

Future Maritime Workforce in the Green and Digital Era

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Abstract. The maritime sector is undergoing an unprecedented phase of transformation driven by three converging forces: decarbonisation, digitalisation, and heightened geopolitical risk. These transitions are reshaping not only ship technologies and regulatory frameworks but also the skills, safety exposure, and welfare needs of the global maritime workforce. Stricter emissions controls, the introduction of alternative fuels, expanding digital and automated systems, and recurring security disruptions collectively demand new operational competencies and greater organisational resilience from seafarers and shore-based personnel alike. This study examines how these structural shifts alter workforce requirements, with particular attention to labour-supplying countries in the Global South. Using a comparative policy and institutional analysis of international regulations, industry practices, and national training systems, the paper synthesises evidence on alternative-fuel readiness, digital and cyber competence, and emerging psychosocial pressures. A focused comparison of India, the Philippines, and China highlights differences in scale, governance models, and transition preparedness. The findings identify critical capability gaps in fuel-specific safety training, simulator infrastructure, quality assurance in maritime education, and ethical recruitment practices. The paper argues that workforce readiness constitutes the enabling condition for safe, equitable, and effective maritime transition. It concludes that India, given its institutional base and policy momentum, can move beyond labour supply to become a regional leader in maritime skills, safety, and sustainable development through targeted reforms and coordinated investment.

Key Words: maritime workforce; decarbonisation; digitalisation; just transition; India.

1. Introduction: A Transition Like No Other

Maritime transport has long been the backbone of global trade, carrying between 80 and 90 per cent of goods by volume (UNCTAD, 2024). Throughout history, the sector has adapted to successive technological shifts — from sail to steam, coal to oil, and paper charts to electronic navigation. Each transition altered ship design, reshaped operational practices, and redefined the skills expected of seafarers. However, the present moment differs from earlier phases of change in both its scale and urgency.

The first driver of this transformation is decarbonisation. The International Maritime Organization’s Revised GHG Strategy (2023) sets an ambition to achieve net-zero emissions from international shipping “by or around 2050,” with interim checkpoints targeting reductions in carbon

intensity of 40 per cent by 2030 and 70 per cent by 2040 (IMO, 2023). In parallel, the European Union has extended its Emissions Trading System (EU ETS) to shipping, requiring companies to purchase allowances for a growing share of their emissions — 40 per cent in 2024, 70 per cent in 2025, and full coverage from 2026 (European Commission, 2024). The FuelEU Maritime Regulation further imposes limits on the greenhouse-gas intensity of energy used on board vessels trading in the EU/EEA. These measures are not merely regulatory adjustments; they influence voyage economics, fuel choices, reporting systems, and day-to-day shipboard operations.

A second driver is digitalisation and automation. Ships are increasingly embedded within global data networks through sensors, satellite connectivity, and performance-monitoring software. Concepts such as Maritime Autonomous Surface Ships (MASS) are moving steadily towards regulatory recognition, with the IMO expected to finalise a non-mandatory MASS Code by 2026 (IMO, 2024). As a result, the role of the seafarer is evolving. Modern crews are required not only to manage equipment but also to interpret data, oversee automated systems, and maintain cyber security.

A third driver arises from geopolitics and security. Maritime transport remains directly exposed to global conflict and instability. Attacks on merchant vessels in the Red Sea during 2023–2024 forced widespread rerouting and demonstrated the physical and psychological risks faced by seafarers. Similarly, disruptions linked to the war in Ukraine have affected trade flows and increased operational uncertainty in the Black Sea region (UNCTAD, 2024). These developments underline that seafarers experience the immediate consequences of geopolitical shocks.

What distinguishes the current phase of change is the convergence of these forces. Decarbonisation, digitalisation, and security pressures are unfolding simultaneously rather than sequentially, compressing the time available for adaptation. Moreover, they interact with one another: alternative fuels require digital monitoring and specialised safety protocols; carbon pricing influences routing and cost structures; and automation reshapes onboard responsibilities. Together, these trends intensify both operational complexity and risk exposure.

Against this backdrop, the maritime workforce emerges as the central enabling factor of transition. Policies, technologies, and market instruments can only succeed when the people operating ships possess the necessary skills, training, and institutional support. The challenge is therefore not solely technical but also social and ethical: who bears the costs of transition, and how can benefits be distributed more equitably across ship-owning and seafarer-supplying nations?

