

The Socio-Technical Impact of Maritime Autonomous Surface Ships (MASS) on Myanmar Seafarer Officers: An Empirical Analysis of Readiness and Competency Gaps

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ABSTRACT

The global diffusion of Maritime Autonomous Surface Ships (MASS) poses significant but underexamined challenges for seafarers in developing nations. Drawing on a quantitative survey of 51 active Myanmar seafarer officers administered via Google Forms between June and September 2025, this paper investigates perceptions of employment security, socio-economic impact, and competency readiness in relation to emerging autonomous shipping technologies. Descriptive statistical analysis was conducted using IBM SPSS Statistics. Results indicate that 51.0% of respondents expected MASS to reduce job availability, whereas 41.2% anticipated a transition toward new professional responsibilities. A critical competency gap was identified: 49.0% of respondents identified remote ship monitoring as the most essential emerging skill, followed by autonomous systems maintenance (31.4%). Findings indicate that existing Standards of Training, Certification and Watchkeeping for Seafarers (STCW) frameworks are inadequately aligned with these emerging competency requirements. Evidence-based recommendations are advanced for Myanmar's maritime education and training institutions and regulatory authorities, with broader implications for developing seafarer-supplying nations.

Keywords: Myanmar, Maritime, Seafarer, Automation, Technology

The maritime industry is undergoing a consequential technological transition driven by the convergence of artificial intelligence, advanced sensor technologies, satellite communications, and data analytics. Maritime Autonomous Surface Ships (MASS) have evolved from theoretical formulation into operational application: vessels including the YARA Birkeland and HD Hyundai's LNG carrier, which completed the world's first transoceanic autonomous voyage in June 2022, demonstrate that remote and autonomous maritime operations now form part of the commercial shipping landscape (Lee, 2024). The International Maritime Organization (IMO) has responded through its Regulatory Scoping Exercise for MASS, establishing a four-degree autonomy framework ranging from onboard decision-support tools to fully autonomous, crewless operation (IMO, 2021a). This reflects broad institutional recognition that autonomous technologies represent an advancing

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Received: August 27, 2026; Revision Received: September 25, 2026; Accepted: September 29, 2026

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operational and commercial imperative for global shipping, with direct consequences for maritime labor markets (Kim et al., 2020).

Against this backdrop, the human dimensions of maritime autonomy have received comparatively limited scholarly attention, particularly with respect to seafarers from developing nations (Xiang et al., 2025). Myanmar's maritime human resource sector has historically been a significant supplier of skilled officers to international shipping companies, occupying a position of considerable vulnerability in the current transition. With approximately 60,000 active Myanmar seafarer officers deployed globally across oil and chemical tankers, bulk carriers, and container vessels, the socio-economic stakes of maritime automation are substantial (Department of Marine Administration [DMA], 2024). Seafaring income constitutes a principal source of foreign currency remittances that sustain local communities and national economic stability; economists classify such earnings as an invisible export, reflecting their significance to the balance of payments of labor-supplying nations (Badawy, 2025). Disruption to Myanmar seafarers' employment prospects therefore carries implications extending beyond individual careers to household welfare, community stability, and national foreign exchange earnings.

Despite this relevance, empirical research addressing the MASS-related awareness, professional readiness, and competency gaps of Myanmar seafarer officers is absent from the academic literature. Existing studies predominantly examine the technological dimensions of autonomy or seafarer and institutional perspectives in developed, technology-leading nations, leaving a substantive gap with respect to developing-world maritime labor suppliers (Belabyad et al., 2025; Bogusławski et al., 2022; Shahbakhsh et al., 2022). This study addresses that gap through quantitative survey research, with the dual objectives of advancing academic knowledge and informing practical policy responses. The findings carry implications not only for Myanmar but for the broader community of developing nations whose economic development and maritime competitiveness depend on their capacity to supply qualified, technologically proficient seafarers to the global fleet (Badawy, 2025).

LITERATURE REVIEW

Technological Development and the Global Trajectory of MASS Adoption

The conceptual foundations of maritime autonomous shipping predate current technological developments. The Maritime Safety Committee of the IMO considered the regulatory implications of automated vessels as early as 1964; it is within the past decade, however, that technological progress has translated those concepts into deployable systems (Shahbakhsh et al., 2022). The IMO's working definition characterizes MASS as a ship that, to a varying degree, can operate independently of human interaction (IMO, 2021a). The associated four-degree framework has become the primary reference structure for international regulatory discourse, ranging from Degree One (decision-support tools for onboard crew) through Degree Two (remotely controlled with crew present) and Degree Three (remotely controlled without crew) to Degree Four (fully autonomous operation). Classification societies have developed parallel frameworks: Lloyd's Register employs a six-point autonomy scale (AL 0 to AL 6), while DNV and Bureau Veritas have articulated similar taxonomies addressing the progressive transfer of decision-making authority from human operators to automated systems (Kilinc, 2025).

The scope of recent technological demonstration is considerable. HD Hyundai achieved the world's first transoceanic autonomous voyage of an LNG carrier in June 2022, and Samsung

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Heavy Industries completed the autonomous operation of the Segero across approximately 950 kilometres over four days that same year (Lee, 2024). In Norway, the Kongsberg-designed YARA Birkeland has undergone successive stages of autonomous testing (Schottel, 2024), and Japan's Nippon Foundation has set a national objective of achieving autonomous navigation for 50% of domestic shipping by 2040 (Nippon Foundation, 2025). These developments indicate that MASS adoption represents an accelerating global trajectory with direct implications for all segments of the maritime labor market.

