

Autonomous Shipping and the Seafarer of the Future: Requisite Hybrid Skills and Maritime Education Adaptation

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Available Online: August 2026
Revised: July 2026
Accepted: July 2026
Received: June 2026

Volume IV Issue 3 (2026)
DOI: 10.5281/zenodo.22045655
E-ISSN: 2984-7184
P-ISSN: 2984-7176
<https://getinternational.org/research/>

ABSTRACT

This study aimed to describe the perceptions of maritime instructors at the Asian Institute of Maritime Studies (AIMS) on the impact of Maritime Autonomous Surface Ships (MASS) technology on future seafaring careers. Using a qualitative-descriptive research design, data were collected from a purposive sample of four (N=4) maritime instructors through a combination of online surveys and face-to-face interviews. The findings reveal mixed perceptions characterized by optimism about automation's potential to enhance operational efficiency and safety, alongside concerns about job displacement and the irreplaceable role of human seamanship. Key thematic insights include a shift towards hybrid skill sets integrating traditional maritime knowledge with advanced digital and technical competencies, significant readiness gaps in current Maritime Education and Training (MET) programs, and financial and regulatory barriers limiting adaptation. The main takeaway highlights the transformation of seafaring careers rather than their elimination, underscoring the critical need for urgent curriculum reform, continuous faculty development, and stronger policy frameworks. These measures are essential to effectively prepare future seafarers to thrive in the evolving automated maritime industry.

Keywords: *Maritime Education, Autonomous Shipping, Maritime Instructors, Future Seafaring Careers, Skills Development, Maritime Autonomous Surface Ships*

Recommended Citation:

Arce, J. M., Balase, D. C., Barrameda, J. R. D., Olega, P. M., & Pael, N. S. (2026). Autonomous shipping and the seafarer of the future: requisite hybrid skills and maritime education adaptation. *GET International Research Journal*, 4(3), 50–56. <https://doi.org/10.5281/zenodo.22045655>

INTRODUCTION

Technological advancements have continually shaped the maritime industry, from the introduction of steam engines in the 18th century to the digital revolution of the 21st century. Most recently, the introduction of Maritime Autonomous Surface Ships (MASS) offers profound opportunities and challenges to maritime operations, safety, and career trajectories. MASS ranges from ships with automated processes but manned control to fully autonomous vessels without onboard crews.

The global shipping sector is transitioning into an era characterized by automation, digital integration, and human-machine collaboration. This industrial shift is deeply rooted in the framework of the United Nations Sustainable Development Goals (SDGs). Specifically, this research intersects with SDG 9 (Industry, Innovation, and Infrastructure), SDG 4 (Quality Education), and SDG 8 (Decent Work and Economic Growth). The rapid adoption and integration of autonomous ship technologies directly support SDG Target 9.5, which aims to enhance scientific research and upgrade the technological capabilities of industrial sectors **(United Nations, n.d.-c)**. Furthermore, as technological disruptions require seafarers to acquire new hybrid competencies, the necessary curriculum modernization within Maritime Education and Training (MET) institutions fulfills SDG Target 4.4, which seeks to substantially increase the number of youth and adults who have relevant technical and vocational skills for employment and decent jobs **(United Nations, n.d.-a)**. Finally, navigating workforce adaptation, mitigating potential job displacement, and maintaining productivity amidst automation align directly with SDG Target 8.2, which emphasizes achieving higher levels of economic productivity through technological upgrading and innovation **(United Nations, n.d.-b)**.

This evolution mirrors broader industrial revolutions from Industry 1.0 through 4.0 and ventures toward Industry 5.0 emphasizing personalized human-centric automation. This evolution portends significant implications for seafaring careers. While automation is posited to optimize efficiency and safety by taking on repetitive, hazardous, or complex tasks, concerns emerge regarding job displacement, skill obsolescence, and requisite educational reform. The maritime sector demands seafarers who can wield hybrid competencies, combining traditional seamanship with advanced skills in information technology, artificial intelligence (AI), cybersecurity, and remote operations **(Pundars, 2020)**.

Despite extensive studies on cadets' and seafarers' perceptions of automation, scant research exists capturing maritime instructors' perspectives—critical stakeholders responsible for educating the next generation of seafarers **(Boguslawski et al., 2022; Belabyad et al., 2025)**. This study seeks to fill this gap by examining AIMS maritime instructors' perceptions on the impact of autonomous shipping on future seafaring careers. Their insights can inform Maritime Education and Training (MET) institutions and policymakers on essential education reforms and competency frameworks.

While previous research has examined technological impacts on seafarers and cadets **(Boguslawski et al., 2022)**, the evolving role and preparedness of maritime educators themselves remain under-explored. Understanding instructors' views helps reveal readiness challenges in MET curricula and institutional capacity, especially in developing countries like the Philippines where seafarers are critical to the national economy **(Nepa, 2021)**.