This paper addresses these questions through a structured analysis. Section 2 examines the implications of decarbonisation, digitalisation, and geopolitics for workforce skills and safety. Section 3 explores global labour market dynamics and the concept of a just transition. Section 4 focuses on India's position within this evolving landscape. Section 5 presents illustrative case examples of institutional and industry responses. Section 6 outlines policy and institutional pathways, and Section 7 concludes by reaffirming that workforce readiness is central to a safe and equitable maritime future.

2. Global Transitions and Workforce Implications

2.1 Decarbonisation and Emerging Competencies

Decarbonisation represents the most far-reaching structural change currently confronting international shipping. The IMO's Revised Greenhouse Gas Strategy (2023) sets a pathway towards net-zero emissions from international shipping by or around 2050, supported by interim reduction checkpoints for 2030 and 2040 (IMO, 2023). Regional mechanisms, particularly the European Union's Emissions Trading System (EU ETS) and the FuelEU Maritime Regulation, have already translated these ambitions into enforceable operational requirements. Under the EU ETS, operators must monitor, report and surrender allowances for an increasing share of emissions, reaching full compliance by 2026 (European Commission, 2024). FuelEU Maritime, applicable from January 2025, mandates progressive reductions in the well-to-wake greenhouse-gas intensity of marine fuels, linking fuel choice directly to voyage economics and compliance costs (EMSA, 2025).

For seafarers, these developments convert climate policy into everyday operational reality. Alternative fuels such as liquefied natural gas (LNG), methanol, ammonia and hydrogen each introduce distinct safety and handling challenges. LNG involves cryogenic risks; methanol burns with an almost invisible flame; ammonia presents acute toxicity hazards; and hydrogen is susceptible to leakage and embrittlement. Consequently, crews require not only conventional engineering competence but also fuel-specific safety knowledge, chemical awareness and advanced emergency response capabilities (Lloyd's Register, 2025).

The scale of retraining implied by this transition is considerable. Estimates suggest that hundreds of thousands of seafarers will require additional training within the coming decade to safely manage alternative fuels (Reuters, 2024). Without timely upskilling, the sector risks safety incidents, environmental liabilities and operational disruption. Moreover, the competence demands extend beyond ships. Shore-based personnel — ship managers, charterers, compliance officers, surveyors and port authorities — must interpret carbon indicators, trading obligations and overlapping regulatory regimes. Decarbonisation therefore generates a cascading skills agenda across the entire maritime ecosystem.

2.2 Digitalisation, Automation and the Changing Nature of Work

Alongside decarbonisation, shipping is undergoing rapid digital transformation. Vessel-performance optimisation tools, predictive maintenance systems, digital twins and remote inspection technologies are increasingly embedded in everyday operations. The widespread acceptance of remote surveys and electronic certification since the pandemic has accelerated this shift towards digitally enabled compliance (DNV, 2022).

These developments substantially reshape competence expectations. Traditional seamanship and engineering skills must now be complemented by data literacy and cyber awareness. Officers are expected to interpret algorithmic outputs, supervise automated processes and safeguard onboard

information systems. Recognising these risks, the IMO has required cyber-risk management to be incorporated within Safety Management Systems since 2021 (IMO, 2021).

Automation extends this trajectory further. Maritime Autonomous Surface Ships (MASS) are progressing from experimental projects towards structured regulation, with a non-mandatory MASS Code anticipated by 2026 (IMO, 2024). Several administrations are already piloting semi-autonomous operations. While full autonomy for deep-sea shipping remains distant, short-sea and coastal applications are advancing steadily.

Rather than eliminating jobs, automation is likely to reconfigure them. Emerging roles include remote operators, system supervisors and cyber-incident responders. Evidence from the SkillSea initiative indicates that futureproof skills combine technical competence with transversal capabilities such as communication, problem-solving and systems thinking (SkillSea, 2023). In effect, tomorrow's officer functions less as a manual operator and more as a systems integrator managing complex human-machine interactions.