The primary rationale for MASS development is the mitigation of maritime accidents attributable to human error, historically a substantial proportion of maritime casualties (Askari & Hossain, 2022; Sanchez-Beaskoetxea et al., 2021). Autonomous shipping also offers potential to reduce operational costs by up to 20% and fuel consumption by up to 30% through optimized route planning (ATL Marine & Energy Ltd., 2025). Artificial intelligence underpins the principal subsystems of autonomous ships, including AI processing, cybersecurity infrastructure, land-based control systems, and network communications (Lee, 2024). Nonetheless, industry forecasts indicate that widespread MASS deployment on international voyages remains approximately 25 years away for passenger ships and large tankers, owing to concerns about remote communications reliability and stringent safety requirements (IALA, 2024). Near-term deployment is therefore expected to concentrate in small specialized vessels operating in technologically advanced nations.

The Impact of Maritime Automation on Seafarer Employment and Professional Roles

How maritime automation will affect seafarer employment is one of the most actively debated questions in contemporary maritime policy. Historical evidence indicates that major technological transitions in shipping have tended to reconfigure rather than eliminate seafarer roles. The transition from sail to steam, and later from steam to diesel-electric propulsion, reduced particular categories of onboard labor while generating demand for new technical specializations. The Global Maritime Distress and Safety System (GMDSS) rendered the dedicated shipboard radio officer redundant while increasing demand for officers competent in electronic navigation and communications (Shahbakhsh et al., 2022). These authors argue that successive industrial revolutions in maritime have followed this pattern of role substitution rather than wholesale displacement, though the scale and pace of the current transition may prove more disruptive than historical precedent suggests.

The operational architecture emerging around MASS introduces the Shore Control Center (SCC) as the central node of a reconstituted maritime labor system. As vessel autonomy increases beyond Degree Two, human operators migrate from the bridge to land-based facilities from which multiple vessels may be supervised concurrently, with direct intervention required only when autonomous systems reach operational limits (Bogusławski et al., 2022). This reconfiguration generates novel employment categories, including Remote Monitoring Specialists, Autonomous System Managers, and maritime cybersecurity technicians, while reducing demand for onboard watchkeeping officers and engine room personnel. Saha (2023) developed a detailed SCC manning framework and found that 80% of surveyed informants identified experienced seafarers as the most suitable candidates for front-line SCC operator roles, suggesting the MASS transition may represent an opportunity for professional continuity rather than displacement, provided accessible retraining pathways are established.

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The distributional consequences of this transition are substantively unequal across national contexts. Developed maritime nations possess the institutional, financial, and technological infrastructure to develop SCC networks and integrate MASS competencies into existing maritime education frameworks. Developing nations functioning primarily as labor suppliers face structural barriers, including constrained investment capital for maritime education and training (MET) modernization, restricted access to MASS simulation technologies, and the continuing dominance of conventional STCW certification as the principal credential of international maritime employability. Badawy (2025) identifies a tangible risk that seafarers from developing nations will be systematically excluded from emerging SCC-based roles absent proactive national policy intervention, a risk particularly acute for seafarer-supplying countries including Myanmar, the Philippines, and Indonesia given their economic dependence on maritime labor export earnings.

Seafarer Competency, Training Frameworks, and Readiness for Technological Change

The STCW Convention, adopted in 1978 and most recently substantively revised through the 2010 Manila Amendments, is the foundational international framework for seafarer training, certification, and watchkeeping, defining minimum knowledge, understanding, and proficiency requirements for all major officer categories. The pace of technological change associated with MASS has, however, outpaced the Convention's revision cycle. Belabyad et al. (2025), in a systematic review and bibliometric analysis, establish that the emerging autonomous shipping workforce will require both cognitive competencies (data analytics, AI system management, cybersecurity awareness) and functional competencies (remote vessel monitoring, system troubleshooting, digital navigation tools). Current STCW competency tables provide limited provision for any of these emerging domains, a deficiency with significant implications for national maritime administrations responsible for curriculum and certification.

This regulatory gap is widely acknowledged in the scholarly and policy literature. The IMO has indicated, through MSC.1/Circ.1638, that remote operators of autonomous vessels may be designated as seafarers and that specific requirements for remote control stations will require address in future regulatory instruments (IMO, 2021b). The draft MASS Code, under development, is expected to incorporate competency standards for remote operators; national maritime administrations must navigate regulatory ambiguity until it is finalized (IMO, 2021a). This places a premium on proactive national curriculum development and investment in simulation infrastructure capable of replicating the future SCC environment (Kilinc, 2025). Xu and Soares (2026) emphasize that while certain traditional competencies, such as magnetic compass operation and landmark-based positioning, will diminish in relevance, foundational attributes including communication proficiency, emergency response capability, risk assessment, and leadership will remain indispensable to maritime safety in the autonomous era.

A generational dimension further complicates the competency landscape. Bogusławski et al. (2022) report that younger seafarers demonstrate higher baseline digital literacy and adaptability, rendering them more responsive to MASS-related training, yet lack the practical sea service experience and situational judgment that underpins high-stakes decision-making. The industry thus faces a structural challenge in which those with the greatest technological fluency lack operational depth, while those with the greatest operational experience lack digital fluency, requiring blended instructional approaches that combine simulator-based digital skills development with structured mentoring across generational cohorts.

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Developing Nations and Maritime Technological Transitions: The Myanmar Context

Myanmar occupies a distinctive position within the global maritime labor market as a significant supplier of skilled officer-level human resources to international shipping companies (DMA, 2024). The socio-economic importance of this sector extends well beyond direct employment: seafarer remittances constitute a substantial and relatively stable source of foreign currency earnings that sustain local economies in seafaring communities, and the profession carries considerable socio-cultural significance. Seafaring is regarded in Myanmar as a high-status occupation that provides economic security and maintains the country's connection to global trade networks (Bogusławski et al., 2022). This combination of economic centrality and cultural prestige means that disruptions to Myanmar's maritime labor market would carry consequences at both household and national levels.

