those functions will be qualified and protected. This is the basis for the Just Technological Transition proposed in this article: an approach founded upon anticipation, participation, skills development and protection rather than resistance to technological innovation.

The period preceding the mandatory MASS regime provides a critical opportunity to apply this approach. The IMO Experience-Building Phase should generate evidence not only about technological performance and maritime safety, but also about human-machine interaction, remote operations, competence

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transformation and working conditions. Such evidence can help ensure that the future mandatory regime develops from an understanding of MASS as a socio-technical system rather than as technology operating independently of human responsibility.

The central regulatory question is therefore no longer whether the human element will remain relevant to autonomous shipping. It is where that human element will be located, what responsibilities it will exercise, what legal status it will possess and how its transformation will be governed.

Regulating autonomous ships consequently means regulating the transformation of maritime work.

Maritime autonomy will be legally and socially sustainable not when it makes the human element invisible, but when it can redefine that element without making invisible the workers who bear the costs and responsibilities of technological transition.

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