2.3 Geopolitical Disruptions and Security Risks

Maritime labour is equally affected by geopolitical instability. Attacks on merchant vessels in the Red Sea during 2023–2024 forced widespread rerouting and increased voyage times and costs (UNCTAD, 2024). Similar disruptions in the Black Sea following the Russia–Ukraine conflict have constrained trade flows and heightened operational uncertainty. For crews, these events translate directly into longer contracts, increased stress and elevated exposure to physical risk.

The psychological dimension of such disruptions is increasingly recognised. Isolation, uncertainty regarding repatriation and the threat of violence impose significant welfare pressures. Amendments to the Maritime Labour Convention adopted by the International Labour Organization strengthen provisions related to shore leave, repatriation and protection from harassment and violence (ILO, 2025). However, effective implementation by flag states and employers remains critical to translating these protections into practice.

Geopolitical risk also intersects with technological change. Rerouting raises fuel consumption and therefore carbon costs under emissions regimes. At the same time, digital dependence introduces new vulnerabilities to cyberattack. Workforce preparedness must therefore encompass not only technical competence but also resilience, adaptability and access to psychosocial support.

2.4 Intersections and Cumulative Impacts

The defining feature of the current period is the convergence of these transitions. Decarbonisation, digitalisation and security pressures operate simultaneously and reinforce one another. Alternative fuels rely on digital monitoring and control systems; conflict-driven rerouting increases both fuel use and emissions costs; and automation reshapes responsibilities while increasing cognitive load.

The cumulative effect is a marked escalation in the professional, technical and emotional demands placed on seafarers. With adequate training, institutional support and welfare safeguards, these transitions can strengthen the profession and enhance safety outcomes. If neglected, they risk deepening skill shortages, undermining operational reliability and weakening the human foundation upon which global maritime trade ultimately depends.

3. Labour Market Dynamics and the Just Transition

3.1 Officer Shortages and Structural Imbalances

Even prior to the current green and digital transitions, the maritime industry struggled to align labour supply with demand. The BIMCO/ICS Seafarer Workforce Report identified a global shortage of more than twenty-six thousand officers and warned that the gap could widen if training pipelines did not expand in step with fleet growth (BIMCO & ICS, 2021). While the availability of ratings was broadly balanced, demand for certified officers — particularly electro-technical officers and other specialised roles — remained consistently higher than supply.

These shortages are reinforced by demographic and institutional pressures. Ageing officer cohorts in several developed maritime nations reduce replacement rates, while younger entrants often view seafaring as less attractive due to extended contracts, family separation and limited shore-side mobility. Attrition also occurs within training systems: many cadets struggle to secure mandatory sea time, delaying or preventing certification. Wage competition from shore-based industries and persistent welfare concerns further weaken retention.

The result is a labour market characterised not only by quantitative deficits but also by qualitative mismatches. As competencies related to alternative fuels, digital systems and cyber resilience become essential, existing gaps risk deepening. Without timely intervention, such shortages may compromise operational safety and constrain the industry's ability to meet decarbonisation and compliance targets.

3.2 Supply-Country Dynamics: India, the Philippines and China

Global seafaring labour is concentrated in a small number of supply countries. The Philippines remains the largest contributor, accounting for roughly one-quarter of the world's seafarers (POEA, 2023). India is among the next largest suppliers, and China is likewise recognised as a major contributor to the global workforce (DG Shipping, 2024; UNCTAD, 2024). These nations exhibit distinct institutional models and transition capacities.

India maintains a sizeable pool of English-speaking officers supported by national institutions such as the Indian Maritime University and the Directorate General of Shipping. Estimates place the number of active Indian seafarers between 2.5 and 4.8 lakh, depending on definitional coverage (DG Shipping, 2024). While recent policy initiatives emphasise skilling and training expansion, challenges

remain, including uneven quality among private training institutes, limited readiness for alternative fuels and vulnerability to unethical recruitment practices.

The Philippines benefits from a highly centralised governance structure under the Philippine Overseas Employment Administration, which coordinates training, certification and international deployment. This system has enabled consistent global placement and strong market visibility. However, oversupply of ratings and downward wage pressure create long-term sustainability concerns.

China has invested heavily in state-led academies and fleet-linked training systems, particularly in high-value segments such as LNG carriers and offshore operations. Although Chinese officers are increasingly visible in international markets, language barriers and issues of certification recognition continue to affect deployment flexibility.