Myanmar's maritime education and training infrastructure comprises Myanmar Maritime University (MMU), Myanmar Mercantile Marine College (MMMC), and several private training centers, which together deliver STCW-mandated training programs. These institutions have historically concentrated on conventional seafarer competencies, and as MASS reshapes global demand for maritime labor, the adequacy of this ecosystem in preparing officers for the digital maritime environment is subject to increasing scrutiny. This transition requires capital investment in simulation infrastructure, faculty retraining, and programmatic redesign that may exceed current resource capacities (Kilinc, 2025).

The widening technological gap between developed and developing maritime nations generates what Badawy (2025) describes as a risk of accelerated brain drain from seafarer-supplying countries, whereby Myanmar's most technically capable officers are those most likely to be recruited by shipping companies in nations that have invested in MASS infrastructure. If entrenched, this pattern leaves Myanmar losing its most competitive maritime talent while remaining unable to modernize its own fleet operations or regulatory capacity. Addressing this risk requires coordinated action at the levels of national maritime policy, MET investment, and bilateral engagement with international maritime organizations to prevent developing nations from being systematically excluded from the governance processes shaping the MASS regulatory framework (Kim et al., 2020).

Purpose of the Study

The maritime industry's transition toward MASS is well documented in technical and regulatory literature, yet empirical research examining how seafarers from developing nations perceive, anticipate, and prepare for this transition remains substantially underrepresented in academic scholarship (Xiang et al., 2025). Myanmar, as a significant seafarer-supplying nation, faces considerable vulnerability to the employment and socio-economic disruptions that autonomous shipping may generate, yet the awareness, readiness, and competency gaps of its seafarer officers with respect to MASS have not previously been examined through systematic empirical inquiry.

This study addresses that gap through a quantitative, survey-based examination of the socio-technical dimensions of MASS adoption as perceived by active maritime professionals, guided by four interrelated objectives: to assess current levels of MASS awareness among Myanmar seafarer officers, including their understanding of IMO autonomy degrees (IMO, 2021a); to evaluate perceptions of how MASS will affect employment security, professional status, and Myanmar's national economy (Badawy, 2025; Shahbakhsh et al., 2022); to identify the specific competency gaps recognized as barriers to effective participation in the

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autonomous maritime workforce (Belabyad et al., 2025; Saha, 2023); and to derive evidence-based recommendations for Myanmar's maritime education and training institutions, regulatory authorities, and industry stakeholders to support workforce adaptation and competitiveness (Kim et al., 2020; Kilinc, 2025).

By foregrounding the perspective of developing-nation seafarers rather than technology developers or regulatory bodies, this study contributes an empirical dimension frequently absent from MASS scholarship (Belabyad et al., 2025; Xiang et al., 2025). The findings are intended to inform maritime policymakers, MET curriculum developers, international regulatory bodies including the IMO, and the scholarly community working at the intersection of maritime studies, labor economics, and technology governance (Badawy, 2025).

METHODS

Research Design

A quantitative, cross-sectional survey design was employed to examine the perceptions, attitudes, and self-assessed competency gaps of Myanmar seafarer officers in relation to MASS technologies. This approach was adopted because the objectives required systematic measurement of attitudes across a defined professional population and frequency distributions directly interpretable by policymakers and MET administrators (Bogusławski et al., 2022). Cross-sectional survey methodology is well established in maritime social science for capturing workforce perceptions at a defined point in time, and has been applied in analogous studies of seafarer attitudes toward autonomous shipping (Belabyad et al., 2025; Shahbakhsh et al., 2022).

Participants

The target population comprised active Myanmar seafarer officers employed by international shipping companies. Purposive sampling was adopted as the primary strategy since respondents required professional background sufficient to evaluate autonomous ship technologies and their potential impact on maritime careers (Bogusławski et al., 2022). All 51 participants were active or recently active Myanmar seafarer officers with direct experience of international shipping operations.

The sample was composed exclusively of male respondents, consistent with the prevailing gender profile of the Myanmar seafarer officer workforce. The largest age cohort comprised officers aged 35 to 44 years (64.7%), reflecting the perspectives of mid-career professionals with substantial operational experience. Deck officers constituted the largest functional subgroup (70.6%), with the remainder drawn from engineering, maritime administration, maritime instruction, and other roles. Over half of respondents (71.6%) reported more than 10 years of sea service, indicating a professionally senior sample whose range of experience levels and functional roles supports representativeness within the Myanmar seafarer officer population (Belabyad et al., 2025). Table 1 presents the complete demographic and professional profile of the sample.

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Table 1 Sample Characteristics of Myanmar Seafarer Officer Participants (N = 51)

Characteristic	n	%
<i>Gender</i>		
Male	51	100.0
Female	0	0.0
<i>Age (years)</i>		
18-24	2	3.9
25-34	11	21.6
35-44	33	64.7
45-54	1	2.0
55-64	4	7.8
<i>Professional Role</i>		
Deck Officer	36	70.6
Maritime Administrator	5	9.8
Engineering Officer	4	7.8
Maritime Training / University	2	3.9
Master	1	2.0
Shore-based Staff / Other	3	5.9
<i>Years of Maritime Experience</i>		
Less than 5 years	5	9.8
5-10 years	10	19.6
11-15 years	12	23.5
16-20 years	10	19.6
Over 20 years	14	27.5
<i>Primary Vessel Type</i>		
Cargo (Bulk/General)	34	66.7
Tanker (Oil/Chemical)	13	25.5
Container	1	2.0
Other (RoRo, FSO, Field Trip)	3	5.9
<i>Primary Vessel Size (GT)</i>		
Less than 3,000	5	9.8
3,000-15,000	9	17.6
15,000-30,000	9	17.6
30,000-60,000	21	41.2
Over 60,000	7	13.7
<i>Trading Area</i>		
Worldwide	32	62.7
Foreign Going	15	29.4
Near Coastal / Offshore	4	7.8

Note. Data were collected via purposive sampling of active Myanmar seafarer officers between June and September 2025. Trading area categories follow IMO voyage classification conventions. GT = gross tonnage.