Objectives

This study aims to describe maritime instructors' perceptions of MASS and its effect on seafaring careers to contribute nuanced insights that can guide curriculum modernization, faculty capacity-building, and regulatory policy. Specifically, it sought to answer the following questions:

1. What is the perception of maritime instructors on autonomous ships?
2. What is the perception of maritime instructors on the impact of autonomous ships on future seafaring careers?
3. What are the implications of autonomous ship technology for the preparation and training of future seafarers in terms of:
 - a. Equipment availability and;
 - b. Technical expertise of the faculty

METHODS

This exploratory study employed a qualitative descriptive-survey approach, well suited to capturing detailed and nuanced instructor perceptions about the emergent MASS technologies and their career impacts. This design facilitates a comprehensive description of instructors' views on complex phenomena without hypothesis testing.

Participants

A purposive sample of four maritime instructors teaching maritime-related courses at AIMS during the 2025–2026 academic year was selected. These instructors were chosen for their experience in maritime education and insight into industry training needs. Although the sample size limits the breadth of generalization, it offers depth into instructors' perspectives at a leading Philippine MET institution.

Data Collection

Data were gathered via a semi-structured questionnaire administered online through Google Forms and supplemented by in-depth interviews conducted onsite and virtually as per participants' availability. Open-ended questions encouraged instructors to elaborate on their perceptions of autonomous ship technology's implications on seafaring roles, skill requirements, and MET adaptation.

Data Analysis

Thematic analysis framework was applied: transcripts and open-ended responses were coded inductively to identify recurrent themes representing instructors' perceptions. Themes were iteratively refined and reviewed by the research team to ensure validity. Quotes were translated where necessary and integrated into the analysis textually.

Ethical Considerations

Participants volunteered informed consent and confidentiality was assured. The small sample size necessitates careful anonymization to protect identities.

Limitations

The primary methodological limitation is the small sample size (N=4), which restricts generalizability. The findings should be viewed as an initial in-depth exploration. Further research with larger and diverse samples is recommended.

RESULTS

Theme 1: Recognition of Autonomous Shipping as Inevitable and Beneficial

All participants acknowledged the inevitability of autonomous shipping technology in the global maritime industry. One instructor expressed, "It is inevitable...good because automation handles tedious tasks, optimizes routes, and reduces risks." This aligns with literature framing MASS as a natural progression under Industry 4.0 innovations.

Automation was seen as particularly valuable for mitigating repetitive and high-risk onboard duties. Yet, despite optimism, participants signaled cautious enthusiasm contingent on effective human-machine cooperation.

Theme 2: Emphasis on the Irreplaceable Role of Human Seamanship

Instructors unanimously emphasized that while automation supports operations, human skill and judgment remain irreplaceable. A participant noted, "*Seamanship is irreplaceable... automation should not replace the presence of crew because manual intervention is necessary during failures or storms.*" This echoes findings by **Belabyad et al. (2025)** and **Chan et al. (2025)** regarding continued reliance on human decision-making for safety.

Theme 3: Future Seafaring Careers Require Hybrid Competencies

Participants agreed future seafarers must develop hybrid skills combining traditional maritime knowledge with digital literacy, AI system handling, cybersecurity, and remote operation capacities. One remarked, "Traditional seamanship will remain important but must be paired with new digital and technical competencies." This concurs with **Mallam and Sharma (2020)**, who call for expanded competencies encompassing human-machine interfaces (HMI) and AI.

Theme 4: Potential Job Displacement and Restructuring of Seafaring Roles

Members expressed concerns about possible displacement of traditional positions due to automation. The shift to shore-based control centers may reduce onboard crew numbers, impacting Filipino seafarers' employment. A respondent lamented, "If ships become fully automatic, where will seamen go?" These concerns reflect broader industry debates about balancing efficiencies and social impact (**Mallam & Sharma, 2020**).

Theme 5: Training Barriers—Cost and Limited Access

Respondents identified expensive specialized training and limited institutional resources as major barriers. One stated, "*Additional training is needed, but adaptation and skill updating are pricey and often available only through company support.*" This suggests inequities affecting seafarers' continuous learning opportunities.

Theme 6: Philippine MET and Regulatory Readiness Gaps

Instructors perceived Philippine MET institutions and government regulatory bodies—as represented by MARINA—as currently unprepared for autonomous shipping integration. Comments such as “The Philippine MET system is not ready—it needs an overhaul to incorporate AI, cybersecurity, and remote operation” highlight urgent systemic modernization needs. This resonates with **Nepa (2021)** and **De Silva-Lucencio (2022)**, who document curricular and infrastructural deficits.