These contrasts are summarised in Table 1, which compares scale, institutional strengths and structural challenges across the three principal supply nations.

Table 1. Comparative Overview of Seafarer Supply Nations (2023–2024)

Indicator	India	Philippines	China
Estimated active seafarers	2.5 - 4.8 lakh	~5.5 - 6 lakh	~3 - 4 lakh
Share of global workforce	~10 - 12%	~25%	~12 - 14%
Institutional strength	IMU, DG Shipping, mixed private METs	Centralised training and deployment under POEA	State academies, fleet-linked training
Key strengths	English-speaking officers, academic base	Global reputation, coordinated deployment	LNG/offshore expertise
Key challenges	Uneven quality, limited alternative-fuel training, recruitment malpractice	Oversupply of ratings, wage pressure	Language and certification barriers

Source: Compiled from DG Shipping (2024), POEA (2023), UNCTAD (2024), and author's synthesis.

3.3 *The Just Transition Lens*

Debates on workforce change increasingly draw upon the concept of a just transition, which emphasises that workers should not disproportionately bear the social and economic costs of environmental and technological transformation (ILO, 2022). Applied to the maritime sector, this perspective extends beyond technical upskilling to questions of fairness, protection and participation.

First, access to affordable training and reskilling opportunities is essential. Without targeted support for alternative-fuel handling and digital competencies, seafarers from developing economies risk exclusion from higher-value roles. Second, the transition must guard against precarity. Labour shortages, extended contracts, fraudulent recruitment and abandonment during financial distress highlight the continued importance of effective Maritime Labour Convention enforcement. Third, workers and their representative bodies require meaningful participation in policy discussions.

Decisions on standards, certification and safety protocols directly shape working lives and therefore benefit from practitioner input.

Viewed through this lens, workforce transition is not merely a problem of closing skills gaps but a broader socio-economic challenge concerning equity between ship-owning and labour-supplying nations.

3.4 Interlinkages with Global Value Chains

Seafarers constitute a critical yet often invisible component of global value chains. Their labour enables the continuous movement of containers, energy commodities and bulk cargoes that underpin international trade. Nevertheless, the costs and risks generated by regulatory and market shifts are frequently transmitted downstream to crews. Carbon pricing mechanisms may indirectly lengthen voyages or intensify monitoring demands, while digitalisation initiatives designed for efficiency often add new responsibilities without proportional institutional support.

Recognising these interdependencies is therefore essential. Workforce planning cannot be isolated from trade policy, energy markets or security considerations. A holistic approach situates seafarers within broader debates on supply-chain resilience and climate justice, ensuring that human capabilities remain central to the sustainability of maritime transport.

4. India's Maritime Workforce in Transition

4.1 National Context and Policy Framework

India has consolidated its position as one of the world's leading suppliers of seafarers, alongside the Philippines and China. Official statistics from the Directorate General of Shipping indicate more than 2.5 lakh active Indian seafarers, while broader estimates suggest totals approaching 4.8 lakh depending on definitional coverage (DG Shipping, 2024). Although precise figures vary, the overall trend is unequivocal: India constitutes a major and expanding labour pool for the global fleet.

National policy direction reflects this strategic importance. Maritime India Vision 2030 identifies workforce development and skilling as central pillars of competitiveness, recognising that maritime human capital underpins both employment generation and industrial growth (NITI Aayog, 2021). Recent investments in specialised training infrastructure — including facilities such as the Indian Ship Technology Centre at Visakhapatnam and new regional centres of excellence — signal an intent to embed advanced competencies within domestic institutions rather than relying solely on external demand (Press Information Bureau, 2025a; 2025b).

Complementing these initiatives, the Government of India has announced substantial maritime modernisation outlays aimed at upgrading ports, shipbuilding capacity and skill development programmes (Press Information Bureau, 2025c). This broader industrial push creates an opportunity to integrate seafarer training with national logistics and manufacturing strategies, moving beyond a narrow labour-export model towards higher-value participation in the maritime economy.

4.2 *Institutional Strengths*

India's training ecosystem possesses a comparatively strong institutional foundation. The Indian Maritime University provides degree-level education, research capability and curriculum standardisation across multiple campuses, while the Directorate General of Shipping regulates certification, licensing and compliance. In parallel, a large network of private Maritime Education and Training institutes contributes scale and geographic reach. Together, these actors create a diversified system capable of producing officers and ratings across a wide spectrum of vessel types.