Survey Instrument and Data Collection

Primary data were collected through a structured online questionnaire administered via Google Forms between June and September 2025. The instrument was developed by the principal investigator on the basis of a comprehensive review of the MASS literature, IMO regulatory documents, and prior empirical studies addressing seafarer perceptions of automation and technological change (Belabyad et al., 2025; Bogusławski et al., 2022). The

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final instrument comprised 34 items organized into five thematic domains: Demographics, General Awareness, Impact Assessment, Skills Gap Analysis, and Socio-Economic and Regulatory Context. Table 2 provides a complete overview of the survey instrument, including the abbreviated item stem, response format, and thematic domain for each question.

Table 2 Survey Instrument Overview: Question Items, Response Formats, and Thematic Domains

Q#	Survey Item (abbreviated)	Response Format	Domain
1-2	Gender; Age	Categorical (nominal)	Demographics
3	Current role in the maritime industry	Categorical (7 options)	Demographics
4	Years of experience in the maritime sector	Categorical (5 bands)	Demographics
5-7	Primary vessel type, size, and trading area	Categorical (multiple options each)	Demographics
8	Awareness of MASS (yes/no)	Dichotomous	General Awareness
9	Familiarity with MASS technology	Likert: 1 (none) to 5 (expert)	General Awareness
10	Primary source of MASS information	Multiple-select categorical	General Awareness
11	MASS perceived as threat or opportunity	5-point scale: Major threat to Major opportunity	Impact Assessment
12	Expected timeline for MASS adoption in Myanmar	Categorical (4 options)	Impact Assessment
13	Likelihood MASS reduces job availability	5-point Likert: Very unlikely to Very likely	Impact Assessment
14	Roles most at risk due to MASS (rank top 3)	Open/ranked categorical	Impact Assessment
15	How MASS might affect own job within a decade	Categorical (5 options)	Impact Assessment
16	Could MASS create new job opportunities	5-point Likert: Strongly disagree to Strongly agree	Impact Assessment
17	Should shipping companies retrain displaced seafarers	Categorical: Yes / No / Unsure	Impact Assessment
18	Adequacy of current Myanmar MET programs for MASS	5-point Likert: Strongly disagree to Strongly agree	Skills Gap
19	New skills required for MASS operations (select all)	Multiple-select categorical (5 options)	Skills Gap
20	Willingness to participate in MASS training	Categorical: Yes / No / Depends on cost	Skills Gap
21	Preferred training format	Categorical (4 options)	Skills Gap
22	Who should fund MASS-related training	Categorical (3 options)	Skills Gap
23	How MASS might affect Myanmar's economy overall	5-point scale: Very negatively to Very positively	Socio-Economic
24	Could MASS reduce seafarer remittances	5-point Likert: Strongly disagree to Strongly agree	Socio-Economic
25	Impact of MASS on social status	Categorical (5 options)	Socio-Economic

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Q#	Survey Item (abbreviated)	Response Format	Domain
	of seafarers		
26	How coastal communities relying on seafaring will be affected	Categorical (5 options)	Socio-Economic
27	Preparedness of Myanmar maritime authorities to regulate MASS	Categorical (5 options)	Regulatory
28	Safety concerns associated with MASS (select all)	Multiple-select categorical (5 options)	Safety
29	Could MASS improve environmental sustainability	5-point Likert: Strongly disagree to Strongly agree	Environmental
30	Who should bear liability for MASS accidents	Categorical (5 options)	Regulatory
31	Is Myanmar's legal framework ready for MASS challenges	5-point Likert: Strongly disagree to Strongly agree	Regulatory
32	Overall impact of MASS on Myanmar seafarers (scale 1-5)	Numeric scale 1 (not at all) to 5 (very well)	Overall Assessment
33	Open-ended view on MASS impact on Myanmar seafarers	Free-text narrative	Overall Assessment

Note. Q = question number as administered in the survey. Response formats followed established conventions in maritime social research (Belabyad et al., 2025; Bogusławski et al., 2022). Likert-scale items used five-point anchors throughout: 1 = Strongly disagree / Very unlikely, 5 = Strongly agree / Very likely. MET = maritime education and training; MASS = Maritime Autonomous Surface Ships.

As shown in Table 2, the domains build progressively from respondent background through awareness, perceived impact, competency gaps, and socio-economic and regulatory context, concluding with an open-ended narrative item (Question 33) and a five-point overall impact rating (Question 32). Five-point Likert-scale items employed anchors ranging from Strongly disagree to Strongly agree for attitudinal propositions, and from Very unlikely to Very likely for probability assessments, consistent with methodological conventions in maritime social research (Belabyad et al., 2025). Multiple-select items permitted respondents to identify all applicable responses from a predefined list, and ranked items required respondents to prioritize up to three options from a provided set. The questionnaire was reviewed informally by three maritime professionals prior to full administration to assess item clarity. Distribution was conducted via professional email networks and Facebook groups serving the Myanmar maritime community, the primary digital communication channels for this population, yielding 51 completed responses by the close of the data collection period. The secondary data component was informed by a comprehensive literature review encompassing peer-reviewed journal articles, IMO regulatory documents, industry publications from classification societies including DNV, Lloyd's Register, and Bureau Veritas, and outputs from international bodies including IALA and the International Labour Organization (ILO).

Data Analysis

Quantitative data were processed and analyzed using IBM SPSS Statistics (Version 27), supplemented by Microsoft Excel for data visualization. In accordance with the study's descriptive design, the analytical strategy comprised frequency distributions and percentage analyses applied to each survey item, and cross-tabulations used to identify response patterns across thematic domains. Descriptive statistics are the appropriate and standard analytical

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method for this type of purposive survey research, where the objective is to characterize the distribution of perceptions and self-assessments across a defined professional population rather than to test hypotheses or establish causal relationships (Belabyad et al., 2025; Bogusławski et al., 2022). Prior to analysis, all data were cleaned and numerically coded, with each row representing an individual participant and each column a distinct survey variable, and findings were then interpreted within the broader socio-technical and policy context of Myanmar's maritime sector (Xiang et al., 2025).