DISCUSSION

The findings of this study reveal critical insights into how autonomous shipping is perceived by maritime instructors and its implications for future seafaring careers and Maritime Education and Training (MET) in the Philippines. A key theme emerging from the data is the acknowledgment of autonomous ship technology as an inevitable transformation that demands not only updated technical skills but also significant adaptation within MET institutions.

This transformation presents urgent challenges that directly intersect with ongoing policy frameworks, particularly the Maritime Industry Development Plan (**Presidential Communications Office, 2024**). MIDP 2028 underscores the modernization of the Philippine maritime sector through digitalization and skills enhancement, but our findings suggest that practical implementation lags behind policy aspirations. Maritime instructors highlight a pressing need for curriculum reform to integrate topics such as artificial intelligence, cybersecurity, remote operations, and human-machine interface skills—areas currently underrepresented in MET programs. Without such advancements, Filipino seafarers risk losing their competitive edge in a global workforce increasingly defined by automation.

Moreover, the role of the Maritime Industry Authority (MARINA) emerges as pivotal in bridging this gap. The instructors pointed to the necessity for MARINA to update certification standards and training requirements to encompass autonomous shipping technologies. This aligns with MIDP 2028’s call for stronger regulatory frameworks and capacity building to support the sector’s digital transition. However, concerns remain regarding MARINA’s ability to implement these changes effectively, given the rapid pace of technological innovation and the complexities of international regulatory alignment.

The financial barrier for updating training facilities and providing specialized education also carries significant policy implications. The study highlights that access to specialized training in autonomous ship technology remains limited and costly, potentially exacerbating inequalities among maritime students and professionals. This echoes broader concerns about equitable access raised in policy discussions, suggesting that MARINA and educational institutions must collaborate to develop inclusive training programs and allocate resources strategically.

In sum, this study provides empirical support for the Philippine government’s ongoing efforts to position the country as a leader in the digital maritime economy. By integrating instructors’ perspectives, policymakers can better understand the concrete educational and regulatory challenges that must be addressed to realize the goals set out in MIDP 2028. Strengthening MET curricula, enhancing faculty expertise, ensuring equitable training access, and timely regulatory updates under MARINA’s stewardship are critical steps for preparing Filipino seafarers for the future maritime landscape shaped by autonomous shipping.

CONCLUSION

Based on the findings of the study, the following conclusions are drawn:

1. Maritime instructors at the Asian Institute of Maritime Studies (AIMS) perceive autonomous ships as an inevitable technological advancement that brings both benefits and risks to future seafaring careers. While automation is recognized for improving efficiency and reducing human error, instructors strongly believe that human seamanship, judgment, and manual intervention remain essential due to potential system failures, adverse weather conditions, and cybersecurity threats.
2. Instructors view seafaring careers as transforming rather than disappearing. Traditional shipboard roles, particularly navigational positions, are expected to decline or shift to shore-based operations, increasing concerns over job security for those unable to adapt. Consequently, future seafarers will need hybrid competencies that combine traditional maritime knowledge with advanced digital and technical skills to remain competitive in the evolving maritime industry.

RECOMMENDATIONS

1. Maritime Education Institutions, particularly the Asian Institute of Maritime Studies (AIMS), should prioritize addressing the financial barriers associated with autonomous ship technology training. They need to seek partnerships with industry stakeholders and government agencies to provide affordable or subsidized specialized training programs that ensure equitable access for all students.
2. Incorporate actionable faculty development initiatives by establishing mandatory industry-academia collaborations, creating dedicated training tracks focused on emerging areas such as cybersecurity, human-machine interfaces (HMI), and remote operations, and forming research groups committed to autonomous shipping technologies. This will enable instructors to remain current and effectively deliver cutting-edge knowledge.
3. Update maritime curricula to balance traditional seamanship skills with modern automation competencies, emphasizing hybrid skill development that prepares students for both onboard and shore-based roles in an automated maritime environment.
4. Encourage maritime students to adopt a proactive learning attitude by participating in training, simulations, and continuous upskilling programs that enhance their technical and practical capabilities, ensuring readiness for the evolving demands of autonomous maritime operations.
5. The Philippine Maritime Industry Authority (MARINA) should strengthen policies and regulatory frameworks that clearly define certification, training, and competency standards tailored for autonomous ship technology integration. This includes guidelines that address equitable training access and long-term career sustainability for maritime professionals.
6. In discussions about autonomous ships' impacts, maintain a balanced perspective acknowledging both potential risks such as job displacement and safety concerns, and the transformative opportunities including enhanced safety and emerging new roles. This approach supports effective risk management and career adaptation strategies for seafarers.

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