Language proficiency in English has historically provided Indian officers with an advantage in international placements, facilitating communication on multinational ships and with global operators. Indian seafarers are often regarded as technically competent, adaptable and disciplined, attributes that have supported their presence in tanker, bulk carrier and cruise segments (Ghosh, 2022). These characteristics constitute an important platform for future upgrading.

4.3 *Persistent Gaps and Challenges*

Despite these strengths, several structural constraints continue to limit India's readiness for emerging transitions.

First, training quality remains uneven. While IMU campuses and established academies maintain high standards, many smaller private institutes face constraints related to infrastructure, faculty expertise and sea-time placement opportunities. Such disparities create bottlenecks in officer certification and affect overall system credibility.

Second, readiness for alternative fuels is limited. Dedicated simulators, safety laboratories and specialised curricula for methanol, ammonia or hydrogen operations remain scarce. Without accelerated investment, India risks lagging behind supply countries that are already integrating alternative-fuel modules into mainstream training.

Third, recruitment malpractice and abandonment persist as reputational risks. Unauthorised intermediaries occasionally charge illegal fees or place seafarers with substandard employers, while cases of unpaid wages or delayed repatriation undermine welfare protections. Strengthened enforcement of the Registered Recruitment and Placement Service Licence system and closer monitoring of employers are therefore essential (ISWAN, 2024).

Finally, welfare and mental-health pressures have become more visible. Prolonged contracts, exposure to security risks and limited shore leave contribute to stress and fatigue. Although recent amendments to the Maritime Labour Convention strengthen safeguards, consistent implementation at the national level remains uneven.

4.4 *Comparative Insights*

Comparison with other leading supply nations highlights both opportunities and vulnerabilities for India.

The Philippines has institutionalised a centralised deployment framework through the Philippine Overseas Employment Administration, enabling coordinated training, certification and placement. This approach enhances predictability and market visibility, whereas India's decentralised structure, while flexible, can expose seafarers to inconsistent standards.

China, by contrast, closely aligns maritime training with national industrial policy, particularly in high-value sectors such as LNG carriers, offshore energy and technologically advanced vessels. If India remains concentrated in conventional segments, it risks losing competitiveness in emerging niches that command higher wages and strategic value.

India's comparative advantage therefore lies in its scale, language capability and institutional base. Sustaining these strengths requires deliberate upgrading rather than reliance on historical momentum.

4.5 India's Opportunity for Strategic Leadership

India's future role need not be confined to labour supply alone. With targeted reforms, it can position itself as a regional leader in skills and safety for the Global South. Three strategic shifts are particularly relevant.

First, the focus must move from volume to value by prioritising advanced competencies such as alternative-fuel operations, LNG and offshore systems, cyber security and integrated ship management. Second, training policy should become anticipatory rather than reactive, aligning curricula with forthcoming regulatory milestones well before compliance deadlines. Third, India can leverage regional platforms such as BIMSTEC and IORA to share training expertise and build collaborative capacity across neighbouring maritime economies.

Ultimately, the effectiveness of these strategies will depend on translating policy commitments into sustained institutional investment, modernised curricula and robust enforcement of recruitment and welfare standards. If implemented coherently, India is well placed not only to meet global labour demand but also to shape the standards of the next generation maritime workforce.

5. Case Illustrations: Translating Policy into Practice

While regulatory debates on decarbonisation and digitalisation often remain abstract, several recent industry initiatives illustrate how these transitions are already reshaping day-to-day workforce requirements. These cases demonstrate that adaptation is neither theoretical nor distant; it is occurring now through targeted training, operational trials and cross-sector collaboration.

5.1 Alternative Fuel Readiness: Methanol Operations in Container Shipping

The commissioning of methanol-fuelled container vessels by Maersk in 2023 provides an early example of alternative-fuel integration at scale (Maersk, 2023). Prior to deployment, crews underwent specialised instruction covering methanol bunkering procedures, revised fire-fighting techniques, toxicity awareness and emergency response protocols. Unlike conventional fuels, methanol burns with

a near-invisible flame and requires modified detection and suppression approaches, altering shipboard safety practices.