Ethical Considerations

The study received ethical approval from the Institutional Review Board at the International Executive School, Strasbourg, France, prior to data collection. The research followed established principles of human subjects research, including voluntary informed consent, confidentiality of personal data, and the right to withdraw without consequence (Bogusławski et al., 2022). All participants were informed of the purpose and scope of the research prior to completing the survey, and written consent was obtained from each respondent. The instrument collected no personally identifying information, all data were reported in aggregate form to preclude identification of individual respondents, and the survey procedure entailed no physical, environmental, or psychological risk to participants.

RESULTS

This section presents the descriptive statistical findings derived from 51 completed survey responses, organized according to the instrument's thematic domain structure. All findings are reported as frequencies and percentages, consistent with the study's descriptive design (Belabyad et al., 2025; Bogusławski et al., 2022). Table 3 summarizes the principal policy-relevant findings across domains.

Table 3 Summary of Key Descriptive Findings by Thematic Domain

Thematic Domain	Key Finding	% of Respondents
Employment security	Expected MASS to be likely or very likely to reduce job availability	51.0%
Employment security	Anticipated new responsibilities rather than role elimination	41.2%
Employment security	Expected own role to be eliminated	9.8%
Skills gap	Identified remote ship monitoring as the most critical future competency	49.0%
Skills gap	Identified autonomous systems maintenance as a critical future competency	31.4%
Skills gap	Identified AI and software management as a critical future competency	13.7%
Training adequacy	Disagreed or strongly disagreed that Myanmar MET is adequate for MASS	58.8%
Training willingness	Would participate in MASS-related training if offered	72.5%
Remittances	Agreed or strongly agreed that MASS could reduce seafarer remittances	66.7%
Economic outlook	Selected a neutral position on MASS's overall impact on Myanmar's economy	41.2%

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Thematic Domain	Key Finding	% of Respondents
Economic outlook	Anticipated a positive or very positive overall economic impact	37.2%
Social status	Expected a slight improvement in the professional social status of seafarers	41.2%
Social status	Expected a decline in the professional social status of seafarers	37.2%
Regulatory readiness	Rated Myanmar maritime authorities as not prepared or only slightly prepared to regulate MASS	74.5%
Safety concerns	Identified cybersecurity risks as the primary safety concern associated with MASS	62.7%
Overall impact (1-5)	Rated the overall impact of MASS on Myanmar seafarers as 2 out of 5	41.2%

Note. Percentages are based on the total sample (N = 51) unless otherwise indicated. For multiple-select items, the most frequently selected single response is reported as the primary finding. MET = maritime education and training.

MASS Awareness and Familiarity

Survey data indicated that 74.5% of respondents (n = 38) had prior awareness of MASS as a concept, while 25.5% (n = 13) reported no prior awareness. Among those aware, self-rated familiarity was concentrated at the lower end of the scale: 41.2% rated their familiarity at 1 out of 5 (awareness of the term only), and 39.2% rated it at 2, indicating minimal substantive knowledge. A further 19.6% rated their familiarity at 3, and no respondents reported familiarity above that level, a pattern consistent with Bogusławski et al. (2022) and Badawy (2025) on the limited, informal, and incidental nature of MASS awareness among non-specialist maritime professionals in developing countries. The principal reported information sources were social media (25.5%), traditional news media (19.6%), and combinations of multiple channels (23.6%); a further 11.8% had not previously encountered the concept.

Perceptions of Threat, Opportunity, and Adoption Timeline

When asked to characterize MASS as a threat or opportunity, the largest proportion of respondents (41.2%) selected the neutral midpoint. Among those expressing a directional view, 23.5% characterized MASS as a slight threat and 13.7% as a major threat (combined threat assessment 37.2%), while 13.7% perceived a slight opportunity and 7.8% a major opportunity (combined opportunity assessment 21.5%). Threat perceptions were thus more prevalent than opportunity perceptions overall, consistent with seafarer attitudes documented in other developing maritime nations (Badawy, 2025; Shahbakhsh et al., 2022).

With respect to the expected timeline for MASS adoption within Myanmar's maritime sector, 39.2% of respondents anticipated widespread adoption within a 10- to 20-year horizon, while 23.5% anticipated adoption within 5 to 10 years and 13.7% within five years, expectations broadly consistent with IALA's (2024) projections and indicating a medium-term rather than immediate transition. This has implications for the urgency of training reform: a 10- to 20-year horizon may generate institutional complacency absent proactive policy intervention (Kim et al., 2020; IMO, 2021a), particularly since the pace of regulatory and technological development can outpace earlier projections (Xu & Soares, 2026).

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Career and Employment Security Perceptions

Analysis of employment security data revealed substantial concern regarding the future employment implications of MASS. When asked to assess the likelihood that autonomous shipping would reduce overall job availability, 37.3% of respondents indicated this was likely and a further 13.7% very likely, a combined concern rate of 51.0%. An additional 29.4% were neutral, while 13.7% considered reduction unlikely and 5.9% very unlikely, reflecting employment-related anxieties consistent with the broader maritime automation literature (Bogusławski et al., 2022; Shahbakhsh et al., 2022; Badawy, 2025).

Responses to the item assessing anticipated effects on respondents' own roles within the next decade yielded a more differentiated picture: 41.2% anticipated new professional responsibilities, 33.3% expected reduced scope of work, 9.8% anticipated role elimination, 9.8% expected no change, and 5.9% anticipated an enhanced role. These data suggest that while the quantitative dimension of maritime employment may contract under MASS, the qualitative character of retained roles will undergo substantial transformation (Shahbakhsh et al., 2022; Xu & Soares, 2026), consistent with Saha's (2023) finding that seafaring experience retains credential value in SCC-based remote operations. Deck officers were identified as the most vulnerable category (36.0%), followed by captains (24.0%), with remaining responses distributed across chief engineers, deck ratings, and engine room personnel.

Skills Gap and Training Readiness

Survey findings pertaining to skills gap perceptions have direct implications for Myanmar's MET policy and institutional planning. When asked to assess the adequacy of current Myanmar maritime training programs for MASS-related competencies, 43.1% of respondents disagreed and a further 15.7% strongly disagreed, indicating that 58.8% considered current MET provision insufficient for the autonomous maritime era. Only 15.7% agreed that existing programs were adequate, with 25.5% neutral. This is consistent with the documented divergence between STCW competency tables and the digital and remote operational requirements of autonomous maritime operations (Belabyad et al., 2025; Xu & Soares, 2026), and with Kim et al.'s (2020) identification of inadequate MET provision as a structural barrier to developing-nation seafarer competitiveness.

With respect to the most critical emerging competencies for MASS operations, 49.0% of respondents identified remote ship monitoring as the single most important skill, followed by maintenance of autonomous systems (31.4%), AI and software management (13.7%), and cybersecurity (3.9%), with 2.0% selecting all listed options. This hierarchy provides an empirical foundation for curriculum reform, indicating that an effective MASS-readiness framework for Myanmar seafarers should prioritize remote operational monitoring, with autonomous systems maintenance and AI literacy as secondary areas (Belabyad et al., 2025; Kilinc, 2025). These priorities correspond closely to the foundational competency requirements identified for SCC operators internationally (Saha, 2023), suggesting that Myanmar seafarers' self-assessments reflect awareness of emerging global standards notwithstanding limited access to formal MASS education.

Notwithstanding these gaps, the data indicated strong willingness to engage with MASS-related training: 72.5% of respondents confirmed they would participate if offered, and 23.5% expressed conditional willingness contingent on cost and accessibility. Only 3.9% declined. Regarding preferred formats, 29.4% favored online delivery, 25.5% favored hybrid formats, 23.5% favored in-person instruction, and 21.6% favored on-the-job apprenticeships,

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suggesting blended delivery models would best accommodate seafarers' schedules and connectivity constraints (Bogusławski et al., 2022). On funding, 47.1% identified the government as the appropriate source, 41.2% identified shipping company employers, and 11.8% identified international organizations such as the IMO or ILO.

Socio-Economic and Remittance Impact Assessments

Given Myanmar's structural dependence on seafarer remittances, the data on socio-economic impact perceptions are of particular policy relevance (Badawy, 2025). A substantial proportion of respondents expressed concern about MASS's potential impact on remittance flows: 60.8% agreed and a further 5.9% strongly agreed that MASS could reduce foreign remittances, a combined agreement rate of 66.7%. Only 5.9% strongly disagreed, while 27.5% were neutral. These data indicate widespread recognition that automation of shipboard functions represents not only a professional risk but an economic threat to communities and households dependent on seafarer income, corroborating Badawy's (2025) cross-national assessment of remittance vulnerability and Xiang et al.'s (2025) observation on the broader socio-economic consequences of MASS for labor-exporting nations.

Assessments of MASS's prospective impact on Myanmar's broader economy were more varied. When asked to evaluate the overall economic impact, 41.2% of respondents selected a neutral position. Among the remainder, 33.3% anticipated a positive economic impact and 3.9% a strongly positive impact, while 19.6% anticipated a negative impact. The distribution of positive assessments may reflect awareness that MASS could, under favorable institutional conditions, generate new forms of maritime employment in SCC operations, autonomous systems maintenance, and maritime cybersecurity even as it reduces demand for traditional shipboard roles (Lee, 2024; Saha, 2023). The high proportion of neutral responses reflects the substantive difficulty of forecasting the net economic effects of a transition whose full implications remain uncertain.

Professional and Social Status Perceptions

Respondents' assessments of MASS's impact on the professional and social status of Myanmar seafarer officers yielded divergent expectations. Approximately 41.2% anticipated a slight improvement in social standing, likely attributable to the expectation that technical competencies associated with autonomous shipping would confer enhanced professional prestige (Belabyad et al., 2025; Kilinc, 2025). Conversely, 33.3% anticipated a slight decline and 3.9% a significant decline, reflecting concern that a shift from active seafaring to shore-based remote operations might diminish perceived social standing, historically tied to seafaring's physical demands, international scope, and substantial remuneration in Myanmar (Bogusławski et al., 2022). The remaining 19.6% anticipated no change in social status.

When asked to rate the overall impact of MASS on Myanmar seafarers on a five-point scale from 1 (not at all significant) to 5 (very significant), the modal response was 2, selected by 41.2% of participants. A further 31.4% selected 3, 9.8% selected 4, 9.8% selected 1, and 7.8% selected 5. This distribution reflects a collective assessment that the impact of MASS, while acknowledged, is perceived as moderate in magnitude and one that will materialize progressively rather than abruptly (IALA, 2024; Lee, 2024), broadly consistent with IALA's (2024) projection that full deployment on the large vessel types employing most Myanmar seafarer officers remains multiple decades away.

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Regulatory, Safety, and Environmental Perceptions

With respect to Myanmar's maritime regulatory readiness for MASS, 39.2% of respondents characterized the country's maritime authorities as only slightly prepared, and 35.3% as not prepared at all, a combined inadequacy assessment of 74.5%. Only 9.8% rated authorities as well-prepared and 2.0% as very prepared, with 13.7% moderately prepared. This is consistent with the literature identifying a significant gap between high-level IMO MASS deliberations and the practical regulatory preparedness of developing maritime nations (Kim et al., 2020; IMO, 2021a; Kilinc, 2025). When asked whether Myanmar's legal framework is adequate to address MASS challenges, 21.6% disagreed and 19.6% strongly disagreed, with only 21.6% agreeing and 3.9% strongly agreeing, while 33.3% were neutral, indicating that legal readiness concerns extend into the broader legal infrastructure governing liability and jurisdiction (Kim et al., 2020; Xu & Soares, 2026).