This case underscores that fuel transition is primarily a human transition. Even when propulsion technologies are available, safe operation depends on retraining officers and ratings in chemical hazard management and risk assessment. For labour-supplying nations, it signals that simulator upgrades and fuel-specific safety modules are now essential components of maritime education.

Ammonia Safety Pilots and Structured Competence Building

Mitsui O.S.K. Lines (MOL) has conducted controlled ammonia-handling pilots involving Japanese officers, focusing on leak detection systems, personal protective equipment, toxic exposure thresholds and emergency drills under supervised conditions (MOL, 2024). Given ammonia's high toxicity, even minor operational errors can have severe consequences.

These pilots highlight the value of staged competence development before commercial deployment. Rather than retrofitting skills after incidents occur, operators are embedding safety knowledge into training curricula in parallel with technology trials. The approach offers a replicable pathway for developing countries: begin with pilot simulations, develop standard operating procedures and progressively scale training as fleet adoption grows.

5.2 *Cross-Sector Skilling: Cruise and Blue Economy Integration in India*

Workforce transitions are not confined to fuels and automation alone. In India, collaboration between the Indian Maritime University and the Institute of Hotel Management has supported integrated training for cruise hospitality and service personnel (Press Information Bureau, 2023). This initiative broadens the conventional boundaries of maritime skills beyond deck and engine roles to include hospitality, safety awareness and passenger services.

The case illustrates an additional dimension of workforce strategy: diversification. By linking maritime training with cruise tourism and the wider blue economy, India can develop alternative career pathways and reduce over-dependence on conventional shipping segments. Cross-sector skilling may be particularly relevant for younger entrants and coastal communities seeking stable employment opportunities.

5.3 *Lessons from the Cases*

Taken together, the cases point to three consistent patterns. First, workforce preparation must precede technological adoption; training needs to lead, not follow, innovation. Second, new competencies are highly specialised and fuel- or system-specific, requiring targeted curricula rather than generic modules. Third, institutional collaboration—between industry, regulators and training providers - enables rapid implementation.

These illustrations reinforce the central argument of this paper: maritime transition is constrained less by technology or regulation than by human readiness. Nations that invest early in

structured training ecosystems are more likely to capture emerging opportunities, while those that delay risk exclusion from higher-value segments of the global fleet.

6. Policy and Institutional Pathways

The preceding analysis demonstrates that workforce readiness is not an automatic by-product of technological change; it requires deliberate policy coordination, institutional investment and regulatory foresight. For labour-supplying nations such as India, reactive adaptation risks persistent skill gaps and competitive disadvantage. Instead, a proactive and structured approach is necessary to align training systems with the accelerating timelines of decarbonisation and digital transformation.

6.1 Curriculum Modernisation

Maritime Education and Training (MET) programmes must evolve beyond conventional STCW compliance towards anticipatory competence building. Modules on alternative fuels, hybrid propulsion systems, emissions monitoring, digital navigation tools and cyber-risk management should be embedded within mainstream curricula rather than treated as optional add-ons. Anticipating forthcoming revisions to the STCW framework and related IMO instruments will allow institutions to prepare graduates before regulatory mandates take effect. Early integration reduces retraining costs and strengthens employability in emerging vessel segments.

6.2 Simulation and Applied Safety Infrastructure

Classroom instruction alone is insufficient for managing the operational risks associated with methanol, ammonia or LNG. Practical competence requires exposure to realistic operating environments. Investment in bunkering simulators, engine-room mock-ups, and digital-twin laboratories can bridge this gap. Partnerships between the Indian Maritime University, ports, shipping companies and equipment manufacturers would enable shared facilities and cost-effective deployment. Such applied training environments enhance safety culture and allow officers to rehearse emergency scenarios before encountering them at sea.

6.3 Ethical Recruitment and Welfare Governance

Workforce expansion must be matched by strong governance. Persistent issues of fraudulent recruitment, excessive placement fees and crew abandonment undermine both seafarer welfare and India's reputation as a reliable labour supplier. Strengthened enforcement of the Registered Recruitment and Placement Service Licence (RPSL) regime, transparent placement records and digital tracking of contracts can reduce malpractice. Aligning these measures with the protections of the Maritime Labour Convention ensures that skill development is accompanied by dignity and security of employment.