Regarding safety concerns, cybersecurity risks were identified by 62.7% of respondents as the principal concern, followed by collision risks (13.7%), emergency response delays (11.8%), and reduced human oversight (7.8%). This emphasis is consistent with the NATO Cooperative Cyber Defence Centre of Excellence's (CCDCOE, 2022) assessment that network-dependent autonomous systems present defining cybersecurity vulnerabilities, suggesting an informed appreciation among Myanmar seafarers of autonomous vessels' risk profile. On environmental sustainability, 56.9% agreed and 13.7% strongly agreed that MASS could improve environmental outcomes, a combined agreement rate of 70.6%, consistent with evidence that autonomous shipping can reduce fuel consumption and emissions through optimized route management (ATL Marine & Energy Ltd., 2025). With respect to liability for MASS-related accidents, 35.3% favored a combination of responsible parties, 25.5% identified shipowners, 15.7% technology providers, 15.7% insurers, and 7.8% government, reflecting the complexity of liability attribution absent a finalized international MASS liability framework (Kim et al., 2020).

DISCUSSION

The findings of this study contribute to an emerging body of scholarship indicating that MASS will generate substantial and unequally distributed consequences for seafarer workforces globally, with the most significant impacts concentrated among workers and institutions in developing seafarer-supplying nations (Badawy, 2025; Belabyad et al., 2025). The survey data characterize a professional community that is aware of the technological transition underway, concerned about its employment consequences, conditionally open to emerging professional opportunities, and cognizant of the competency gap separating Myanmar seafarer officers from the requirements of the autonomous maritime era.

The finding that 51.0% of respondents anticipated a reduction in job availability is consistent with employment-related anxieties documented in maritime labor research in other national contexts (Bogusławski et al., 2022; Shahbakhsh et al., 2022). Notably, this concern coexists with a more adaptive set of career expectations: the 41.2% who anticipated new professional responsibilities rather than outright job loss suggests a degree of professional adaptability, resonating with Saha's (2023) argument that experienced seafarers constitute a valuable but underutilized resource for SCC-based remote operations. This must nonetheless be qualified by the substantial barriers Myanmar seafarers currently face in accessing the MASS-relevant training that would render such transitions viable.

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The socio-economic dimension of the findings warrants particular attention. The 66.7% aggregate agreement rate on potential reductions in seafarer remittances reflects recognition that the professional risks of MASS extend beyond individual career outcomes to the financial security of dependents and local communities, corroborating Badawy's (2025) cross-national analysis identifying remittance-dependent communities as among those most exposed to the distributional consequences of maritime automation. The divided assessments of MASS's broader economic impact, with 37.2% anticipating net positive effects alongside dominant remittance-reduction concerns, suggest awareness of both displacement risks and potential economic opportunities (Lee, 2024; Saha, 2023), while the high proportion of neutral responses (41.2%) reflects the difficulty of forecasting consequences whose second-order effects remain uncertain.

The skills gap findings are among the most operationally significant of the study's results. The identification of remote ship monitoring as the priority competency by 49.0% of respondents provides a clear empirical foundation for MET curriculum reform, corroborating the competency hierarchy established by Belabyad et al. (2025). The secondary emphasis on autonomous systems maintenance (31.4%) and AI and software management (13.7%) further defines the parameters of an effective MASS-readiness framework, indicating that digital engineering, AI literacy, and cybersecurity should be integrated into existing officer training curricula. The absence of these elements from the STCW syllabi currently implemented by Myanmar's MET institutions constitutes a structural deficiency that will expand as MASS deployment accelerates (Belabyad et al., 2025; IMO, 2021b). The high training willingness observed (72.5%) is a favorable precondition for reform, indicating that professional resistance to upskilling is not a primary obstacle in the Myanmar context.

The finding that 74.5% of respondents assessed Myanmar's maritime authorities as inadequately prepared to regulate MASS points to a perceived misalignment between the pace of technological change and Myanmar's regulatory capacity, mirroring the global regulatory challenge documented in the IMO's Regulatory Scoping Exercise (IMO, 2021a; Kim et al., 2020). The identification of cybersecurity as the dominant safety concern (62.7%) is consistent with the CCDCOE's (2022) assessment that network-dependent autonomous systems present novel vulnerabilities; that Myanmar seafarers flagged cybersecurity despite its minimal representation in current STCW frameworks suggests an intuitive awareness of systemic risk not yet matched by formal competency provision (Belabyad et al., 2025).

Implications

The findings carry practical implications across three levels: national regulatory policy, maritime education and training, and the practices of international shipping companies employing Myanmar seafarers. At the regulatory level, the Department of Marine Administration (DMA) faces an urgent need to develop a proactive national maritime competency strategy that explicitly incorporates MASS-relevant skills into the certification framework, beginning with aligning existing STCW syllabi with IMO MASS Degree 1 and Degree 2 competency requirements. This would signal engagement with the emerging competency demands of autonomous shipping (IMO, 2021a; Kim et al., 2020) and support Myanmar's bilateral engagement with the IMO during development of the MASS Code, which will define the competency standards remote and autonomous operators must satisfy (IMO, 2021b). The 74.5% of respondents who assessed regulatory authorities as unprepared underscores the scale of the institutional gap that must be addressed if Myanmar is to remain a competitive maritime labor supplier (Kilinc, 2025).