6.4 Regional and Global Leadership

Beyond domestic reform, India is well placed to exercise regional leadership. Platforms such as BIMSTEC and the Indian Ocean Rim Association offer avenues for sharing training standards, faculty expertise and simulator access with neighbouring states. By positioning itself as a hub for maritime

skilling and safety in the Global South, India can move from being primarily a labour supplier to a provider of knowledge and institutional capacity. Such leadership enhances both diplomatic influence and economic opportunity.

6.5 *Regulatory Timeline and Workforce Implications*

The urgency of these measures is underscored by the compressed regulatory horizon facing the industry. Table 2 summarises key milestones between 2023 and 2030, illustrating how environmental regulation, security events and labour standards converge within a single decade. For training institutions, each milestone effectively represents a deadline for competence development.

Table 2. Regulatory milestones and corresponding workforce implications (2023–2030)

Year	Regulatory / Industry Event	Workforce Implication
2023	IMO Revised GHG Strategy adopted; methanol vessels launched	Initial alternative-fuel training begins
2024	Red Sea disruptions; EU ETS phase-in	Higher operational risk; compliance monitoring skills required
2025	FuelEU Maritime enters into force; MLC amendments	Fuel reporting competence; welfare safeguards strengthened
2026	EU ETS full compliance; anticipated STCW updates	Formal curriculum revisions and certification changes
2030	IMO 40% carbon intensity checkpoint; large-scale alternative fuel adoption	Mass retraining and specialised fuel competence needed

Source: Compiled from IMO (2023, 2024), European Commission (2024), Reuters (2024).

Taken together, these milestones demonstrate that workforce planning cannot be incremental. Training cycles, infrastructure investment and regulatory coordination must proceed in advance of compliance deadlines. Countries that delay action risk shortages of certified personnel precisely when demand peaks.

In sum, policy and institutional pathways constitute the bridge between aspiration and implementation. Without systematic reform of curricula, infrastructure, governance and regional collaboration, the promise of a safe and equitable maritime transition will remain unrealised.

7. **Conclusion**

The analysis presented in this paper demonstrates that the maritime workforce is no longer a peripheral consideration within shipping policy but its central enabling condition. Decarbonisation targets, digital technologies and geopolitical disruptions are not abstract regulatory or technical developments; they translate directly into new competence requirements, altered risk profiles and evolving welfare needs for seafarers. In practice, the success or failure of the green and digital transition will depend less on hardware and regulation than on the preparedness of the people who operate ships and manage maritime systems.

The scale of change is substantial. Hundreds of thousands of seafarers are expected to require retraining in alternative-fuel operations, digital tools and cyber resilience within a single decade, even

as persistent officer shortages constrain capacity. Without coordinated investment in education, simulation infrastructure and welfare governance, these pressures risk widening existing inequalities between shipowning and labour-supplying nations and undermining safety at sea.

Within this global landscape, India occupies a pivotal position. Its large and growing seafarer base, expanding institutional framework and policy momentum under Maritime India Vision 2030 provide a strong foundation for leadership. At the same time, uneven training quality, limited readiness for emerging fuels and weaknesses in recruitment governance remain structural constraints that require sustained reform. Comparative experience from the Philippines and China indicates that strategic coordination between training systems, labour deployment and industrial policy is critical for maintaining competitiveness in higher-value segments of the market.

The concept of a just transition offers a useful normative and practical lens for navigating these changes. Ensuring equitable access to training, protection from precarious employment and meaningful participation of seafarers in decision-making processes is not only a matter of fairness but also of operational effectiveness. A workforce that is skilled, secure and respected is more capable of supporting safe and sustainable shipping.

Ultimately, the strategic choice for India—and for other Global South labour suppliers - is whether to remain a quantitative provider of manpower or to evolve into a qualitative leader in maritime skills, safety and governance. By shifting emphasis from volume to value, investing in advanced training infrastructure and strengthening institutional oversight, India can position itself as a regional hub for maritime human capital. Such a transformation would secure livelihoods for its seafarers while enabling the broader objectives of decarbonisation, digitalisation and resilient global trade.

In this sense, the future of maritime sustainability is inseparable from the future of maritime labour. Placing the workforce at the centre of policy is therefore not optional but essential for the next phase of global shipping.

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