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At the institutional level, the findings justify MET providers investing in new training infrastructure and curricula without waiting for the MASS Code to be finalized. Myanmar Maritime University, Myanmar Mercantile Marine College, and accredited private training centers should prioritize Remote Control Center simulation facilities and faculty expertise in digital maritime systems, AI-supported navigation, and maritime cybersecurity, benchmarking against voluntary MASS-readiness programs already operating in Norway, the United Kingdom, the United States, and Australia (Kilinc, 2025). The strong training willingness evidenced here (72.5%) confirms demand for such provision, and given that 29.4% preferred online delivery and 25.5% preferred hybrid formats, providers should explore flexible, technology-enabled delivery models suited to seafarers deployed internationally (Bogusławski et al., 2022). On funding, 47.1% identified government and 41.2% identified employers, suggesting a co-investment model between the DMA and shipping companies should be explored through structured stakeholder dialogue (Badawy, 2025).

At the industry level, international shipping companies that recruit Myanmar officers have both a practical and ethical interest in this transition. Companies that invest in structured MASS-related upskilling will preserve institutional knowledge and operational experience while developing the competency profiles required for future SCC-based operations (Saha, 2023); the alignment between Myanmar seafarers' self-assessed competency priorities and international SCC operator demands suggests that the professional capital of experienced officers is transferable when systematic retraining pathways are provided. Companies defaulting to recruitment from nations with more advanced MET infrastructure risk both organizational knowledge loss and accelerated labor market exclusion for Myanmar's seafaring community (Belabyad et al., 2025). More broadly, as Xu and Soares (2026) note, autonomous shipping raises unresolved questions about liability, insurance, and flag state jurisdiction requiring coordinated international responses; developing nations such as Myanmar cannot address these unilaterally, and their interests must be represented within IMO working groups to ensure the emerging regulatory architecture does not reproduce existing inequalities in the maritime labor market (Xiang et al., 2025).

Limitations and Directions for Future Research

Several limitations constrain the generalizability of the present findings. The most significant is sample size: while the 51 respondents constitute a substantive and internally differentiated cross-section of Myanmar seafarer officer perspectives, this figure is modest relative to the estimated population of approximately 60,000 active Myanmar seafarer officers serving internationally (DMA, 2024). The purposive sampling strategy, appropriate to the exploratory nature of the inquiry, does not produce a probability-based representative sample, so extrapolation to the broader population should be undertaken with caution (Bogusławski et al., 2022). A second limitation concerns survey language: although English serves as the operational lingua franca of international maritime employment and was therefore selected as the instrument language, most respondents communicated in English as a second or third language, and comprehension of particular item stems may have varied in ways that introduced unmeasured error. A third limitation is the cross-sectional design, which captures perceptions at a single point in time and cannot account for how these may evolve as technologies advance and regulatory instruments develop (Belabyad et al., 2025; Lee, 2024). A fourth concerns reliance on self-reported data, subject to well-documented limitations including social desirability bias and divergence between self-assessed and objectively

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measured capability (Shahbakhsh et al., 2022); the study captures perceptions of readiness rather than demonstrated readiness.

These limitations point toward several productive directions for future research. Longitudinal survey designs tracking the evolution of Myanmar seafarer officers' MASS awareness, competency self-assessments, and employment outcomes would yield a dynamic understanding that the present cross-sectional approach cannot provide (Belabyad et al., 2025; Xiang et al., 2025), and would help establish whether the perceived urgency of training reform increases as the anticipated 10- to 20-year adoption timeline approaches, or whether complacency persists absent institutional intervention (Kim et al., 2020). Comparative research encompassing seafarer populations from other developing seafarer-supplying nations, including the Philippines, Indonesia, India, and Bangladesh, would enable systematic evaluation of whether the patterns observed in Myanmar generalize or reflect country-specific institutional structures (Badawy, 2025), supporting recommendations applicable to this broader category of nations (Belabyad et al., 2025). Qualitative research, including interviews and focus groups with senior officers, MET faculty, DMA officials, and shipping company human resource managers, would complement these findings by revealing the institutional logics and resource constraints shaping Myanmar's capacity to respond to the transition (Xiang et al., 2025; Saha, 2023). Institution-level research examining curriculum content, simulation capabilities, and faculty and financial resources would provide the granular evidence needed for costed curriculum reform recommendations (Kilinc, 2025). Finally, research examining shipping companies' intentions to retain, retrain, or replace Myanmar seafarers would provide a demand-side complement to the supply-side perspective captured here, informing co-investment frameworks between government, industry, and MET institutions (Saha, 2023; Xu & Soares, 2026).

CONCLUSION

This study provides foundational empirical evidence on the perceptions, competency gaps, and socio-economic concerns of Myanmar seafarer officers in the context of the global transition toward Maritime Autonomous Surface Ships. The findings characterize a professional community that is aware of the technological transformation underway, genuinely concerned about its employment and remittance consequences, and conditionally willing to engage with the upskilling required to navigate that transition, provided that accessible and affordable pathways are established. The identification of remote ship monitoring, autonomous systems maintenance, and AI literacy as priority emerging competencies, alongside widespread recognition that existing Myanmar maritime education and training programs are inadequate for the autonomous era, constitutes a direct empirical mandate for institutional reform at the levels of national regulatory policy, maritime training provision, and industry practice. Myanmar's seafaring workforce retains the operational experience, international professional orientation, and self-awareness of its own competency gaps that are necessary preconditions for a managed and equitable transition; whether those attributes translate into a sustainable competitive position in the evolving global maritime labor market will ultimately depend on the quality and timeliness of the coordinated policy, institutional, and industry responses that evidence of this kind is intended to inform.

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Acknowledgment

The author(s) appreciates all those who participated in the study and helped to facilitate the research process.

Conflict of Interest

The author(s) declared no conflict of interest.

How to cite this article: Thant, M. M. & Kyriakou, S. (2026). The Socio-Technical Impact of Maritime Autonomous Surface Ships (MASS) on Myanmar Seafarer Officers: An Empirical Analysis of Readiness and Competency Gaps. *International Journal of Social Impact*, 11(3), 243-261. DIP: 18.02.022/20261103, DOI: 10.25215/2455/1103022